THE LARGER INVERTEBRATE FOSSILS OF THE NAVARRO GROUP OF TEXAS

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## THE LARGER INVERTEBRATE FOSSILS OF THE NAVARRO GROUP OF TEXAS

# (Exclusive of Corals and Crustaceans and Exclusive of the Fauna of the Escondido Formation)

By

### LLOYD WILLIAM STEPHENSON

Bureau of Economic Geology E. H. Sellards, Director



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PUBLISHED BY THE UNIVERSITY FOUR TIMES A MONTH AND ENTERED AS SECOND-CLASS MATTER AT THE POST OFFICE AT AUSTIN, TEXAS, UNDER THE ACT OF AUGUST 24, 1912 The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

#### Sam Houston

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

Mirabeau B. Lamar

#### ~ DCAR7 SACERSITT **TEXAS**

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#### ERRATA

In Table 2 and in Table 5, Part 2 (in pocket), the name Cerithium simpsonensis should read Cerithium simpsonense.

In Table 3 and in Table 5, Part 1 (in pocket), the name Micraster (Plesiaster) americana should read Micraster (Plesiaster) americanus.

In Table 4 and in Table 5, Part 2 (in pocket), the name Ringicula culbertsoni should read Ringicula culbersoni.



An unusually large specimen of *Baculites Claviformis* Stephenson from the Nacatoch sand near Kaufman, shown with its collector, Dr. T. W. Stanton.

### THE LARGER INVERTEBRATE FOSSILS OF THE NAVARRO GROUP OF TEXAS LLOYD WILLIAM STEPHENSON

#### INTRODUCTION

The project to monograph the fossils of the Navarro group of Texas had its inception in April, 1928, when Dr. E. H. Sellards, then the Associate Director of the Bureau of Economic Geology of The University of Texas, asked me informally to undertake the preparation of a treatise on this subject. The terms of a formal agreement subsequently entered into provided that I should prepare a monograph, under the auspices of the United States Geological Survey, to be entitled, "The larger invertebrate fossils of the Navarro group of Texas," and that the Federal Survey should transmit the completed manuscript to Doctor Sellards for publication under the auspices of the Bureau of Economic Geology.

Work was begun on the monograph in the summer of 1928 and the routine of handling, identifying and describing the fossils, assembling the synonymies of previously described species, selecting the types and other specimens to be illustrated, preparing the plates, writing the introductory and general matter, and reading the typed manuscript and the printer's proof, was carried on at such times as other official duties permitted; considerably less than half of the working time elapsed since the beginning of the project was given to its furtherance, a fact that explains the seemingly long time required for its completion.\*

At the time the project was begun, the Navarro was classed as a formation, but later the unit was found to be divisible into four parts, each of the rank of formation, and the name Navarro was raised to the rank of group. The parts were named, in ascending order, Neylandville marl, Nacatoch sand, Corsicana marl, and Kemp The present treatise includes these clay. formations in its scope, but does not include the Escondido formation of the Rio Grande region, which since 1935 has been considered a unit of the Navarro group. The Escondido, though known to be of upper Navarro (Kemp) age, carries a facies fauna many elements of which are unlike the fauna of the Kemp clay. At

\*Aid in completing this publication has been received from The University of Texas Research Institute funds. the time the Escondido was accepted as a formational unit of the Navarro group the preparation of the monograph was well advanced, and to have added the Escondido fauna would have materially increased the already large size of the work and would have unduly delayed its publication.

The groups of invertebrate organisms included in the scope of this monograph are Porifera (sponges), Vermes (worms), Echinodermata (echinoids and one crinoid), and Mollusca (bivalves, toothshells, univalves, and chambered shells).

In a study covering as numerous and varied forms of life as are contained in the sediments of the Navarro group, many genera and species of which are imperfectly preserved and meagerly represented, an author obviously can not treat his subject as critically and thoroughly as he would were he dealing with only one family, or a few closely related families, represented by an abundance of material. Nevertheless a serious attempt has been made to place the species in their proper genera, and new genera have been erected to hold those species not assignable to previously described -genera.

The bulk of the collections studied were those bearing the collection numbers of the United States Geological Survey and the catalogue numbers of the United States National Museum; to these were added important collections furnished by the Bureau of Economic Geology of The University of Texas. Among the personnel of the Bureau to whom I am indebted for fossil material, or for other courtesies and favors, are the present Director, Dr. E. H. Sellards, Prof. F. B. Plummer and Mrs. Plummer, Drs. W. S. Adkins and H. B. Stenzel, and Miss Gene Ross; particular mention should be made of collections obtained by Doctor Sellards in Bexar County, and by Miss Ross in Navarro County.

Such measure of success as may have attended my endeavor to make this treatise authoritative must be attributed in no small part to contemporaries, who have collaborated generously in matters pertaining to the identification, the taxonomy, the nomenclature, and the stratigraphic significance of the fossil organisms under investigation. Among the persons who have thus been especially helpful are Doctors T. W. Stanton, J. B. Reeside, Jr., Ralph B. Stewart, Julia Gardner, W. P. Woodring, Lloyd G. Henbest, Rowland W. Brown, Arthur G. Cooper, and the late W. C. Mansfield, and Mr. F. Stearns MacNeil.

Dr. Paul Bartsch, Curator of Mollusks and Cenozoic Invertebrates of the National Museum, has placed at my disposal the extensive collections of the Museum for comparison with the Navarro forms, and has also made available the fine library of the late Dr. Wm. H. Dall; Dr. Harald A. Rehder, Assistant Curator of the Division of Mollusks, has given generously of his time in helping me to find some of the rare books in this library, in which certain of the earlier genera were described.

Many of the Navarro species are identical with, or closely related to, Upper Cretaceous species described by earlier American paleontologists, including S. G. Morton, T. A. Conrad, W. M. Gabb, R. P. Whitfield, Stuart Weller, and others. The principal depository of the types of these species is the Academy of Natural Sciences of Philadelphia. Two visits were made to the Academy to compare the Texas shells with these types, and I gratefully acknowledge the many courtesies extended to me by the officials and custodians of the collections, especially by Dr. H. A. Pilsbry, Dr. B. F. Howell, and Miss Anne Harbison. Others of the types are kept in the State Museum at Trenton, N. J., the American Museum of Natural History, New York City, and the Field and Walker Museums, Chicago: to the officials of these institutions. I am also grateful for the opportunity to study these types.

An important factor in the success of an undertaking of this sort is the technical assistance one receives in matters relating to presentation. The major portion of the manuscript was typed by Miss Nell L. Bowen of the secretarial staff of the Geological Survey, who also gave painstaking attention to the checking of collection numbers, the securing of uniformity and consistency in punctuation, the form of citations, and the wording of locality descriptions, and to many other Most of the specimens selected details. for illustration were photographed by Mr. N. W. Shupe, and retouching was done by Miss Frances Wieser, both of the Federal

Survey. Valuable assistance in the preparation of the illustrations and the tables of range and distribution was rendered by the following personnel of the Geological Survey: Miss Mary F. Bugbee, Editor; Mr. G. W. Stose, Map Editor; Mr. C. A. Weckerly, Chief Illustrator; Mr. F. J. Burrows, Chief Engraver; and the efficient members of their staffs.

The Navarro group contains an abundance of fossil marine organisms. The nucleus of the fossil material on which the present work is based is a collection from the Nacatoch sand made by Dr. Charles A. White and Mr. C. B. Boyle more then fifty years ago (Oct. 1887), on Postoak Creek at the north edge of Corsicana, Navarro County. Three years later (1890) Dr. T. W. Stanton made extensive collections from the Nacatoch sand in the vicinity of Corsicana and Chatfield. Navarro County, and near Kaufman, Kaufman County, and from the Kemp clay in Travis County. During subsequent years additions to these early collections were made from time to time by others as indicated in the detailed locality descriptions. Donations received included collections from several localities in Hunt County, presented by Mr. and Mrs. D. A. Saunders; one large ammonite, here named Parapachydiscus scotti, from the Nacatoch sand in Navarro County, presented by Dr. Gavle Scott: a fine piece of richly fossiliferous sandstone from the Nacatoch sand in Hunt County, presented by Mr. F. B. Plummer: and a large nautiloid, Eutrephoceras planoventer Stephenson, from the Nacatoch sand in Navarro County, presented by Mr. W. A. Bramlette.

The classification, distribution, and range of the fossils are discussed on following pages. The distribution and range are also given in tabular form (tables 1 to 6). The fossils are systematically described and illustrated in a subsequent section. The places at which the fossils were collected are shown in a series of small maps, figures 3 to 10.

## CLASSIFICATION OF THE NAVARRO GROUP

The historical development of the nomenclature of the Navarro group and its subdivisions was briefly outlined by Ad-

kins in 1933.<sup>1</sup> Shumard<sup>2</sup> in 1861 applied the name Navarro rather loosely to fossiliferous beds in Navarro County. He said: "The fossils from Navarro come from an interesting series of beds not hitherto recognized in Texas. Most of them were obtained from septariae imbedded in blue and gray arenaceous clavs." Although Shumard made several references to the Navarro beds he apparently had no intention of formally proposing Navarro as the name of a geologic unit, for in no less than 16 of the Navarro County locality descriptions he ascribes the source of the fossils to the Ripley group, to which unit he obviously intended to refer the fossiliferous beds in Navarro County.

Navarro was first formally introduced as a unit name by Hill<sup>3</sup> in 1887; in a tabular classification of the Cretaceous sediments of east-central Texas he applied the name Navarro beds to all the strata intervening between the "Dallas limestone" (= Austin chalk) below and the basal Tertiary above; the Navarro unit therefore included the *Exogyra ponderosa* marl (= Taylor marl).

In 1892 Hill<sup>4</sup> gave to the Exogyra ponderosa marl the geographic name Taylor marl, thus by inference restricting the Navarro to the Cretaceous beds above that zone, which, however, he called the "Uppermost or Glauconitic Division." Hill in 1901<sup>5</sup> applied the name Navarro formation to the strata lying between the Taylor formation (= Exogyra ponderosa marl) below and the Eocene (= Paleocene according to present classification) strata above, thus definitely restricting the name Navarro to the unit now known as the Navarro group. In the same publication the names Corsicana beds and Kemp clay beds

<sup>4</sup>Hill, R. T., Artesian investigations, final report, pt. 3, pp. 73-74, 52d Congr., 1st sess., Ex. Doc. 41, pt. 3, 1892. were proposed as subdivisions of the Navarro formation in the area between North Sulphur River in Delta County, and Brazos River in Falls County. The stratigraphic limits of these units were not Precisely defined, but the geographic distribution given for the Corsicana beds indicates that this unit included in its upper part the Corsicana marl (restricted) of the present report. Presumably the Kemp clay beds included the remainder of the Navarro to the base of the overlying Midway group of the Paleocene. The present usage of Kemp seems therefore to conform approximately to Hill's original usage.

The belt of ountcrop of the Navarro group in Texas is shown in figure 1.

The principal subdivisions of the Upper Cretaceous or Gulf series now recognized in east-central Texas are graphically shown in figure 2.

The four subdivisions of the Navarro group in east-central Texas, indicated above, were suggested by me in a note quoted by Adkins (1933),<sup>6</sup> and these names were adopted by the United States Geological Survey for the coöperative geologic map of Texas published in 1937, and for the Cretaceous correlation chart prepared by geologists of the United States Geological Survey, under the auspices of the National Research Council, in 1941.7 The name Nacatoch sand was first used by A. C. Veatch in 1905<sup>8</sup> for a marine sand formation in southwestern Arkansas, and the Nacatoch sand of Texas is the equivalent of the Arkansas unit.

From Bexar County westward the Navarro group is represented only by the Escondido formation, a unit which, though of the age of the Kemp clay, nevertheless possesses certain distinctive lithologic and faunal characteristics. The fauna of the Escondido is not included in the scope of the present monograph.

<sup>&</sup>lt;sup>1</sup>Adkins, W. S., The Mesozoic systems in Texas: Univ. Texas Bull. 3232, Geology of Texas, vol. 1 (Stratigraphy), pp. 480-481, 516, 1933.

<sup>&</sup>lt;sup>2</sup>Shumard, B. F., Descritions of new Cretaceous fossils from Texas: Boston Soc. Nat. Hist. Proc., vol. 8, pp. 188-205, 1861.

<sup>&</sup>lt;sup>3</sup>Hill, R. T., The Texas section of the American Cretaceous: Am. Jour. Sci., 3d ser., vol. 33, p. 298, 1887. See also White, C. A., Acad. Nat. Sci. Philadelphia Proc., vol. 39, p. 40, 1887.

<sup>&</sup>lt;sup>5</sup>Hill, R. T., Geography and geology of the Black and Grand prairies, Texas: U. S. Geol. Survey 21st Ann. Rept., pt. 7, pp. 338-345, 1901.

<sup>&</sup>lt;sup>6</sup>Op. cit., p. 516.

<sup>&</sup>lt;sup>7</sup>Stephenson, L. W., King, P. B., Monroe, W. H., and Imlay, R. W., Correlation of the outcropping Cretaceous formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas: Bull. Geol. Soc. Amer. (in press).

<sup>&</sup>lt;sup>8</sup>Veatch, A. C., The underground waters of northern Louisiana and southern Arkansas: Louisiana Geol. Survey Bull. 1, pp. 84, 85, 87-88, 1905. [Underground waters of] Louisiana and southern Arkansas: U. S. Geol. Survey Water-Supply Paper 114, pp. 180, 183, 1905.



Fig. 1. Map showing the helt of outcrop of the Navarro group in Texas, and index map showing the location of areas covered by a series of small maps (figures 3 to 10) on which are plotted the localities at which the fossils treated in this report were obtained.

#### GENERAL FEATURES OF THE GROUP

The sediments composing the Navarro group were deposited in marine waters probably not exceeding 100 fathoms in depth, but for the most part deep enough to escape disturbance by wave action. The materials consist mainly of massive or only feebly bedded marls, chalky marls, clays, and sands, with subordinate indurated, concretionary masses or layers cemented with calcium carbonate; cross bedding has been observed in some of the sand beds and in places the broken condition of the fossil shells indicates that locally the sediments were laid down in the zone of active wave action. Bentonite forms a minor, though well distributed, part of the group. The aggregate thickness of these sediments is estimated to range from 550 to 750 feet or more.

The group appears in surface outcrops in Texas in a belt 1 to 23 miles wide (figure 1) extending from Red River valley in Bowie County in the northeast, westward to Hunt County, thence southward and southwestward to Rio Grande valley in Maverick County. The belt is in general gently rolling, becoming moderately hilly only where underlain by the relatively more resistant sandy facies of the group, and in the breaks of the larger streams crossing the belt. Most of the area is under cultivation. The belt is exceptionally wide in Hunt County and in Maverick County, due to the flattening out of the strata composing the group in those areas; elsewhere the belt is much narrower, decreasing in places to a mile or less, as in Bexar County and in southern Uvalde County, where the section is partly, and in places completely, cut out by faulting. In east-central Texas the belt forms the eastern part of the physiographic division known as the Black Prairies.

The marls, clays, and sands composing the group weather to gray and black soils and subsoils that blanket and effectually conceal the true nature of the formations, except in fresh exposures afforded by the banks and bluffs of streams, gullies and bald spots in the fields, and artificial excavations such as road and railroad cuts and ditches. Because of this covering of weathered materials the differentiation and mapping of the formations of the group has been a slow, laborious process, requiring long continued search for such exposures of the strata as are available for study.

The five formations of the group indicated on a previous page have been satisfactorily differentiated and mapped, not in detail, but in a somewhat generalized fashion (geologic map, 1937), from Hunt County to the Rio Grande in Maverick County; from Hunt County eastward



Fig. 2. Generalized section showing the position of the Navarro group in the Upper Cretaceous (Gulf) series, in east-central Texas, and the relation of the group to the overlying Paleocene series.

to Bowie County the different formations of the group have been recognized in scattered outcrops, but their distribution has been inadequately determined, and the undifferentiated group as a whole is represented on the map. Throughout the area of the group in Texas the mapping of the finer details of the boundaries and the recognition and tracing of individual beds and fossil zones within the formations, still remains to be done. The fossils are not uniformly distributed throughout the group, some parts of each of the formations being barren, or nearly so, of the remains of macroscopic organisms; in some layers, lenses, and concretionary masses these larger fossils are present in greater or less abundance. Because of the inadequacy of the field work it has not been possible to indicate the exact zonal position of many of the individual fossil collections, but so far as possible the distance of each lot above the base or below the top of the containing formation



Fig. 3. Map showing fossil localities of the Navarro group in Bowie and Red River counties. Collection numbers of the United States Geological Survey are placed adjacent to the locality symbol (X).



Fig. 4. Map showing fossil localities of the Navarro group in Franklin, Hopkins, and Delta counties. Collection numbers of the United States Geological Survey are placed adjacent to the locality symbol (X). TxU

is stated. The possibility of differentiating zones within the formations is recognized. The places at which the fossils were collected are shown on a series of small maps, figures 3 to 10; figure 1 (p. 8) is an index map showing the geographic position of the areas covered by these maps, with respect to the belt of outcrop of the group. The numbers given on the maps are the collection numbers of the United States Geological Survey, except as otherwise indicated.

Groups of invertebrate organisms not included in the scope of this work are Foraminifera, Ostracoda, Bryozoa, Coelenterata (corals), and Arthropoda (crustaceans, etc.).

Nine species of corals from the Navarro group are described (or redescribed) by Wells.<sup>9</sup> They are: *Trochocyathus woolmani* Vaughan, from the Neylandville marl  $2\frac{1}{2}$  miles north of Corbet, Navarro County (U.S.G.S.coll. 16170), and  $3\frac{1}{2}$ miles west-northwest of Corsicana (U.S.

<sup>10</sup>Wells, John W., Corals of the Cretaceous of the Atlantic and Gulf Coastal Plains and Western Interior of the United States: Bull. Am. Paleontology, vol. 18, no. 67, 200 pp. (vol. pp. 83-288), 16 pls., 1933.



Fig. 5. Map showing fossil localities of the Navarro group in Hunt, Collin, and Rockwall counties. Numbers adjacent to the locality symbol (X) are the collection numbers of the United States Geological Survey except as otherwise indicated.



Fig. 6. Map showing fossil localities of the Navarro group in Kaufman and Navarro counties. Numbers adjacent to the locality symbol (X) are the collection numbers of the United States Geological Survey except as otherwise indicated.



Fig. 7. Map showing fossil localities of the Navarro group in Navarro (southern part), Limestone, and Falls counties. Collection numbers of the United States Geological Survey are placed adjacent to the locality symbol (X).

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G.S.coll. 16166); Siderastrea cretacea (Bölsche), from the Neylandville marl 10 miles north of Cameron, Milam County (U.S.G.S.coll. 13864); Caryophyllia stephensoni Wells, from the Nacatoch sand 3/5 to 4/5 mile northeast of Chatfield, Navarro County (U.S.G.S.coll. 7572), from the base of the Kemp clay 3 miles southwest of Thrall, Williamson County (U.S.G.S.coll. 15537, type locality), and from the Kemp clay 4 miles southeast of Zorn, Guadalupe County (10877); Micrabacia hilgardi occidentalis Wells, from the Nacatoch sand at the north edge of Corsicana, Navarro County (U.S.G.S.coll. 518, type locality), and from 3/5 mile west of Kaufman (U.S.G.S.coll. 14103); Micrabacia mineolensis Stephenson, from the Nacatoch sand I 4/5 miles northeast of Quinlan, Hunt County (U.S.G.S.coll. 16171), from the Corsicana marl 2½ miles west of old Garfield, Travis County (U.S.



Fig. 8. Map showing fossil localities of the Navarro group in Milam and Williamson counties. Collection numbers of the United States Geological Survey are placed adjacent to the locality symbol (X).

G.S.coll. 15532), and from the Kemp clay 3½ miles northwest of Bazette, Navarro County (U.S.G.S.coll. 12922); *Micrabacia navarroensis* Wells, from the upper part of the Kemp clay 6 miles north of Lockhart, Caldwell County (U.S.G.S.coll. 13777, type locality); *Dasmosmilia reesidei* Wells, from the Corsicana marl 1 1 3 miles north of McQueeney, Guadalupe County (U.S. G.S.coll. 15524, type locality); *Hindesastraea discoidea* White, from the Navarro group near Terrell, Kaufman County (U.S. N.M. no. 19166, type locality); Steriphonotrochus? manorensis Wells, from the Kemp clay (Cucullaea bed) 2 2/5 miles southeast of Manor, Travis County (type locality).

In the Arthropoda Rathbun<sup>10</sup> has recorded 4 species of crustaceans from the

<sup>10</sup>Rathuo, Mary J., Fossil Crustacea of the Atlantic and Gulf Coastal Plain: Geol. Soc. Amer., Special Papers No. 2, 160 pp., 26 pls., 1935.



Fig. 9. Map showing fossil localities of the Navarro group in Travis, Caldwell, and Guadalupe (in part) counties. Numbers adjacent to the locality symbol (X) are the collection numbers of the United States Geological Survey except as otherwise indicated.



Navarro group, as follows: Dakoticancer overana australis Rathbun, from the Corsicana marl 6 miles east of Castroville, in Bexar County (U.S.G.S.coll. 16156); Notosceles bournei Rathbun, from the Kemp clay near Elgin, Bastrop County; Ophthalmoplax stephensoni Rathbun, from the Escondido formation, southern Maverick County (Univ. Texas K512); Palaega williamsonensis Rathbun, from the Kemp clay 2½ miles southwest of Thrall, Williamson County (type locality).

Aside from shark teeth, which are fairly common, vertebrate remains are rare and widely scattered in the Navarro group. They include teeth, scales, and otoliths of fish, and vertebrae and fragments of other bones of swimming reptiles, such as mosasaurs and plesiosaurs; these have not been systematically studied.

The figures given on following pages for the range and distribution of genera and species should be regarded as tentative and subject to revision from time to time as additional collections throw new light on these subjects. It is believed, however, that the collections already made are sufficient to show the general order of the range relationships, and that those species that may be found to have a greater range than previously supposed, will be offset in part at least by the finding of new species of restricted range. Furthermore, certain changes could be made in the numerical range relationships by slightly different classificatory treatment of the organisms. For example, by treating the subgenera Camptonectes, Syncyclonema, Neithea, and Radiopecten in the family Pectinidae and Granocardium, Pachycardium, and Ethmocardium in the family Cardiidae, as genera, seven are added to the list of Navarro genera that do not range upward into the Tertiary.

#### NEYLANDVILLE MARL

#### DEFINITION

The Neylandville marl consists of 150 to 300 feet of gray sandy, calcareous clay or marl that rests unconformably upon the Taylor marl, and is conformably(?) overlain by the Nacatoch sand. The formation has been traced in a narrow belt of outcrop from the type locality near Neylandville in Hunt County, southward through Kaufman, Navarro, Limestone and Falls counties, to the vicinity of Buckholtz in Milam County, south of which it is overlapped and concealed by the transgressing Corsicana marl. The base of the formation is marked by a sandy, glauconitic bed containing scattered phosphatic nodules and phosphatic internal molds of fossils, mainly mollusks. Bentonite forms a subordinate part of the group.

As seen at a few favorable localities the unconformity at the base of the formation is sharp, gently undulating, and more or less irregular in detail. It probably does not represent a relatively long period of geologic time. The contact of the formation with the overlying Nacatoch sand has not been seen clearly exposed but at one small poor exposure in a road ditch 31/2 miles north by west of Cash, a mile west of Highway 34, Hunt County, a 6-inch bed of soft sandstone, resting upon sandy marl containing Exogyra cancellata Stephenson, is believed to mark the contact. No definite evidence of an unconformity was observed.

The formation is more or less fossiliferous in its different parts and is particularly characterized by the shells of Exogyra cancellata Stephenson and Anomia tellinoides Morton. The formation marks the lower limit of the range of Exogyra costata and the upper limit of the range of the ammonite genus *Placenticeras*, large specimens of which, belonging to the species P. meeki Böhm, are present in a zone well above the base. In Navarro County the formation contains soft, richly fossiliferous concretions of calcium carbonate, which have yielded a varied fauna, mainly of pelecypods, gastropods, and ammonites, many species of which are not known outside of this formation, and some of which will doubtless prove to be restricted in range to this unit.

#### ANALYSIS OF THE FAUNA

The Neylandville fauna (table 1, in pocket) includes 102 named species and varieties of invertebrates, including 1 species of Vermes, 1 of Echinodermata, and 100 species and varieties of Mollusca. Of the Mollusca, 43 are Pelecypoda, 3 are Scaphopoda, 38 are Gastropoda, and 16 are Cephalopoda. In addition to the named forms there are 30 or more forms listed as unidentified species; these are disregarded in the further consideration of the fauna.

The one species of Vermes, *Serpula cretacea* (Conrad), is long ranging in Upper Cretaceous marine strata younger than the Austin chalk.

The one species of Echinodermata, *Hemiaster benhurensis.* is recorded only from one locality in the Neylandville marl, and from one locality in the lower part of the overlying Nacatoch sand.

Of the 100 species and varieties of Mollusca, 56 are described as new species and 8 as new varieties, making a total of 64 new forms. In the further analysis of the fauna the varieties will be counted as species.

Of the 64 new forms, 37 as now known are restricted to the Neylandville: 27, one questionably, range upward into the Nacatoch sand, and of the 27, 3 range upward into the Corsicana marl; 3, one questionably, into the Kemp clay; and 2 range downward into Taylor marl equivalents. Two of the new species that range upward into the Nacatoch are present also in the Nacatoch sand of Arkansas: these are Parapachydiscus arkansanus and Scaphites rugosus: one species, Baculites claviformis, occurs in the Coon Creek tongue of the Ripley formation in Tennessee. The range of these new forms indicates a close faunal relationship with the Nacatoch sand.

The number of the new forms that will eventually prove of value as index fossils is problematical, but doubtless some of them will be found to be definitely restricted to the Neylandville and to beds of Neylandville age. Some are unique forms not closely related to previously known Upper Cretaccous genera and species in the Coastal Plain. Such are the gastropod *Tundora tuberculata*, the ammonite *Anaklinoceras reflexum*, and the 3 species and 1 variety of the ammonite genus *Axonoceras*.

Of the 36 previously named species, 20 are stratigraphically long-ranging in Texas or elsewhere in the Atlantic and Gulf Coastal Plain, and practically all of them are geographically wide ranging in the same region. Of the 20, 19 may be considered diagnostic of the Upper Cretaceous beds younger than the Eagle Ford shale, and one, *Gryphaeostrea vomer*, ranges upward through the Paleocene and well into the Eocene.

Of the 16 remaining previously named species that are not known to be longranging, the following 6 range upward into, but not above, the Nacatoch sand: Inoceramus vanuxemi (also in Pierre shale of Western Interior). Lucina parvilineata, Creonella triplicata, Sargana stantoni, Solenoceras texanum, and Helioceras navarroense. Three of the 16 species, Exogyra costata, Cadulus obnutus, and Acmaea occidentalis, range throughout the Navarro group; the last named was originally described from the upper part of the Pierre shale of the Western Interior. Of the 16, Placenticeras meeki and P. intercalare have the upper limit of their stratigraphic range in Texas in the Nevlandville marl; in the Western Interior these two species do not range above the Pierre shale. Exogyra cancellata (typical) and Anomia telli*noides* are common in the Nevlandville marl, and in beds of that age throughout the Atlantic and Gulf Coastal Plain; they are therefore exceptionally valuable index Eulina clara and Caveola acuta fossils. are known only from the Nevlandville in Texas and from the Coon Creek tongue of the Ripley formation in Tennessee; the Coon Creek is of upper Neylandville age. Dentalium pauperculum is restricted to the Nevlandville in Texas, but is recorded in the Western Interior from the stratigraphically higher Fox Hills sandstone and Cannonball marine member of the Lance formation. Since 9 of the 16 species range upward into or through the Nacatoch these previously described species agree with the new species in indicating that the Neylandville fauna is closely related to that of the Nacatoch.

Combining the new and previously described forms, 41 forms are in Texas restricted to the Neylandville and beds of Neylandville age; of these 37 have not been recorded outside of Texas; 4 occur in beds of Neylandville age outside of Texas as indicated below:

*Exogyra cancellata*, throughout Coastal Plain in *E. cancellata* zone.

Anomia tellinoides, throughout Coastal Plain in E. cancellata zone,

- Eulima clara. Coon Creek tongue of Ripley formation, Tenn.
- Careola acuta. Coon Creek tongue of Ripley formation, Tenn.

Excluding the long-ranging species from consideration, at least 33 of the new and previously described Neylandville species range upward into the overlying Nacatoch sand, whereas only 5 or 6 range downward into the Taylor marl. The evidence, therefore, based on the macroscopic forms, would seem to be strongly in favor of classifying the Neylandville marl with the Navarro group rather than with the Taylor marl.

#### CORRELATION

The Neylandville marl lies unconformably upon the Taylor marl. The top of the Taylor marks the upper limit of the zone of Exogyra ponderosa (sensu lato), which has been traced throughout the length of the Atlantic and Gulf Coastal In the Neylandville the large Plain. Exogyras are represented by E. costata and E. cancellata. The fact that small nontypical *Exogyra* shells with regular costae are occasionally found at lower stratigraphic positions in beds of Taylor age does not detract from the usefulness of E. costata as an index fossil, for the species appears first in typical form in the Neylandville and beds of Neylandville age, and ranges upward to the top of the Upper Cretaceous series. The Navarro group and beds of Navarro age elsewhere in the Atlantic and Gulf Coastal Plain have long been known as the Exogyra costata zone. The Neylandville marl forms the lower part of the *E. costata* zone.

Correlation of the Neylandville marl with Upper Cretaceous sediments in other parts of the Coastal Plain has been made mainly on the evidence afforded by the stratigraphically narrow-ranging species *Exogyra cancellata* and *Anomia tellinoides*, both of which range geographically from Texas to New Jersey.

In Arkansas Exogyra cancellata is typically and abundantly present in the Saratoga chalk, particularly in its lower part; it is associated with *E. costata; E. ponderosa* is wanting. In the uppermost part of the Marlbrook marl, which unconformably underlies the Saratoga, is a prolific

development of large Exogyras many of which are smooth or nearly so, and essentially like E. ponderosa; a few of the shells exhibit cancellated sculpture closely approaching that of the typical E. cancellata; between these two extremes are shells showing all intermediate degrees of cancellation. The obvious conclusion seems to be that this assemblage marks an intermediate zone between the zones of E. ponderosa and E. cancellata, and that the former species is ancestral to the latter. There is an academic question as to whether this zone should be included in the E. ponderosa zone or should be considered a part of the E. cancellata zone. The former alternative has been chosen because of the unconformity separating the Marlbrook from the Saratoga; it is probable that the lower part of the E. cancellata zone proper has been cut out by this unconformity. An assemblage of large Exogyras similar to that at the top of the Marlbrook, some of them showing moderately strong cancellation on the umbonal portion, is present at the top of the Taylor marl in Travis County, Texas.

In McNairy County, Tennessee, the lower part of the *Exogyra cancellata* zone lies within the upper part of the Selma chalk as it is developed there, and the upper part of the zone is in the Coon Creek tongue of the Ripley formation. In east-central Mississippi and in westcentral Alabama the E. cancellata zone lies within, and somewhat above the middle of, the Selma chalk, and is about 150 feet In central Alabama the zone inthick. cludes the upper part of the Selma (as there developed) and the lower part of the Ripley formation. In the Chattahoochee region (Alabama-Georgia) the zone forms the lower part of the Ripley formation of that area. The zone is included in the lower part of the Peedee formation of North Carolina, in the lower part of the Monmouth formation of Kent and Cecil counties, Maryland, and is coextensive with the Mount Laurel sand of Delaware and New Jersey.

The Neylandville marl is shown to be closely related in age to the middle and higher parts of the Pierre shale and their equivalents in the Western Interior, by the common occurrence of such species as Ostrea plumosa, Exogyra costata (not typical), *Baculites claviformis*, and *Placenticeras meeki*, and by several closely analagous species known by different names in the two areas (see p. 33).

Outside of the United States the species Exogyra cancellata is known only from the State of San Luis Potosi, Mexico, showing that the zone extends at least 400 miles south of the international boundary. However, from Milam County, Texas, to some undetermined point south of the Rio Grande at Eagle Pass, the zone is over-lapped and concealed by younger Cre-taceous formations. Several specimens of E. cancellata have been collected near Maiz and one specimen near Cardenas, in San Luis Potosi; those from near Maiz lack exact data as to their occurrence: the one from near Cardenas came from somewhat below the middle of a thick series of Upper Cretaceous sediments known as the "Cardenas series."

#### NACATOCH SAND

#### DEFINITION

The Nacatoch sand of Texas is the westward and southwestward extension of the formation of the same name in southwestern Arkansas. In Texas the formation consists mainly of gray massive, more or less calcareous marine sand, subordinate parts of which are indurated to hard, calcareous, concretionary masses of various sizes up to several feet in longest dimension: the thickness of the sand ranges from 100 to 200 feet or more. The concretions are of various shapes ranging from subspherical through subovate to irregular, and may be scattered irregularly through the sand or may form discontinuous layers of hard rock. Many of the concretions are fossiliferous, some of them richly so. More than twice as many species of mollusks have been collected from this formation, as from any one of the other three formations composing the group.

The narrow belt of outcrop of the formation lies immediately to the cast of, and parallel to, that of the Neylandville marl, and has been traced southward through Texas as far as northern Falls County where it passes under the transgressing Corsicana marl, and is not seen again in that direction. The formation weathers to a sandy soil, and, because of its relatively greater resistance to erosion, produces a more strongly rolling to moderately hilly topography.

So far as known there is no stratigraphic break separating the Nacatoch sand from the underlying Neylandville marl. There is on the other hand a definite break between the Nacatoch and the overlying Corsicana marl; this contact is somewhat irregular and is marked by a sharp change in lithologic character from the massive marine sand of the former to the whitish chalky marl of the latter.

A significant fossil in the Nacatoch sand is the ammonite genus Sphenodiscus Meek, which, however, is rare and, so far as known, is represented by small specimens only. Ostrea owenana Shumard is a large and conspicuous species that appears to be a reliable index fossil restricted to this formation; it is present in considerable numbers in a zone about midway of the thickness of the sand. Many of the molluscan species are not known to range either above or below the formation in Texas. Most of these restricted species are doubtless adapted to a sandy bottom and would not be expected to be present in the underlying and overlying marls; some identical and some closely analogous species are known in sandy beds at both lower and higher stratigraphic positions in the eastern Gulf region.

#### ANALYSIS OF THE FAUNA

The fauna of the Nacatoch sand, as here recorded, includes 245 named species and varieties of invertebrates (table 2) distributed as follows: Vermes, 4; Echinodermata, 1; Molluscoidea, 1; and Mollusca, 239. Of the Mollusca, 106 are Pelecypoda, 4 are Scaphopoda, 106 are Gastropoda, and 23 are Cephalopoda; 42 or more imperfectly preserved molluscan forms are given generic names without specific assignment, and are disregarded in the analysis.

Of the 4 species of Vermes. 3 are both long-ranging in time and wide-ranging in the Coastal Plain: one, *Hamulus? huntensis* is questionably recorded from the overlying Corsicana marl.

The one named species of Echinodermata, *Hemiaster benhurensis*, is recorded from the underlying Neylandville marl. The family Cidaridae is represented by one nearly complete spine that can not be more closely identified. Molluscoidea is represented by one species of *Lingula* related to *L. subspatulata*, which was originally described from the Pierre shale of the Western Interior.

Of the 239 species and varieties of Mollusca, 171 are described as new (144 new species, 27 new varieties). Of the remaining 68 previously described forms, 65 are classed as species, and 2 as varieties. In the discussion that follows the varieties are counted as species.

Of the 171 new forms, 135, as at present known, are restricted in Texas to the Nacatoch sand, and the remaining 36 range to different stratigraphic positions below and above the Nacatoch, as follows: 1, Cymella bella texana, ranges downward into the Upson clay (lower Taylor age); 1, Polinices rectilabrum texanus, ranges downward into the San Miguel formation (upper Taylor age), and upward to the top of the Navarro group; 21 (3 questionably) range downward into the Neylandville marl; 2 range downward into the Neylandville marl and upward into the Corsicana marl (1 questionably in the Corsicana); 2 range through the Navarro group, one of them questionably reaching the Neylandville below, and the other questionably reaching the Kemp above; 6 (1 questionably) range upward into the Corsicana; and 3 range through the Corsicana, questionably reaching the Kemp. The proportionately large number (21) that are common to the Neylandville, indicates a close faunal relationship with the Neylandville fauna. Of the new species restricted to the Nacatoch in Texas, one, Cadulus coonensis, is recorded from the Coon Creek tongue of the Ripley formation in Tennessee, and another, Liopistha formosa, is questionably present in the Coon Creek. Of the 21 new species that range Neylandville 2, into the downward Cyprimeria coonensis and Baculites claviformis, are recorded from the Coon Creek tongue; three species, Baculites claviformis, Parapachydiscus arkansanus, and Scaphites rugosus are present in the Nacatoch sand of Arkansas.

Of the 68 previously described species and varieties, 8 are long-ranging in the

Upper Cretaceous series from the upper part of the Austin chalk and beds of upper Austin age upward to the top of the series, and 8 are long-ranging in the series above the Austin chalk; 2 range through the Navarro group, and 3 (one questionably) range from the Nacatoch sand upward to the Kemp clay. Seven of the 68 forms are recorded as ranging downward into, but not below, the Neylandville in Texas, but one of these, Nucula perequalis, is known to be longranging elsewhere in the Coastal Plain in beds of post-Austin age; Creonella triplicata, Sargana stantoni, and Helioceras navarroense are recorded in Tennessee from the Coon Creek tongue of the Riplev formation (of Neylandville age); and Inoceramus vanuxemi is common to the Pierre shale of the Western Interior.

Of the 68 previously described forms, 34 are not recorded in Texas in strata either older or younger than the Nacatoch; of these, the following 14 are not recorded anywhere outside of Texas: Linter acutata, Laternula? sulcatina. Veniella lineata, Belliscala forsheyi, Turritella winchelli, Volutomorpha retifera, Volutoderma (Longoconcha) navarroen-Ellipsoscapha striatella, Cylichna sis. secalina, Nostoceras stantoni, Nostoceras stantoni prematurum, Nostoceras stantoni aberrans, Nostoceras helicinum, and Turrilites splendidus; of the remaining 20 forms, the following 9 are present in the Coon Creek tongue of the Ripley formation in Tennessee: Limopsis meeki, Corbula williardi, Proscala? americana, Polstephensoni, Anchura? inices lobata (also in Ripley of Mississippi), Seminola crassa, Lomirosa cretacea, Remnita biacuminata, and Ringicula pulchella; Solemya bilex was originally described from a stratum in the Western Interior, that is either of upper Pierre or of Fox Hills age, and the species ranges from the upper Pierre upward into the Cannonball marine member of the Lance formation: Pteria linguaeformis, Capulus spangleri, and Anisomyon borealis are common to the Pierre shale; Ostrea owenana, Panope subplicata, and Anisomyon haydeni are present in the Nacatoch sand of Arkansas; Pholadomya littlei is recorded from the Ripley formation and the Providence sand of Georgia; and *Nucula microstriata* and *Cymbophora berryi* are common to the Monmouth formation of Maryland.

Combining the new and the previously named forms, of the 245 species and varieties, 154 have not been reported from beds stratigraphically either higher or lower than the Nacatoch, and most of these (146) are known only from the Nacatoch of Texas; the following 8, however, are recorded from beds of Nacatoch age outside of Texas:

Nucula microstriata, Monmouth formation, Maryland.

Ostrea owenana, Nacatoch sand, Arkansas.

Cardium (Granocardium) bowenae, ?Nacatoch sand, Arkansas.

- Cardium (Granocardium) tholi, ?Nacatoch sand, Arkansas.
- Cymbophora berryi, Monmouth formation, Maryland.
- Capulus cuthandensis, ?Ripley formation, Mississippi.
- Liopeplum leioderma tabulatum, ?Nacatoch sand, Arkansas.
- Anisomyon haydeni, Nacatoch sand, Arkansas.

The large proportion of species and varieties known only from the Nacatoch of Texas indicates the existence of a faunal subprovince in the sea of eastcentral Texas in Nacatoch time.

#### CORRELATION

The Nacatoch sand in Texas is a well defined lithologic unit lying between the Nevlandville marl below and the Corsicana marl above. It carries a large macrofauna, chiefly molluscan, considerably more than half of which is distinctive of the formation within the faunal subprovince of eastcentral Texas. Few of these distinctive forms, however, range outside of Texas, and evidence for the close correlation of the Nacatoch with Upper Cretaceous sediments in other parts of the Coastal Plain must depend only in part on direct faunal evidence. Satisfactory correlations can, however, be made by utilizing a combination of physical and faunal relationships that may serve as criteria for determining the age limits of the sediments in question.

The Nacatoch sand of Texas has long been recognized as the westward and southwestward extension of the Nacatoch sand of Arkansas. In Arkansas the Nacatoch is limited below by the Saratoga chalk, which carries *Exogyra cancellata*, a species that is wanting in the Nacatoch, and is overlain by the lithologically different Arkadelphia marl. A direct faunal tie with the Nacatoch of Texas is afforded by the index fossil, *Ostrea owenana*, which in Arkansas is present in the upper part of the formation. Other common fossils are: *Cardium (Granocardium) bowenae*, *C. (G.) tholi*, and *Liopeplum leioderma tabulatum* (all questionably identified), and *Anisomyon haydeni*.

In the eastern Gulf region a lower limit to beds of Nacatoch age is afforded by the casily recognized zone of Exogyra cancellata, which stretches from Tennessee to Georgia. An upper limit is determined by the unconformity at the base of the synchronous Owl Creek formation, Prairie Bluff chalk, and Providence sand. The sediments that lie between these limits include: The McNairy sand member of the Ripley formation of Tennessee; the Ripley formation of northern Mississippi (exclusive of the Coon Creek tongue at the base); the upper part of the Selma chalk of east-central Mississippi and westcentral Alabama; and the upper part of the Ripley formation of central and eastcentral Alabama and the Chattahoochee region (Georgia-Alabama). These sediments contain many species that are common to the Nacatoch, but practically none of these species as at present known are definitely restricted to beds of Nacatoch age. In other words, nearly all the common species range either above or below the beds of Nacatoch age.

In the Carolinas the lower third, more or less, of the Peedec formation carries the *Exogyra cancellata* zone and an undetermined upper part is believed to correspond in age to the Corsicana marl; the middle part of the Peedee, perhaps about the middle third, is of the age of the Nacatoch sand.

In Maryland the *Exogyra cancellata* zone is in the lower part of the Monmouth formation, the upper part of which is of Nacatoch age; the Corsicana marl may or may not be represented in the upper part of the Monmouth formation.

The Navesink marl of New Jersey is approximately equivalent in age to the Nacatoch sand. The Mount Laurel sand carrying *Exogyra cancellata* limits the Navesink below and the Red Bank sand (of Corsicana age) limits it above. Here again the direct faunal evidence for synchroneity is meager. Thirteen or 14 species are common to the Nacatoch and Navesink, but none of them is known with certainty to be restricted to sediments of that age.

The sediments equivalent lo the Nacatoch sand in the Upper Cretaceous section of the Western Interior have not been precisely determined. The following common species suggest that these equivalents are to be found in the upper part of the Pierre shale or beds of that age: Solemya bilix, Pteria linguaeformis, Capulus spangleri, Anisomyon borealis, Baculites claviformis, and Scaphites brevis; to these might be added several related analogous species that are known by different names in the two regions. On the other hand the ammonite genus Placenticeras, which ranges to the top of the Pierre, has never been found in the Nacatoch, and the genus Sphenodiscus, which is present in the Nacatoch, is not known in any part of the Pierre. This suggests the possibility that the Nacatoch is as young as the Fox Hills sandstone, in which Sphenodiscus is a characteristic form.

The Nacatoch sand is certainly represented above the *Exogyra cancellata* zone in the thick section of Upper Cretaceous sediments near Cardenas, San Luis Potosi, Mexico, but just how much of that section should be considered of Nacatoch age has not been determined. The Cardenas faunas have not as yet been adequately studied and compared with the corresponding Texas faunas.

#### CORSICANA MARL

#### DEFINITION

The Corsicana marl consists typically of 20 to 100 feet or more of chalky marl, gray or bluish-gray in a fresh damp condition, but drying to a whitish or lightgray chalky appearance. The basal 5 or 6 feet is generally more or less sandy and the proportion of clay to calcium carbonate in the main part of the formation varies from place to place. The lower sandy bed contains phosphatic nodules and phosphatic molds of mollusks and other organisms, which are generally most plentiful in the basal 2 to 12 inches, and more widely distributed, or even rare, above. Most of the fossils recorded from the formation in the area north of Brazos River have come from this basal sandy bed.

The eastern part of the town of Corsicana is underlain by the marl but exposures are rare within the town limits; the basal phosphatic materials have been observed in weathered marly spots in the slopes in the immediate vicinity of the Court House. The marl was formerly well exposed in the pit of the Corsicana Brick Company east of the Southern Pacific Railway, 2 miles south of the Court House. Several feet of the fresh marl was exposed in the lower slopes of the pit and it yielded an exceptionally large fauna of microscopic organisms, mainly Foraminifera, which has been studied by Dr. Joseph A. Cushman. When last visited in 1936 the marl was covered with water which partly filled the pit, and the slopes above water level were largely concealed by talus and vegetation. These upper slopes are probably underlain by the Kemp clay, but the position of the contact between the clay and the underlying marl was not precisely determined at this locality.

The marl forms a narrow belt of outcrop that has been mapped from Hunt County southwestward to the eastern part of Medina County, a distance of 350 miles, beyond which it is overlapped and concealed by the Escondido formation. The belt is continuous with the exception of a stretch a few miles long in Williamson County, where it is cut out by an unconformity that allows the Kemp clay to rest directly on the Taylor marl. In Travis County the marl becomes thicker than it is anywhere north of Brazos River; about 105 feet of dark marl is exposed in a bluff on Onion Creek, 21/2 miles west of old Garfield, and neither the base nor the top of the formation is exposed in the

section. Farther south and southwest the marl changes its character somewhat; though still strongly calcareous it is less chalky and more earthy in texture, and certain layers at stratigraphic intervals of several feet apart are indurated to impure, more or less nodular limestone. One conspicuous bed containing many shells of *Exogyra costata* Say and *Gryphaea mutabilis* Morton is exposed here and there along the strike from Guadalupe County to eastern Medina County.

Throughout the length of its belt of outcrop the Corsicana marl rests with unconformable relations on the Nacatoch sand or, where that is absent, on the Neylandville marl or the Taylor marl; at most places the contact is marked by an admixture of sand and by phosphatic material at the base of the Corsicana. At the few places where the contact of the Corsicana marl with the overlying Kemp clay has been seen there is a sharp change from the marl below to a dark clay of low calcium carbonate content at the base of the Kemp. At one locality 11/2 miles south of the crossing of State Highway 31. over Richland Creek, 7/10 mile southeast of the highway, Navarro County, the contact is well exposed in a shallow road cut and reveals a few phosphatic pebbles and glauconite in a thin layer at the base of the Kemp. Whether this contact marks an unconformity, or only a diastem of slight time importance, has not been determined.

One of the paleontologic characteristics of the Corsicana is the presence in it of considerable numbers of the shells of Exogyra costata Say belonging to the unnamed variety having narrow costae; shells with medium or broad costae are rare. The ammonite genus Sphenodiscus Meek becomes fairly common, though most of the individuals are small. The small bivalve Crenella serica Conrad is common; it has not been found at a lower level in Texas, but ranges downward into the Nacatoch sand in Arkansas, and into the Exogyra cancellata zone (lower Navarro age) in Mississippi. The Corsicana marl is unsurpassed in the richness of its foraminiferal fauna.

#### ANALYSIS OF THE FAUNA

In the table of distribution (Table 3, in pocket) 98 named species and varieties are listed from the Corsicana marl, and in addition 49 or more poorly preserved forms are assigned to genera without specific identification, and 2 are given only family assignment. The named forms are distributed biologically as follows: Porifera, 1; Vermes, 5; Echinodermata, 5; Mollusca, 87. Of the Mollusca, 64 are Pelecypoda, 18 are Gastropoda, and 5 are Cephalopoda.

The phylum Porifera is represented by one species of boring sponge to which the name Cliona microtuberum is given. In Texas this species ranges from the Corsicana marl upward into the Kemp clay, and specimens that appear to be indistinguishable from it are common in the higher formations of the Upper Cretaceous series of the Atlantic and Gulf Coastal Plain; they are especially common in the Prairie Bluff chalk of the eastern Gulf region. These boring sponges have never been critically studied, and they may later prove to include several species. In some specimens problematical slender, smooth casts are mingled with those of *Cliona microtuberum*: whether or not these represent another species of Cliona or pertain to some other marine organism has not been determined.

The Vermes are represented by 2 species of *Serpula*, one new, and 3 species of *Hamulus*, one new and questionably referred to that genus. The previously described species are long ranging both stratigraphically and geographically in sediments of the Upper Cretaceous series that are younger than the Eagle Ford shale, and in the present state of knowledge they are of little value in correlation.

In Texas the 5 named species of Echinodermata are restricted to the Corsicana marl, as at present known. Outside of Texas *Hemiaster bexari* has a close analogue in *H. slocumi* from the Prairie Bluff chalk and from the Owl Creek formation of the eastern Gulf region; *Linthia variabilis* occurs in both the Owl Creek formation and the Prairie Bluff chalk, and is recorded from the upper part of the Peedee formation of North Carolina; *Micraster (Plesiaster) americanus* is questionably represented by one imperfectly preserved specimen from the Prairie Bluff chalk of Alabama. A few small segments of crinoid roots or stems appear to belong to the same species as an undescribed genus and species that is represented by a fine lot of material from the Prairie Bluff chalk of Mississippi. Dr. Edwin Kirk, who is studying the Mississippi material, refers it to the family Bourgueticrinidae, related to *Mesocrinus*.

The Mollusca include 38 previously described forms (37 species and 1 variety) and 49 new forms (44 species and 5 varicties). Of the 49 new forms, 27 are restricted in Texas to the Corsicana marl (one questionably present there), and 22 range to different stratigraphic positions within the Navarro group; none ranges below the Navarro group. Of the 22, two range downward into the Nevlandville marl; 5 (one questionably) range downward into the Nacatoch sand; 14 (2 questionably) range upward into the Kemp clay, but of the 14 two are questionably identified from the Corsicana; one, Gyrodes rotundus, ranges through the Navarro group, but is questionably identified from the Nevlandville marl; one, Pecten (Camptonectes) bubonis, is questionably present in the Escondido formation (of Kemp age). Of the new forms the following are recorded from localities outside of Texas: Gryphaea belli in the Prairie Bluff chalk of Alabama, and in the Peedee formation of North Carolina; Pecten (Camptonectes) bubonis in the Ripley formation and the Owl Creek formation (type locality) of Mississippi, in the Providence sand of eastern Alabama and Georgia, and in the Monmouth formation of Maryland; Brevicardium fragile in the Owl Creek formation (type locality); Gastrochaena ripleyana in the Owl Creek formation (type locality); Epitonium pondi in the Coon Creek tongue of the Ripley formation (type locality) in Tennessee; Gyrodes subcarinatus questionably in the Ripley formation of Mississippi, and probably in the Monmouth formation of Maryland; and Eutre*phoceras planoventer* in the Coon Creek tongue of Tennessee, and questionably in the Ripley formation of Mississippi.

Of the 38 previously described forms, 16 are long-ranging in Upper Cretaceous strata younger than the Austin chalk in the Atlantic and Gulf Coastal Plain; 2 range from beds of upper Taylor age upward through beds of Navarro age; 9 range through beds of Navarro age in Texas or elsewhere in the Coastal Plain; 1. Pecten venustus, is questionably recorded from both the underlying Nacatoch sand and the overlying Kemp clay; 1, Cuneolus tippana. ranges downward into the Nacatoch sand; 3, Cyprimeria alta, Sphenodiscus tirensis, and S. pleurisepta, range upward into the Kemp clay, and are of value as indicating a stratigraphic position higher than the Nacatoch sand. Eight of the previously described species are restricted to the Corsicana marl in Texas, and of these the following 5 are considered to be of sufficiently restricted range in the Gulf region to be of definite significance in correlating the Corsicana with the Owl Creek formation, the Prairie Bluff chalk, and the Providence sand, in the eastern Gulf region: Idonearca capax, Plicatula mullicaensis, Cardium (Granocardium) tippanum, Pholas? pectorosa. and Baculites columna. However, in Mississippi Cardium (Granocardium) tippanum ranges downward into the uppermost part of the Ripley formation, and the type of *Plicatula mullicaensis* came from the Navesink marl of New Jersev, a somewhat lower stratigraphic position than that occupied by the Corsicana marl.

Combining the new and previously named forms in the Corsicana marl, of the 93 species and varieties of marine invertebrates, 36 are restricted in their stratigraphic range to the Corsicana marl and beds of Corsicana age, and of these 30 are known only in Texas; the other 6 are recorded outside of Texas as indicated in the following list:

- Linthia variabilis?. Owl Creek formation, Prairie Bluff chalk, Mississippi, and Peedee formation (upper part), North Carolina.
- Micraster (Plesiaster) americanus, ?Prairie Bluff chalk, Alabama.
- Idonearca capax, Owl Creek formation, Mississippi, and Prairie Bluff chalk, Mississippi-Alabama.

- Cardium (Granocardium) tippanum?, Owl Creek formation, Prairie Bluff chalk and upper part of Ripley formation, Mississippi, and Providence sand, Georgia.
- Brevicardium fragile?, Owl Creek formation, Mississippi.
- Baculites columna, Prairie Bluff chalk, Mississippi-Alabama.

The proportionately large number of Corsicana species restricted to Texas indicates the continued existence of a faunal subprovince in the east-central part of the State.

#### CORRELATION

The Corsicana marl is a relatively thin and lithologically well defined unit. The unconformity, which everywhere limits the formation at the base, probably represents a short time interval in northeastern Texas, but toward the southwest where the formation overlaps and cuts out the Nacatoch sand and the Neylandville marl and rests directly on the Taylor marl the unconformity marks a stratigraphic break of considerable importance. The formation is particularly characterized by the presence of Idonearca capax, by the abundance of Crenella serica and Exogyra costata (variety with narrow costae), by the common occurrence of the ammonite genus Sphenodiscus (2 or more species), which is rare in the Nacatoch sand and apparently wanting in the Neylandville marl, and by the presence of Discoscaphites spp.

The Corsicana marl is probably represented in the basal part of the Arkadelphia marl of Arkansas, but an exact correlation has not as yet been established with that unit on paleontologic evidence.

The Corsicana marl is lithologically similar to the Prairie Bluff chalk of the eastern Gulf region, which, like the Corsicana, is limited at the base by a well defined unconformity. The following common and closely analogous forms are accepted as indicating approximate synchroneity of the Corsicana and Prairie Bluff units:

- \*Hemiaster bexari (analogous to H. slocumi Lambert)
- Micraster (Plesiaster) americanus
- Aff. Mesocrinus sp.
- \*Idonearca capax
- Plicatula mullicaensis (abundant locally) Crenella serica (first becomes abundant)

- \*Cardium (Granocardium) tippanum Cyprimeria alta
- Baculites columna
- \*Discoscaphites spp. (of the conradi group) \*Sphenodiscus spp. (the genus first becomes common)

The forms in the preceding list marked with an asterisk (\*) apply also to the Owl Creek formation of northern Mississippi, which in addition has the common species Brevicardium fragile and Pholas? pectorosa. Since the Prairie Bluff chalk merges eastward in Alabama into the Providence sand, the Corsicana marl must correspond at least to the lower part of the Providence; the upper part of this unit is believed to be as young as the Kemp clay; the direct faunal evidence, which would be afforded by the common eccurrence in the Corsicana and Providence of closely restricted species, is wanting.

The paleontologic evidence for the correlation of the upper part of the Peedee formation of the Carolinas with the Corsicana marl appears to be reasonably conclusive; this is indicated by the presence of *Linthia variabilis*, *Gryphaea belli*, *Exogyra costata* (variety with narrow costae), and *Lima insolita* (possibly analogous to *L. sayrei*).

The presence of Cyprimeria major (analogous to C. alta), Crenella serica (numerous), Pholas? pectorosa, and Discoscaphites (of the conradi group) in the upper part of the Monmouth formation of Prince Georges County, Maryland, suggests the possibility that the containing beds are of Corsicana age, though other forms throw some doubt on this correlation.

The Red Bank sand of New Jersey, particularly the Tinton sand member at the top, is believed to be approximately of Corsicana age; the Tinton carries *Pholas? pectorosa* (type locality at Tinton Falls) and *Sphenodiscus lobatus?* 

The present available evidence does not permit an exact correlation of the Corsicana marl with any restricted zone in the Upper Cretaceous standard section of the Western Interior. The best evidence appears to be that afforded by several genera of ammonites. The genus *Sphenodiscus* makes its first appearance in the

<sup>\*</sup>Linthia variabilis

Western Interior in the Fox Hills sandstone; in Texas this genus is known at one locality in the upper part of the Taylor marl, is wanting so far as known in the Neylandville marl, is meagerly represented in the Nacatoch sand, is fairly common in the Corsicana marl, and is abundant in certain layers in the Kemp clay. In the Western Interior the genus Placenticeras ranges through the Pierre to its top but no farther, and in Texas it ranges upward into the Neylandville marl. Up to the time that Sphenodiscus was found in the Taylor the ranges of the two genera in the Gulf region were not sup-The genus Disposed to overlap. coscaphites makes its first appearance in Texas in the Corsicana marl and in the Western Interior in the Fox Hills sandstone. Disregarding the one rare occurrence of Sphenodiscus in the Taylor marl, the ammonite evidence seems to favor the lower Fox Hills age of the Corsicana marl.

#### KEMP CLAY

#### DEFINITION

The fourth and youngest formation of the Navarro group in Texas is the Kemp clay. The formation varies somewhat in lithologic character in its different stratigraphic parts, but consists mainly of dark clay having a low content of calcium carbonate. Layers and concretionary masses of gray dense, fine calcareous sandstone are fairly common, though rather widely spaced, in the formation; some of the concretions are completely enveloped in a thick earthy layer exhibiting cone-incone structure. Concretions occupying a zone about midway of the formation tend to weather to reddish tints, while those in the upper part weather to orange, limonitic tints. The maximum and minimum thicknesses of the unit have not been determined; well records in Limestone County have shown that the thickness there is about 370 feet, but that figure may be exceeded in places. In places the formation appears to be no more than 160 feet thick. Differences in thickness may well be accounted for by differences in the amount of the transgressive overlap of the overlying Paleocene strata.

As mapped the Kemp clay extends from western Hopkins County to Bexar County; at most places the belt of outcrop is only a few miles wide, but the flattening of the beds at some places, as in southern Hunt County, has widened the belt to a maximum of 11 miles. In Bexar County the formation merges westward along the strike into materials of somewhat different lithologic facies, to which the name Escondido formation has been given. The change takes place gradually and the separation of the Kemp from the Escondido is necessarily an arbitrary procedure; actually an area in western Bexar County where the unit is completely faulted out provides a convenient place for making the separation; east of that area the unit is called Kemp and west of it Escondido. Compared with the Kemp the Escondido is composed mainly of a more strongly lithified shaly clay and contains a much more conspicuous development of interbedded dense calcareous sandstone layers whose resistance to erosion tends in places to produce ridges in the direction of the strike, as in Maverick County. The difference in facies is also reflected in the faunas, that of the Escondido including many elements that are not known in the Kemp, and vice versa. Although the Escondido is considered a formation of the Navarro group, its fauna is not included in the scope of the present treatise.

The fauna of the Kemp clay is particularly characterized by the presence of species of the ammonite genus Sphenodiscus. Exogyra costata Say is represented by the variety with narrow costae, which ranges in places to the top of the formation. A goodly number of the molluscan species are restricted to the formation; some range downward into lower formations, but none ranges upward into the overlying Paleocene sediments.

Although the Kemp clay is separated from the underlying Corsicana marl by a sharp change in the character of the materials where the contact has been seen, the only evidence suggesting an unconformity is the presence of a few phosphatic pebbles at the base of the Kemp at the locality previously described, 1½ miles south of the bridge of State Highway 31 over Richland Creek in Navarro County. The Kemp clay is everywhere unconformably overlain by the Midway group (Paleocene).

#### ANALYSIS OF THE FAUNA

A total of 105 named species and varieties are listed from the Kemp clay in the table of distribution (Table 4, in pocket). These are distributed biologically as follows: Porifera, 1; Vermes, 3; Molluscoidea, 2; Mollusca, 99; and in addition 54 or more forms are referred to genera without specific identification. Of the specifically named Mollusca, 44 are Pelecypoda, 3 are Scaphopoda, 46 are Gastropoda, and 6 are Cephalopoda.

The Porifera are represented by one species of sponge, Cliona microtuberum.

The Vermes are represented by Serpula cretacea, S.? lineata, and Hamulus squamosus, all long-ranging in Upper Cretaceous strata younger than the Austin chalk.

The Echinodermata are represented by two unnamed species, one of *Hemiaster* and one of *Linthia*?

The Molluscoidea are represented by Lingula aff. L. subspatulata and by Terebratulina noackensis, a new species; the original of L. subspatulata came from the Pierre shale of the Western Interior.

The Mollusca include 70 new forms (63 species and 7 varieties), and 29 previously described species. Of the 70 new forms, 50 are restricted in Texas to the Kemp clay; 14 range downward into the Corsicana marl, but of these 2 are questionably present in the Kemp and 2 questionably present in the Corsicana; 3 range downward into the Nacatoch, but of these 2 are questionably present in the Kemp; 2 range through the Navarro group, but of these one is questionably present in the Kemp and one questionably present in the Neylandville; only one ranges as low as the San Miguel formation (upper Taylor age). Of the new species two are recorded outside of Texas; Gryphaea belli occurs in the Prairie Bluff chalk of Alabama, and in the Peedee formation of North Carolina; Turritella bilira is present in the Providence sand in the Chattahoochee region, Georgia (type locality), and is present mechanically reworked from high Upper Cretaceous beds (Owl Creek) into the basal bed of the Paleocene in northern Mississippi.

Of the 29 previously described species, 14 are long-ranging in Upper Cretaceous strata younger than the Austin chalk; 2 have a known range downward into the upper part of the Exogyra ponderosa zone (upper Taylor age); 5 have a known range through beds of Navarro age, but 2 of the 5 are questionably identified from the Kemp clay; 4 range downward into the Nacatoch, but 3 of these are questionably identified, 2 in the Nacatoch and 1 in the Kemp; 1 ranges downward into the Neylandville; and 2, Titanosarcolites oddsensis and Napulus octoliratus (questionably identified in the Kemp) are restricted to the Kemp in Texas; the type of N. octoliratus is from the Owl Creek formation of Mississippi.

The high percentage of the previously described speqies that range downward into older formations emphasizes the close relationship of the Kemp fauna to the older Upper Cretaceous faunas; nearly 50 per cent of them range through the formations younger than the Austin chalk. On the other hand the high percentage of the new forms (70 per cent) that appear to be restricted to the Kemp, indicates a rapid change in the specific make-up of the faunas from below upward. Most of the new forms belong to genera that were already present in underlying older formations, and doubtless many of them are the evolutionary descendants of older species. A few species such as Titanosarcolites oddsensis, Astartemya fentressensis, Pinella reticulata, the four species of the new genus Deussenia, and Eoancilla acutula, appear to be immigrants into the Gulf region from the Caribbean region or elsewhere.

Combining the new and previously described species, of the 105 forms recorded from the Kemp clay, 53 are restricted to the Kemp in Texas; of the 53, two, *Turritella bilira* and *Napulus octoliratus*, are recorded from high Upper Cretaceous beds in the eastern Gulf region.
#### CORRELATION

The analysis of the fauna of the Kemp clay just given shows that a large percentage of the named forms either are new species not as yet known outside of Texas, or they range to lower stratigraphic levels in the Gulf region. Some, perhaps many, of the new species will eventually prove to be restricted and useful as index fossils. The Kemp is the highest stratigraphic unit in the Upper Cretaceous series of Texas. Traced to the southwest and west the formation merges into the Escondido formation of the Rio Grande region. The fauna of the latter is in the main a different facies from that of the Kemp, but there are certain elements in common, as for example, the abundance of large shells of the ammonite genus Sphenodiscus representing several species, and the abundant occurrence in some layers of Exogyra costata (variety with narrow costae). A systematic study of the Escondido fauna will doubtless bring to light more species that are common to the Kemp clay than are at present known.

Traced to the northeast and east the Kemp clay passes into the Arkadelphia marl in Arkansas, with an undetermined upper portion of which it is synchronous. The fauna thus far recovered from the Arkadelphia marl is meager, but the species *Exogyra costata* (variety with narrow costae) and *Crenella serica* are common forms.

In the Gulf eastern region the equivalents of the Kemp clay appear to be largely overlapped and concealed by transgressing Paleocene beds, with the probable exception of the Chattahoochee region (Alabama-Georgia). The type locality of Turritella bilira is in the Providence sand (marine facies) on Pataula Creek. Clay County, Georgia, and this species is also present in the Kemp clay of Texas; the species appears to be a late Upper Cretaceous evolutionary development of a group of lirate Turritellas, of which T. quadilira and the common and well known T. trilira are the older mem-The lower part of the Providence bers. sand is of Corsicana age but the upper part is probably as young as the Kemp.

T. bilira has also been found mechanically reworked in the base of the Paleocene in Pontotoc and Union counties, Mississippi, and probably was derived from a bed of high Upper Cretaceous age now overlapped by the Paleocene.

There is no evidence that sediments of Kemp age come to the surface in the Atlantic Coastal Plain anywhere north of Georgia; they may be present there in the subsurface, overlapped and concealed by Paleocene or later Tertiary sediments.

In the Western Interior the Kemp clay is represented in the Fox Hills sandstone, presumably in its upper part. Although no species are known with certainty to be common to the Kemp and Fox Hills, the abundant occurrence of the ammonite genera *Sphenodiscus* and *Discoscaphites* in the two formations is accepted as positive evidence of synchroneity.

Although the faunas of the Cardenas beds, near Cardenas, San Luis Potosi, Mexico, have not been adequately studied and compared with the fauna of the Kemp clay, and only one species, *Exogyra costata*, is known to be common to the Kemp and the higher of the Cardenas beds, the great thickness of Upper Cretaceous sediments above the zone of *Exogyra cancellata* in the Cardenas section affords a reasonable basis for correlating the Kemp with an undetermined upper part of that section.

In the lower country toward the coast in the State of Tamaulipas, Mexico, the Kemp is believed to be represented in the upper part of the Mendez shale, which carries the large aberrant bivalve Tampsia bishopi Stephenson.11 Evidence has been given<sup>12</sup> to show that this species is a northern migrant from a tropical assemblage of Upper rudistids Cretaceous that in Jamaica limestone). (Barrettia Cuba (Habana formation), and other West Indian islands, includes such genera as

<sup>&</sup>lt;sup>11</sup>Stephenson, L. W., Some Upper Cretaceous shells of the rudistid group from Tamaulipas, Mexico: U. S. Nat. Mus. Proc., vol. 61, art. 1, pp. 1–28, 15 pls., 1922.

<sup>&</sup>lt;sup>12</sup>Stephenson, L. W., A new Upper Cretaceous rudistid from the Kemp clay of Texas: U. S. Geol. Survey Prof. Paper 193-A, pp. 1-15, 5 pls., 1938.

Barrettia Woodward, Praebarrettia Trechmann, Bournonia Mac Gillavry, Biradiolites D'Orbigny, Antillocaprina Trechmann, Tampsia Stephenson, Lapeirousia Boyle, and Titanosarcolites Trechmann. Titanosarcolites oddsensis from the Kemp clay in Falls County, Texas, appears also to be a northern migrant from the West Indian assemblage. The route of the migration is indicated by the presence of representatives of the assemblage in Guatemala, and in the States of Chiapas and Tamaulipas, Mexico.

# ANALYSIS OF THE NAVARRO FAUNA AS A WHOLE

The Navarro fauna as herein described includes 411 named species and varieties of macroscopic marine invertebrate organ-(See Table 5, in pocket.) isms. In addition there are more than 100 forms represented by material too poorly preserved for satisfactory specific identification; most of these forms are assigned to genera, but a few are referred only to families. Biologically the specifically named forms are distributed among the phyla as follows: Porifera, 1; Vermes, 6; Echinodermata, 6; Molluscoidea, 2; Mollusca, 396, including 174 Pelecypoda, 6 Scaphopoda, 179 Gastropoda, and 37 Cephalopoda. The Pelecypoda and Gastropoda were the dominant forms of macroscopic marine invertebrate life in the Navarro seas and they were nearly equally divided with respect to the number of named species and varieties. The Cephalopoda were next in importance, and the remaining groups were of relatively minor importance. Although the shells of mollusks are abundant in some beds, their aggregations nowhere assume the magnitude of reefs in present known outcrops.

The Navarro fauna includes 30 species (approximately 7 per cent) that may be classed as long-ranging both stratigraphically and geographically, in Upper Cretaceous sediments younger than the Eagle Ford shale, in the Atlantic and Gulf Coastal Plain. In the general table the names of these species are preceded by an asterisk (\*). In addition to these longranging forms the following five forms of less general distribution range downward into the Taylor marl or beds of Taylor age, either in Texas or clsewhere in the Coastal Plain: Lithophaga carolinensis, Cymella bella texana, Dentalium leve, Cadulus obnutus, and Gyrodes supraplicatus (questionably).

The following Navarro species arc recorded as common to the Upper Cretaceous of the Western Interior; the stratigraphic position or range of each with respect to the standard section of that region is indicated in parentheses:

Lingula subspatulata (through the Pierre and Fox Hills)

Solemya bilix (upper Pierre, through Fox Hills to Cannonball member of Lance) Inoceramus vanuxemi (through the Pierre) Pteria? linguaeformis (through the Pierre) Ostrea congesta (through the Niobrara and Pierre) O. plumosa (middle Pierre) Exogyra costata (middle Pierre) Dentalium pauperculum (Fox Hills and Cannonball member of Lance) Acmaea? occidentalis (upper Pierre) Capulus spangleri (upper Pierre) Anisomyon borealis (upper Pierre) Baculites claviformis, equal B. grandis (in part) of previous records (upper Pierre) Scaphites brevis (through the Pierre) Placenticeras meeki (through the Pierre) P. intercalare (through the Pierre)

The upper part of the Pierre shale is interpreted to correspond in age to the lower part of the Navarro group, and the Fox Hills sandstone to the upper Navarro, from which it follows that those species that do not range below the upper Pierre are of Navarro age.

Attention may be called to several Navarro species not included in the preceding list that have more or less closely analogous species (shown in parentheses) in the Western Interior:

- Polinices rectilabrum (P. obliquata (Hall and Meek), upper Pierre)
- Anisomyon haydeni (A. patelliformis Meek and Hayden, upper Pierre)
- Solenoceras texanum (S. mortoni (Meek and Hayden), upper Pierre)
- Scaphites rugosus (S. nodosus Owen, upper Pierre)
- Discoscaphites roanensis (D. conradi (Morton) Meek, Fox Hills)
- Sphenodiscus tirensis (S. lenticularis Meek, Fox Hills)
- Belemnitella americana (B. bulbosa Meek and Hayden, upper Pierre)

From the general table of ranges it appears that about 90 per cent of the named

Navarro species, as at present known, are restricted in range to the Navarro or to sediments of Navarro age, and it is important to note that fully 20 per cent of this new fauna made its first appearance in the Neylandville, the basal formation of the Navarro group. As evidence that the Nevlandville is faunally more closely related to the sediments of the Navarro group above it, than to the underlying Taylor marl, disregarding the long-ranging species. only five Neylandville species range downward into the Taylor marl or beds of Taylor age, whereas 33 or more species (not long-ranging) continue upinto post-Nevlandville beds. ward It should be added that many molluscan species in beds of upper Austin and Taylor age (Exogyra ponderosa zone) in the Atlantic and Gulf Coastal Plain are clearly related to, probably ancestral to, species in overlying beds of Navarro age (Exogyra costata zone). These related species and the 30 long-ranging species indicate a succession of closely related, but gradually changing, faunas from late Austin time to the end of the Cretaceous: there is no evidence of any catastrophic event such as would cause a sweeping destruction of species. until the end of the Cretaccous. The differences that exist between the faunal assemblages of the four formations are due in part to facies differences in the formations, in part to evolutionary devel-opment of the organisms, in part to the extinction of some species, and in part to incoming migrants from other regions.

There is evidence of emergence and erosion within the Upper Cretaceous series at the tops of the following formations: Woodbine sand, Eagle Ford shale, Austin chalk, Wolfe City sand member of Taylor marl (in places), Pecan Gap chalk member of Taylor marl, Nacatoch sand, and Corsicana marl (in places). But none of these interruptions to sedimentation caused destruction of marine organisms on anything like the scale of the one great break that separates the sediments of the Navarro group from those of the overlying Midway group (Tertiary, Paleocene).

Of the 411 species recorded from the Navarro group (Table 5, pts. 1 and 2) the only one known with reasonable certainty to have survived the events of the Cretaccous-Tertiary interval is *Gryphaeostrea vomer*, and it has not been reported from the Midway of Texas except as a mechanically introduced shell reworked from the underlying Kemp formation into the base of the Midway; this species is common in the Eocene of Maryland and New Jersey. As here classified, 192 genera (counting 8 subgenera as genera) are represented in the Navarro fauna (see Table 6; of these, 62 (questionably 64) genera are known to range upward into Tertiary sediments, leaving about 128 genera restricted to sediments below the Tertiary; in other words, about one-third of the recognized genera of the Navarro group range upward into the Tertiary.

If a comparison be made between the Kemp clay, the uppermost formation of the Navarro group, and the Midway group, of the 99 molluscan species identified from the Kemp, none except Gryphaeostrea vomer is known to range upward into beds of Tertiary age. Ninety-four genera of mollusks (including 26 forms that have not been given specific names) have been recognized in the fauna of the Kemp clay. Of this number, 63 (67 per cent) are not known to range upward into the Tertiary; the 63 genera include 1 of Echinodermata (cchinoid), 24 of Pelecypoda, 31 of Gastropoda, and 7 of Cephalopoda (ammonites); the remaining 31 genera (about 33 per cent) do range above the Cretaceous. If to the latter be added those genera that are known both below the Kemp clay in lower strata of the Navarro group, and above the Kemp in the Tertiary, and, though not so recorded, should be present in the Kemp, the percentage of the Kemp genera ranging into the Tertiary would be increased to about 50 per cent.

The Midway fauna of Texas as enumerated by Julia Gardner,<sup>13</sup> contains 56 genera of mollusks, of which 21 are known to range downward into the Cretaceous, and 35 compose a new immigrant fauna in the early Tertiary seas of the Gulf region.

From the data given it is apparent that during the interval represented by the unconformity separating the Navarro group from the Midway group in the Gulf region, a major change took place in the composition of the molluscan fauna of that region, and this is true despite the fact that

<sup>&</sup>lt;sup>13</sup>Gardner, Julia, The Midway group of Texas: Univ. Texas Bull. 3301, 403 pp., 28 pls., 1935,

the Kincaid formation (lower Midway) is lithologically similar, especially in its clavey parts, to the underlying Kemp clay. This faunal change is far greater than that which took place during the long time represented by the Austin, Taylor, and Navarro units for, as previously stated, 30 or more species of mollusks lived throughout that time without important evolutionary change, whereas no species crossed the Navarro-Midway line in Texas. If the time represented by the unconformity separating the Kemp clay from the Kincaid formation was geologically short and represented a relatively insignificant episode, as has been claimed, it would seem theoretically probable that a considerable part of the Kemp fauna would have survived in the presumably similar environmental and climatic conditions that existed in the Kincaid sea.

If the Cretaceous-Tertiary unconformity represented an important time interval in the Gulf region, as the evidence seems to indicate, the time represented by the same unconformity in the Atlantic Coastal Plain must have been much longer, for there sediments of both Kemp and Midway ages are missing from the section.

When a cause is sought for the revolutionary changes in the marine life of the Gulf region during the interval separating the Navarro group from the Midway group possible several explanations present themselves for consideration. It has been satisfactorily determined that the contact between the two groups marks a physical break, an erosional unconformity. The time represented by this break cannot be directly determined on the basis of the physical evidence. However, if the Danian of the European section is not represented by synchronous sediments in the Atlantic and Gulf Coastal Plain, the interval would have had to be long enough to include Danian time. The Danian is certainly not represented in the Navarro group, and Gardner,14 following the generally accepted correlation, has concluded that the Midway group is synchronous with the Paleocene of the European section, which overlies the Danian. As the Danian itself is bounded both below and above by erosional unconformities representing time intervals of unknown length, the NavarroSince evolutionary changes do take place with the passage of time, time may be invoked as one of the causative factors involved in the changed aspect of the Midway fauna. But that factor alone can not be accepted as an adequate explanation of the changes, for it is not conceivable that the Navarro-Midway interval could have been long enough for normal, unstimulated evolutionary processes to have produced the observed sweeping changes in the old faunas, and, of course, would not explain the influx of new faunal elements present in the Midway.

A slight cooling of the climate has been invoked by Schuchert and Dunbar<sup>15</sup> and others as a factor contributing toward the extinction of genera and species at the close of the Cretaceous. Although there may have been slight lowering of the average temperature in the Gulf region, the faunal evidence of such a change, as at present known there, is wanting. The faunal assemblage in the sediments of the Navarro group is about what one would expect it to be in the waters of a warm temperate zone. The presence of rudistids as a rather meager element suggests even the marginal waters of a subtropical sea; the absence of rudistids in the Upper Cretaceous sediments east and northeast of Alabama may indicate a slightly cooler climate in the middle and north Atlantic Coastal Plain. Gardner<sup>16</sup> has said of the Midway fauna:

The Midway fanna of Texas is unmistakably a part of the homogeneous biota which lived on the warm and warm temperate shores of the Gulf of Mexico and as far south as Brazil, and is less definitely a part of the more heterogeneous biota originating in the inshore waters of the old Tethyan sea.

It would appear from this quotation that the waters of the Midway sea were as warm as those of the Upper Cretaceous sea, and that the postulated cooler climate, if it existed, must have been confined within the time limits of the erosion interval separating the Navarro group from the Mid-

Midway unconformity, which includes both Danian time and these erosion intervals, must be put in the category of an important time break.

<sup>&</sup>lt;sup>15</sup>Schuchert, Charles, and Dunbar, Carl O., A Text Book

of geology-Historical geology (3d ed., 1933), John Wiley & Sons, Inc., pp. 366-367, 1933.

<sup>&</sup>lt;sup>16</sup>Gardner, Julia, *op. cit.*, p. 99.

way group. The acceptance of this view would imply the further postulate that the erosion interval was long enough to account for a change from a warm-temperate to a cooler climate after the deposition of the Kemp clay and back again to a warm-temperate climate before the deposition of the Midway sediments.

An explanation that seems to account most satisfactorily for the known faunal changes is one that postulates an emergence of the land, or a lowering of sea level, at the end of Upper Cretaceous time, such that the strand line retreated to the relatively steep outer slope of the Continental Shelf, throughout the length of the Atlantic and Gulf Coastal Plain. The sea bottom suitable for the existence of the multiplicity of organisms that had been maintaining a lazy existence in the salubrious waters of a broad continental shelf was thus reduced to a narrow strip. In this drastically restricted zone competition was severe, and the forms that were unable to adapt themselves to the cramped living conditions perished in the struggle. Just how long the struggle went on in this restricted zone is not known, but the completeness of the change effected in the faunal assemblage suggests that it continued for a considerable stretch of geologic time. The competition stimulated evolution and the forms that survived the struggle were changed creatures when, with the advance of the Midway sea, they finally returned to the ancestral home. So greatly were they changed in form and surface features that they must be classed as new species. Along with these changed forms came also immigrant strangers from other seas, adding thus to the marked differences that distinguish this Midway fauna from the older fauna of the Navarro group.

Because of geographic limitations the new elements that appear in the Midway fauna must have come from the south or east, but neither the exact route nor the manner of their coming has been fully ascertained. Gardner regards them as having come from the inshore waters of the old Tethyan sea, that is, the sea that covered the Mediterranean and West Indian regions. But regardless of their source they form important elements of contrast between the faunas of the Navarro group and those of the Midway group.

# MARINE EQUIVALENTS OF THE NAVARRO IN WESTERN UNITED STATES

Western Interior.-- As at present understood the Navarro group is represented in the Western Interior of the United States by the upper part, probably less than the upper half, of the Pierre shale and by the Fox Hills sandstone, and their equivalents. A comparison of the Upper Cretaceous deposits of the Gulf region with those of the Western Interior was made by Stephenson and Reeside17 in 1938, who summarize the evidence for this correlation. Although the faunas in the two regions are in the main very different the following molluscan forms in the Western Interior afford a basis for correlation with the Navarro group: From the upper Pierre and equivalent beds, Solemya bilix (questionably present), Inoceramus vanuxemi, Exogyra costata (rare), Polinices rectilabrum, Capulus spangleri, Oligoptycha americana, Anisomyon borealis, A. haydeni, Solenoceras spp., Baculites grandis (analogous to B. claviformis), Parapachydiscus (1 or more species), Scaphites brevis, Placenticeras meeki (ranges through Eagle and Pierre; in Neylandville only in Gulf region); from the Fox Hills and equivalent beds, Solemva bilix (questionably present), Discoscaphites (several species), and Sphenodiscus (several species). The question as to whether the strata containing Solemya bilix in Colorado belong to the upper Pierre or to the Fox Hills has not been settled. (See Pl. 2, opp. p. 36.)

The exact lower limit of the equivalents of the Navarro group in the Pierre shale (and beds of Pierre age) has not been determined. The Neylandville marl and the Nacatoch sand of the Navarro group are tentatively considered to be of upper Pierre age, and the Corsicana marl and Kemp clay of Fox Hills age.

West Coast.—The west coast (California and Oregon) Upper Cretaceous (Chico formation), although comparatively near to the Western Interior region geographically, contains faunas that are specifically totally different from those of both the interior region and the Atlantic and Gulf

<sup>&</sup>lt;sup>17</sup>Stephenson, L. W., and Reeside, J. B., Jr., Comparisons of Upper Cretaceous deposits of Gulf region and Western Interior region: Bull. Amer. Assoc. Petr. Geol., vol. 22, no. 12, pp. 1629-1638, 3 figs., 1938.

Coastal Plain. These west coast faunas are Indo-Pacific in their affinities and the seas in which they lived had no direct communication with the Upper Cretaceous seas to the east. Anderson<sup>18</sup> in his latest publication states that the Chico has an aggregate thickness of 26,700 feet, and a time span extending from Albian to upper Maestrichtian or Danian. The most complete section mentioned is on the slopes of the Diablo Range in central California. He does not give the evidence in detail for referring an upper part of the Chico to the Maestrichtian but states that the faunas are composed largely of cephalopods; he does not indicate the limits of the part that should be referred to the Maestrichtian.

Anderson's reference of beds in the upper part of the Chico to an age as young as Maestrichtian or Danian is in contrast to the earlier view of Stanton<sup>19</sup> that "In time range the Chico formation apparently began somewhat earlier and continued somewhat later than the Colorado fauna of the interior sea but it did not extend to the end of the Cretaceous, and latest Cretaceous time is probably not represented by marine deposits on the Pacific Coast."

## MARINE EQUIVALENTS OF THE NAVARRO GROUP OUTSIDE THE UNITED STATES

Any attempt to correlate formations and restricted zones in the Upper Cretaceous series of the Atlantic and Gulf Coastal Plain with zones of corresponding age in foreign countries is fraught with difficulty because of the paucity of common species. Certain common genera, particularly among the ammonites, that occur in the same sequence elsewhere as here, a few molluscan forms so similar that they have been called by the same specific names, and a few closely analogous species, have been found useful in determining approximately the age relationships of faunal zones in widely separated countries. Rarely is it possible to determine the exact age equivalence of restricted zones in

countries as widely separated as those of North America and Europe. Nevertheless considerable progress has been made in dating the Upper Cretaceous sediments in different parts of the world.

A faunal zone somewhat above the middle of the Austin chalk in Texas, that may be correlated with a fair degree of confidence with a corresponding zone in Europe is the one carrying *Inoceramus undulatoplicatus* Roemer. In England the Coniacian (zone of *Micraster cor-anguinum*) carries a form that has been referred to Roemer's species. A closely analogous form is *I. schmidti* Michael from Saghalien, Japan. *I. diversus* Stoliczka from the Trichinopoly group of India, though small and nontypical as figured, is probably an analogous form.

The upper part of the Austin chalk above the zone of Inoceramus undulatoplicatus carries the animonites Mortoniceras texanum Roemer and (rarely) Scaphites hippocrepis (DeKay). Both of these species have been identified in the zone of Marsupites testudinarius in the Upper Chalk of Europe (Santonian division of the Senonian). M. testudinarius is a stemless free-floating crinoid; an analogous species, M. americanus Springer from the Tombigbee sand member of the Eutaw formation of Mississippi, though differing in minor features, is so nearly like M. testudinarius that Springer20 hesitated before giving it a separate specific name. The Tombigbee sand carries ammonites that are closely related to Mortoniceras texanum (Roemer) from the upper part of the Austin chalk of Texas. Since a freefloating form, such as Marsupites, might easily have been transported a long distance in a relatively short time, it seems satisfactorily established that the Tombigbee sand and the upper part of the Austin chalk are of Santonian age.

The Taylor marl of Texas, because of its position between the Austin chalk below and the Navarro group above, must be approximately of Campanian age, though few common species among the larger fossils can be cited in support of the correlation. However, none of the available paleontologic evidence can be construed as opposed to the correlation.

<sup>&</sup>lt;sup>18</sup>Anderson, F. M., Chico series in Calfornia and Oregon: Bull. Geol. Soc. Amer., vol. 49, no. 12, pt. 2, p. 1803, 1938. Abstract.

<sup>&</sup>lt;sup>10</sup>Stanton, T. W., Succession and distribution of later Mesozoic invertebrate faunas in North America: Jour. Geology, vol. 17, pp. 418-419, 1909.

<sup>&</sup>lt;sup>20</sup>Springer, Frank, Harvard College Mem, Comp. Zool., vol. 25, no. 3, pp. 158-161, 1911.

The Navarro group of Texas, and formations of Navarro age in the Atlantic and Gulf Coastal Plain in general, have long been accepted by most authorities as of high Upper Cretaceous (Maestrichtian) age. The principal evidence for this correlation is that afforded by a few identical or analogous forms present in the Navarro equivalents and in the Maestrichtian of Europe, among which may be mentioned: Belemnitella americana (Morton), analogous to B. mucronata (Schlotheim) which, however, ranges downward into the upper Campanian: the ammonite genus Sphenodiscus. none of whose several species is identical on the two sides of the Atlantic; Parapachydiscus aff. P. gollevillensis (D'Orbigny), represented in the Escondido formation of Texas by one specimen; and one small fragment of an internal mold of *Parapachydiscus*, similar to gollevillensis, from the Prairie Bluff chalk of Mississippi.

There is less certainty about the Maestrichtian age of the Neylandville marl than about the other three formations of the Navarro group, and the possibility that the Neylandville may eventually be correlated with the uppermost Campanian is recognized.

Beds of Maestrichtian age are less widespread in Europe and the Mediterranean region in general than are the older Upper and Lower Cretaceous strata, and the fact that the Maestrichtian is not mapped separately on most of the available geologic maps makes the determination of its distribution difficult.

In Europe, Asia. and Africa the presence in a stratum of any one of the following ammonite species is generally accepted as indicative of Maestrichtian age: Parapachydiscus gollevillensis (D'Orbigny), P. oldhami (Sharp), P. neubergicus (Hauer), P. colligatus (Binckhorst). Sphenodiscus ubagshi Grossouvre, S. rutoti Grossouvre, S. binckhorsti J. Böhm, S. konicki Hyatt (or any other authentic species of Sphenodiscus), and Discoscaphites constrictus (Sowerby). Species referable to the genus Sphenodiscus are common in the Navarro group and its American equivalents; however, the genus is known to range downward into the upper part of the Taylor marl at one locality in Travis County, Texas. Related

species of *Parapachydiscus* in the Navarro group are undescribed analogues, one in the Escondido formation of Medina County, Texas, and another in the Prairie Bluff chalk of Mississippi. Several species of *Discoscaphites* are present in the Navarro group. In Europe Belemnitella mucronata (Schlotheim), a close analogue of *B. americana* (Morton), ranges from the Maestrichtian downward into the Campanian, but the species *B. lanceolata* (Schlotheim) appears to be restricted to the Maestrichtian.

Marine sedimentary formations of Maestrichtian age are known in many parts of the world. Those that have come to my attention through consultation of the literature are indicated on the folding map (Pl. 2) opposite page 36; a complete representation of the places at which marine strata of this age have been recorded would require more time for the necessary research than is now available. As the map is on a very small scale the color pattern used is necessarily greatly exaggerated with respect to the actual size of many of the areas of outcrop. On the other hand the published data about many of the localities are inadequate to show the areal extent of the formations containing the fossil-bearing beds.

Canada.—Marine equivalents of the Navarro group extend from the Western Interior of the United States into the Provinces of Alberta and Saskatchewan, Canada, where they are assignable mainly to the Bearpaw shale (upper Pierre age).

*Mexico.*—The Escondido formation of the Navarro group, which is the equivalent of the Kemp clay in the area between Bexar and Maverick counties, Texas, extends from Maverick County southward through the northeastern corner of the State of Coahuila, and for an undetermined distance into the State of Nuevo Leon, Mexico;<sup>21</sup> it carries a typical Escondido fauna. The physical relation of the Escondido of this area to the upper part of the Mendez shale of the Tampico region has not been determined, but the

<sup>&</sup>lt;sup>21</sup>Tatum, J. L., General geology of no-theastern Mexico: Bull. Amer. Assoc. Petro. Geol., vol. 15, no. 8, pp. 867-893, 1931.

Kane, William G., and Gierhart, G. B., Areal geology of Eocene in northeastern Mexico: Bull, Amer. Assoc. Petro. Geol., vol. 19, no. 9, pp. 1357-1388, 1935.

two are considered to be approximately synchronous.

Upper Cretaceous sediments having a thickness estimated by Böse<sup>22</sup> to be 600 meters (nearly 2000 feet), but considered by Wade<sup>23</sup> to be over 5000 feet, are exposed along the railroad between Cár-denas and Canoas, State of San Luis Potosi, Mexico. The greater part of this section is of Navarro age. Exogyra cancellata Stephenson is present somewhat below the middle of the section, as interpreted by Wade, and Exogyra costata Say (variety with narrow costae) occurs considerably above the middle of the section. According to Wade the Coralliochama zone lies still higher, and Muir<sup>24</sup> cites evidence to show that the upper part of the Cárdenas beds, particularly the Coralliochama zone, is synchronous with the upper part of the Mendez shale in the Tampico region, and with the Navarro group of Texas. Additional evidence is given elsewhere in the present work (p. 29) that the upper Mendez is a Navarro equivalent, and also an equivalent of the rudistid-bearing beds of the West Indian region.

Muellerried<sup>25</sup> mentions the occurrence, among other mollusks, of Barrettia monilifera Woodward and Titanosarcolites giganteus (Whitfield) in the Upper Cretaceous of Chiapas, Mexico, but he does not indicate where in that State the specimens were found. He is inclined to doubt the Maestrichtian age of the rudistid fauna of the West Indian region, Central America, and southern Mexico, and prefers to consider the fauna of lower Senonian age; he thus differs from the opinion of most present-day authorities (see p. 37), who consider the fauna Maestrichtian.

Guatemala. -- Representatives of the rudistid fauna of the West Indies have been reported by Mac Gillavry26 from Guate-

22Böse, Emilio, La fauna de moluscos del Senoniano de Cárdenas, San Luis Potosí: Instituto Geológico de México, Bol, num, 24, 95 pp., 18 pls., 1906.

23Wade, Bruce, unpublished notes,

<sup>21</sup>Muir, John M., Geology of the Tamp'co region, Mexico; Published by Amer. Assoc. Petro. Geol., Tulsa, Oklahoma, pp. 72-77, 1936.

<sup>25</sup>Muellerried, F. K. G., Sobre el Hallazgo de paquiodontos gigante-cos en el Cretácico de Chiapas: Inst. Biologia México Anales, tomo 5, no. 1, pp. 81-82, 1934.

<sup>26</sup>Mac Gillavry, H. J., Some rudists from the Alta Verapiz, Guatemala: K. Akad, Wetensch. Amsterdam Proc., vol. 37, no. 4, pp. 232 233, 1 pl., 1934. Also. Remarks on rudists: Same journal, vol. 38, no. 5, pp. 358-565, 1935.

mala. He identifies Biradiolites adhaerens (Whitfield) from San Diego on Rio Isidoro, and gives references to Sapper's recorded occurrence of Barrettia Woodward near Samac and Campur.

West Indies .- Upper Cretaceous strata of Jamaica and other West Indian Islands have yielded a molluscan fauna that includes a varied representation of rudistid species, among which may be mentioned Trechmann, Barrow Trechmann, Trechmann, Via Trechmann, **T**itanosarcolites Woodward, Praebarrettia Bournonia Mac Gillavry, Biradiolites D'Orbigny, Antillocaprina Trechmann. Tampsia Stephenson, and Lapeirousia Bayle. In addition to Jamaica this fauna is present, though in places not fully or only meagerly represented, in Cuba, Haiti, Puerto Rico?, the Dominican Republic, and the Island of St. Croix. Although Hawkins (1923, 1924) and Lambert (1928) placed the rudistid-bearing beds as low as the Cenomanian or Turonian, the opinion of others, including Trechmann (1924), Spath (1925), Palmer (1923),<sup>28</sup> Mac Gillavry (1937), Vermunt (1937), and Stephenson (1938), is that these beds are of late Upper Cretaceous age, either upper Campanian or Maestrichtian. The following are selected references on the Upper Cretaceous of the West Indies.

1897. Whitfield, R. P., Descriptions of species of Rudistae from the Cretaceous rocks of Ja-maica: Am.Mus.Nat.History Bull. 9, pp. 185-196, pls. 6-22.

1921. Cooke, Wythe, Stratigraphy and structural geology and geologic history IDominican Republic1: Dominican Republic Geol. Survey Republic1: Dominic Mem., vol. 1, p. 55.

1922. Stephenson, L. W., Some Upper Cre-Lacous shells of the rudistid group from Tama-ulipas, Mexico: U.S.Nat,Mus,Proc., vol. 61, Art. 1, pp. 4-9, pls. 1 8, 1923, Vaughan, T. Wayland, Stratigraphy of

the Virgin Islands of the United States and of Culebra and Vieques islands, and notes on eastern Puerto Rico: Washington Acad.Sci.Jour., vol. 13, p. 305.

1923. Hawkins, H. L., Some Cretaceous Echinoidea from Jamaica: Geol.Mag., vol. 60, pp. 199-216.

1924. Trechmann, C. T., The Cretaceous lime-

stones of Jamaica and their Mollusca: Geol. Mag, vol. 61, pp. 385–410, pls. 22–26, text fig. 1. 1924. Hawkins, H. L., Notes on a new collec-tion of fossil Echinoidea from Jamaica: Geol.

Mag., vol. 61, pp. 312–324. 1924. Woodring, W. P., Brown, J. S., and Burbank, W. S., Geology of the Republic of

<sup>25</sup>In Geol, Survey Prof. Paper 193-A, p. 2, I mistakenly stated that Palmer favored a Cenomanian or Turonian age for the rudistid-bearing beds.

Plate 2

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Haiti, pp. 97-98, Department of Public Works, Port-au-Prince.

1925. Spath, L. F., On Senonian Ammonoidea from Jamaica: Geol. Mag., vol. 62, pp. 28-32. 1928. Palmer, Robert H., The rudistids of

1928. Palmer, Robert H., The rudistids of southern Mexico: California Acad.Sci.,Occ. Paper 14, 137 pp., 18 pls.

1933. Palmer, R. H., Nuevos rudistas de Cuba: Rev. Agricultura, vol. 14, nos. 15 y 16, pp. 95-125, 10 lams.

1936. Thiadens, A., Rudistids from southern Santa Clara, Cuba: K. Akad. Wetensch. Amsterdam Proc., vol. 39, no. 8, pp. 1010-1019, 1 pl., 3 text figs.

1937. Mac Gillavry, Henry James, Geology of the Province of Camaguay, Cuba, with revisional studies in rudist paleontology: Dissertation, Univ. Utrecht, 1937, 168 pp., 10 pls. (Appears also as No. 14 of the Physiographic and Geologic series of the Geographic and Geologic Communications.)

1937. Vermunt, L. W. J., Geology of the Province of Pinar del Río, Cuba: Geog. geol. Mededeel. Phys. Geol., Reeks, no. 13, 60 pp., 1 pl.

deel. Phys. Geol., Reeks, no. 13, 60 pp., 1 pl. 1937. Vermunt, L. W. J., Cretaceous rudistids of Pinar del Río Province, Cuba: Jour. Paleontology, vol. 11, no. 4, pp. 261–275, pls. 36, 37, 3 text figs.

1938. Stephenson, L. W., A new Upper Cretaceous rudistid from the Kemp clay of Texas: U.S.Geol.Survey Prof. Paper 193-A, 15 pp., 5 pls.

Spath has assigned a Campanian or later age to ammonite-bearing beds in Jamaica that lie below the beds carrying rudistids. He recognizes the following forms: Epigonoceras sp., Parapachydiscus aff. P. stallauensis (Imkeller), P. cf. P. gollevillensis (D'Orbigny), Baculites sp., and Glyptoxoceras cf. G. rugatum Forbes. Assuming the correctness of Spath's correlation the rudistid zone can not be older than upper Campanian or Maestrichtian, with the probability in favor of the latter.

The presence of *Titanosarcolites odds*ensis Stephenson in the Kemp clay of Texas seems to relate the Navarro group to the rudistid-bearing beds of the West Indies, through the *Tampsia*-bearing beds in the upper part of the Mendez shale of Tamaulipas, Mexico, the *Barrettia*- and *Titanosarcolites*-bearing beds of Chiapas, Mexico, and the *Biradiolites*- and *Barrettia*bearing beds of Guatemala. There is no recorded difference of opinion as to the upper Maestrichtian age of the Kemp clay.

Northern South America.—Strata of Lower and carly Upper Cretaccous age are recorded in Venezuela in the mountains flanking the Maracaibo Basin on the west, south, and southeast, east of the Maracaibo Basin in the State of Lara, on the south flank of the mountains on the border between the States of Aragua and Guarico, and in the mountains in the State of Sucre and along the northern border of the State of Monagas. Strata of late Upper Cretaceous age are much more limited in their distribution.

Formations of late Upper Cretaceous age are recognized in the southwestern part of the Maracaibo Basin, Venezuela, and in adjacent parts of Colombia. Hedberg<sup>29</sup> and Sass consider the Mito Juan formation (max. thickness nearly 1000 feet) to be of high Upper Cretaceous age, probably a Navarro equivalent; they cite as evidence the presence of the Foraminifera Gümbelitria, Gümbelina, and Siphogenerinoides. The Rio de Oro formation overlies the Mito Juan formation and is more than 3000 feet thick. The authors record the presence of ammonites in the basal beds of the formation, and in a footnote, p. 86, English edition, say: "A personal communication from Doctor Spath dated London, February 18, 1937, states that the dominant ammonite genus present in this material is Sphenodiscus, and that there is no doubt about the Maestrichtian age of the fauna. He adds that the only other recognizable ammonite is a Coahuilites, known from Mexico and Texas.'

Although the evidence afforded by Doctor Spath's examination of the ammonites would seem to establish the Upper Cretaceous (Maestrichtian) age of the basal part of the Rio de Oro formation, the authors are still in doubt about the age of the higher parts of the formation, as shown by the following quotation (p. 86. English edition). "The fauna seems to indicate uppermost Cretaceous age though ... there are some reasons for correlating the formation with the Guasare formation of supposed Paleocene age."

If the Cretaceous formations of this area form a conformable series through the Upper Cretaceous into the Rio de Oro formation (possibly Paleocene), as interpreted by the authors, equivalents of the Navarro group would necessarily be present in the series. However, in a region

<sup>&</sup>lt;sup>20</sup>Hedberg, H. D., and Sass, L. C., Synopsis of the geologic formations of western part of the Maracaibo Basin, Venezuela: Ministerio de Fomento, Venezuela, Boletín de Geologia y Mineria, Tomo I, Spanish edition, pp. 77-120, 1937; English edition, pp. 73-112, 1938.

of orogenic movements such as this must have been to provide the conditions for the accumulation of more than 8000 feet of mainly clastic sediments, the complete absence of stratigraphic breaks in so thick a series seems highly dubious.

The same authors correlate the Mito Juan formation with the upper part of the Umir formation of Magdalena Valley in Colombia, and with the lower part of the Santa Anita formation of eastern Venezuela,<sup>30</sup> the upper part of which is of Tertiary age (Paleocene or Eocene). Wheeler,<sup>31</sup> however, correlates the Umir formation questionably with the Eocene.

*Brazil.*—Gray limestone in the State of Parahyba do Norte, Brazil, has yielded fossils, some species of which are accepted as indicative of Maestrichtian age.<sup>32</sup> This correlation is based mainly on the evidence afforded by the ammonites, especially *Sphenodiscus braziliensis* Maury, *Sphenodiscus parahybensis* Maury, *Sphenodiscus* sp., and numerous species referable to the genus *Parapachydiscus* Hyatt. Among the latter are species that resemble *P. gollevillensis* (D'Orbigny), the type species of the genus.

Chile.—A cephalopod fauna from the Quiriquina beds, Island of Quiriquina, north of Concepcion, southern Chile, has been classed by Steinmann<sup>33</sup> as of Senonian age, and the presence of Pachydiscus quiriquinae Philippi, apparently a good analogue of Parapachydiscus arkansanus from the Nacatoch sand of Texas and Arkansas, suggests that the containing bed may be as young as the Navarro group (Maestrichtian). The presence in the fauna of the ammonite Discoscaphites *constrictus* (Sowerby) tends to confirm this correlation.

Argentina .--- The Roca formation of west-central Argentina has for many years been controversial as between its early Tertiary and late Upper Cretaceous age. Weaver<sup>34</sup> has recently shown that the formation carries a large species of Baculites (B. argentinicus Weaver), recorded from three localities, and that among other marine mollusks the formation also contains species of Exogyra, Gryphaea, and Belemnites. On the evidence of these fossils, particularly the *Baculites*, he correctly correlates the formation with the Upper Cretaceous. He does not attempt an exact age assignment within the Upper Cretaceous, but suggests that the unit may represent an interval of time ranging from middle Campanian through the Maestrichtian and into the Danian. The figured specimen (p. 431) of Baculites argentinicus is a badly crushed and broken internal mold with the sutures well preserved; it resembles the large Baculites claviformis Stephenson from the Neylandville marl and Nacatoch sand of Texas, both with respect to size and the flattened dorsum, which is well shown in figures 2b and c.

Palmer Land.--Killian and Reboul<sup>35</sup> have described a Senonian cephalopod fauna from the small islands of Seymour and Snow Hill off the east coast of Palmer Land (West Antarctica), near and north of the Antarctic Circle. One species, Parapachydiscus aff. P. gollevillensis (D'Orbiguy), from Seymour, suggests that the containing stratum may be as young as Maestrichtian.

Europe in general.—The Upper Cretaceous sedimentary rocks of Europe were formed in two principal basins: A northern basin of shallow to moderate depths of water which included parts of England, northern France, Belgium, Holland, northern Germany, the Baltic region (Den-

<sup>&</sup>lt;sup>30</sup>Hedberg, H. D., Stratigraphy of the Rio Querecual section of Northeastern Anzoategui, Venezuela: Ministerio de Fomento, Venezuela, Boletín de Geología y Minería, Tomo I, Spanish edition, pp. 257-258, 1937; English edition, pp. 243-244, 1938.

<sup>&</sup>lt;sup>31</sup>Wheeler, O. C., Tertiary stratigraphy of the Middle Magdalena Valley: Acad. Nat. Sci. Philadelphia Proc., vol. 87, pp. 21-39, 1935.

<sup>&</sup>lt;sup>32</sup>Maury, Carlotta, J., O. Cretaceo de Parahyba do Norte: Brazil Serv. Geol. e Miner. Mon., vol. 8, 305 pp., 35 pls. 1930.

<sup>&</sup>lt;sup>30</sup>Steinmann, G., and others, Beitrage zur Geologie und Palaentologie von Südamerika. III, Das Alter und die Fauna der Quiriqu'na-Schichten in Chill, C, Die Gephalopoden der Opfiriquina-Schichten, by Steinmann; Neues Jahrbuch für Mineralogie und Palaeontologie, Beilage-Band 10, pp. 61-94, pls. 1-6, 1895.

<sup>&</sup>lt;sup>34</sup>Weaver, C. E., The Roca formation in Argentina: Amer, Jour, Sci., 5th ser., vol. 13, pp. 417-434, figs. 1 and 2a-e, 1927. Also Paleontology of the Jurassic and Cretaceous of West Central Argentina: Mem. Univ. Washington, Scattle, vol. I, pp. 82-89, 1931.

<sup>&</sup>lt;sup>35</sup>Killian, W., and Reboul, P., The Céphalopodes néocrétacés des lles Seymour and Snow Hill; Wissenschaftliche Ergebrisse der Schwedischen Südpolar-Expedition 1901-1903 (conducted by Otto Nordenskjold), Band 3. Lief, 6, 75 pp., 20 pls., 1909,

Sweden), Poland, and southern mark, central Russia; and a deeper southern trough, a broad east-west Mediterranean basin embracing southern Europe (including the Alpine region), and northern Africa, and extending thence eastward into The distribution of the southern Asia. part of the series of Navarro age (Maestrichtian) is indicated by Haug,36 who gives on page 1299 a small, very much generalized sketch map showing his interpretation of the distribution of the different types of sediments of that age. A similar, but less detailed, treatment of the subject is given by De Lapparent.37 The Maestrichtian part of the section in the northern basin consists mainly of chalk, passing into clay and sand in places around the perimeter of the basin, and carries faunas characteristic of warm temperate waters. The corresponding part of the section in the southern basin is chiefly limestone and marl with a conspicuous rudistid fauna indicating tropical climatic conditions; these beds also pass into clays, sands, and conglomerates in places around the borders.

A generalized account of the Upper Cretaceous sediments of Europe is given in a recent work by Von Bubnoff.<sup>38</sup>

Localities at which marine beds of Maestrichtian age have been recorded are indicated on the folding map (Pl. 2), opposite page 36. No pretense of completeness is intended.

Great Britain.—The Navarro group is correlated with the upper part of the Belemnitella mucronata zone (Maestrichtian) of England; the lower part of this zone is of upper Campanian age. The zone occupies the upper part of the Upper Chalk and has its greatest development in Norfolk County, especially in the vicinity of Norwich; the zone has a lesser development in Hampshire County. The subzone Ostrea lunata Nilsson makes up the upper 20 meters of the Upper Chalk and is of Maestrichtian age. As previously stated B. mucronata (Schlotheim) is considered to be a close analogue of B. americana (Morton), which may be present at any stratigraphic position within the equivalents of the Navarro group (Exogyra costata zone.)

In the Counties of Londonderry and Antrim in northern Ireland are exposures of hard chalk of the *Belemnitella mucronata* zone, beneath Tertiary lava flows, two of the contained fossils of which are the animonites, *Parapachydiscus oldhami* (Sharp), an analogue of *P. arkansanus* of the Nacatoch sand, and *Parapachydiscus gollevillensis* (D'Orbigny), which has a close unnamed analogue in the Escondido formation (upper Navarro) in Texas.

Several species in the Upper Cretaceous of England, as interpreted by Henry Woods,<sup>39</sup> that have close analogues in the Atlantic and Gulf Coastal Plain sediments, range from the Upper Greensand upward through the several chalks and are therefore of little value in correlating narrowly limited zones on opposite sides of the Atlantic. Among the Ostreidae, Ostrea semiplana Sowerby is reported to range from Turonian to the top of the Upper Chalk; figured specimens (vol. 2, pt. 9, pl. 57, figs. 6-7a) from the Belemnitella mucro*nata* zone, are very much like the variable Ostrea panda Morton (zones of Exogyra ponderosa and E. costata). Ostrea incurva Nilsson, whose range is given as Cenomanian to the Belemnitella mucronata zone of the Upper Chalk, is analagous to the long-ranging O. plumosa Morton. Ostrea canaliculata (Sowerby), whose range is from the Upper Greensand to the top of the Upper Chalk, is scarcely distinguishable from Gryphaeostrea vomer (Morton) which, in eastern America, ranges from the Exogyra ponderosa zone well up into the Eocene. In the Pectinidae. Pecten (Neithea) quinquecostatus Sowerby is recorded as ranging from the Upper Greensand upward into the Upper Chalk, but this use of this specific name is probably too broad, and should be restricted to narrower limits. The form of this species from the Upper Chalk (Senonian), Lewes, Sussex County, England, is closely akin

<sup>&</sup>lt;sup>39</sup>Haug, Émile, Traité de Céologie, pt. 2, pp. 1298-1338. 1910.

<sup>&</sup>lt;sup>37</sup>De Lapparent, A., Traité de Géologie, 5th ed., pp. 1454-1468, 1906.

<sup>&</sup>lt;sup>35</sup>Von Buhnoff, Serge. Geologie der Erde: Geologie von Europa, Band 2, Teil 2, pp. 953-1014, Tafel XI (folding at back), 1935.

<sup>&</sup>lt;sup>20</sup>Woods, Henry, The Cretaceous Lamellabranchia of England: Paleontographical Soc. Mon., vols. 1 and 2, 1904-1913.

to *Neithea casteeli* Kniker,<sup>40</sup> from the Austin chalk at Austin, Texas.

France.—The Upper Chalk extends from England into northern France, Belgium, and Holland. The uppermost chalk (Maestrichtian) is present in a small area in the District of Cotentin, Department of Manche, where the following ammonite species, indicative of Maestrichtian age, occur in association: Parapachydiscus gollevillensis (D'Orbigny), P. neubergicus (Hauer), P. colligatus (Binckhorst), and Discoscaphites constrictus (Sowerby).41 Chalk as high as the Maestrichtian has also been recorded at several localities in the Paris Basin including Mendon, d'Epernay, and Saint-Aignan.

The Upper Cretaceous of southern France (Tethyan province) is made up largely of hard limestones, marls, and sandstones in contrast to the chalks of England, northern France, and Belgium. Diagnostic Maestrichtian species are recorded from high Upper Cretaceous beds in several Departments in southern France,<sup>42</sup> as follows: Parapachydiscus gollevillensis (D'Orbigny) from Tercis, Department of Landes; *P. colligatus* (Binckhorst) from the Departments of Charente, Charente-Inferieure, Landes, and Haute-Garonne; P. neubergicus (Hauer) from the Departments of Landes, Basses-Pyrenees, and Hautes-Pyrenees; and Sphenodiscus ubagshi Grossouvre and S. rutoti Grossouvre, from Maurens, Department of Dordogne. The Maestrichtian is also represented in the Departments of Hautes-Alpes, Basses-Alpes, and Alpes-Maritimes.

Belgium and Holland.—Beds of Maestrichtian age carrying the characteristic brachiopods Thecidea papillata and Trigonosemus pectiniformis, and the echinoid Hemipneustes striato-radiatus, are present in the Mons Basin, in the

42Grossouvre, A. de, idem, pp. 202-217, 248-250.

region of d'Hautrage (Hainaut), Belgium.43

Sphenodiscus binckhorsti J. Böhm is recorded from beds of Maestrichtian age in the Province of Limbourg, Holland,<sup>44</sup> where it is associated with *Belemnitella mucronata* (Schlotheim). *Parapachydiscus* colligatus (Binckhorst) from the same beds appears to be a fairly close analogue of *P. scotti* from the Nacatoch sand.

Hyatt<sup>45</sup> describes a new species, *Sphenodiscus konicki*, presumably from the Maestrichtian beds near Maestricht, Holland.

Some of the gastropods of the typical Maestrichtian in Holland<sup>46</sup> appear to be analogues of Navarro species. The following may be mentioned:

Maestricht species	Analogous Navarro species
Turbo rimosus Binck- horst var. granulata Kaunhowen	Calliomphalus micro- cancelli and C. bellulus.
Aporrhais (Arrhoges) pelecyphora Kaun- howen	Anchura? lobata Wade
Aporrhais (Cultrigera) propinqua Kaun- howen	Pterocerella poinsetti- formis

Germany.—The zone of Belemnitella mucronata, including the uppermost or Maestrichtian part, forms the upper part of the Upper Cretaccous series in the Westphalian Basin of northwestern Germany. The same zone appears in outcrops projecting through the glacial drift at Zeltberg north of Lüneburg in the northern part of Hanover Province, Germany. The upper or Maestrichtian part is represented in the Aachen district by tuffaceous limestone which unconformably overlies older parts of the zone. Beds of

<sup>&</sup>lt;sup>40</sup>Kniker, Hedwig T., Comanchean and Cretaceous Pectinidae of Texas: Univ. Texas Bull. 1817, pp. 51-54, pl. 10, figs. 7-11, 1913.

<sup>&</sup>lt;sup>41</sup>Geikie, Archibald, Text-book of Geology: 4th ed., vol. 2, pp. 1195-1201, 1903.

Von Bubnoff, Serge, Geologie der Erde: Geologie von Europa, Band 2, Teil 2, pp. 967 996, Tafel XI, 1935.

Grossouvre, A. de, Les Ammonites de la Craie Supérieure: Mém. pour servir à l'explication de la carte géol. détailée de la France—Recherches sur la Craic supérieure, 2d pt., pp. 141-142, 182-184, 202-216, 1894.

<sup>&</sup>lt;sup>43</sup>Marlière, René, Contribution à l'étude des formations crétacées et tertiaires du Bassin de Mons, Deuxlème fascicule: Soc. Géol. de Belgique, Bull. nos. 2 et 3, pp. B50-B76, 1939.

<sup>&</sup>lt;sup>44</sup>Böhm, J., Ucher Ammonites pedernalis von Buch: Zeitschr. Deutsch, geol. Geselishaft, vol. 50, pp. 193-197, pl. 7, figs. 1, 1a, 1b, 1896. See also: Binckhorst, J. T., Monograph des Gastérpodes et des Céphalopodes de la Graie Supérieure du Limbourg-Classe dés Céphalopodes: pp. 21-30, Bruxelles-Leipzig. 1873.

<sup>&</sup>lt;sup>45</sup>Hyatt, Alpheus, Pseudoceratites of the Cretaceous: U. S. Geol. Survey Mon., vol. 44, p. 82, pl. 12, fig. 8, 1903.

<sup>&</sup>lt;sup>40</sup>Kaunhowen, F., D'e Gastropoden der Maestrichter Kreide: Paleontologische Abhandlungen, Achter Band, 132 pp., 13 Taf., 1898.

Maestrichtian age, representing the southern or Mediterranean facies, are recorded from Gossau and other localities in southern Germany.

Denmark.—In Denmark<sup>47</sup> the approximate equivalent of the Navarro is the White Chalk, referred to the upper part of the zone of Belemnitella mucronata (Maestrichtian), which crops out at a few places and, as shown by borings, is present beneath a covering of younger strata throughout Denmark, except the island of Bornholm, which is mainly granitic.

Throughout most of Denmark the White Chalk is immediately overlain by 10 to 40 meters of chalky limestone referred to the Danian division, the Upper Cretaceous versus Paleocene age of which is in dis-Although lacking such characterpute. istic Cretaceous genera as Scaphites, Baculites. Belemnitella. and Inoceranus, the Danian is said to contain a large number of species, mostly bryozoa, that are common to the underlying Senonian; among the larger common forms mentioned are Terebratulina striata Wahlenberg, Gryphaea vesicularis Lamarck, and Exogyra canaliculata (Sowerby), and these common forms, together with physical considerations have led Ravn, Ødum, Grönwall, and others to refer the Danian to the Cretaceous; others, including Grossouvre and Nielsson, have argued for the Tertiary age of the Danian. No sediments of Danian age are known to be present in the Atlantic and Gulf Coastal Plain, where the time interval of this unit is believed to be represented by the Cretaceous-Paleocene unconformity.

Sweden.—Soft chalk (Senonian) containing Belemnitella mucronata (Schlotheim) is present at Malmö in the southern part of Sweden.<sup>48</sup> The upper part of this chalk is as young as Maestrichtian and is immediately overlain by beds referred to the Danian. Parapachydiscus oldhami (Sharpe) and Belemnitella mucronata (Schlotheim) are recorded from Köpinge, and Discoscaphites constrictus (Sowerby) from Köpinge and from Ulricelund near Jordberga, in southern Sweden.<sup>49</sup>

Poland.—Glauconitic chalky marl exposed in northeastern Poland in the vicinity of Sopoćkinie (northwest of Grodno) is of Maestrichtian age, as indicated by Belemnitella lanceolata (Schlotheim) and other species.<sup>50</sup> B. lanceolata is also present in coccolith limestone (Maestrichtian) in the Lublin-Lemberger (Lvov) region in southeastern Poland.<sup>51</sup>

Southern Russia.—Upper Cretaceous sediments of considerable thickness in the Crimean region in southern Russia,<sup>52</sup> probably include equivalents of the Navarro group in its upper part. Both the Maestrichtian and the underlying Campanian appear to be represented. Belemnitella mucronata is among the fossils listed from the higher beds.

The upper part of the Kotkh formation, chiefly of greenish-gray calcareous marls 130 to 270 meters thick, in the Hadyzhensky region, northwestern Caucasas, is correlated by Keller<sup>53</sup> with the Maestrichtian, the evidence being the presence of the Foraminifera Pseudotextularia varians and Globotruncana (Rzehak) conica White, and the ammonite Pachydiscus col-The lower part of ligatus Binckhorst. the Kotkh formation is correlated with the Campanian, and the formation is overlain by the Teitse formation (Danian). The author correlates the upper part of the Kotkh formation with the upper part of the Mendez shale of castern Mexico on

<sup>&</sup>lt;sup>47</sup>Ødum, Hilmar, Cretaceous (in Summary of the geology of Denmark, by Anderson and others), pp. 43-50, Copenhagen 1923.

<sup>&</sup>lt;sup>48</sup>Geikie, Archibald, Text-book of Geology: 4th ed., vol. 2, p. 1208, 1903. Gives references.

<sup>&</sup>lt;sup>49</sup>Moberg, J. C., Cephal-opoderna, I, Sveriges Kritsystem, II, Artheskriftning: Sveriges Geologiska Undersökning, Ser. C. No. 73, pp. 23, 24, 27, 28, 57-63, 1885.

<sup>&</sup>lt;sup>50</sup>Tulejko-Kongielowa, L., Upper Campanian and Maestrichtian deposits in the environs of Sopoékinie: Trav. S. Sc. Lettres Milno, Milno, tome X1, pp. 333-342, 1937.

<sup>&</sup>lt;sup>51</sup>Von Bubnoff, Serge, Geologie der Erde: Geologie von Europa, Band 2, Teil 2, pp. 989 990, Tafel XI, 1935.

<sup>&</sup>lt;sup>52</sup>Coquand, M. H., Note sur la Craie supérieure de la Crimée et sur son synchronisme avec l'étage campanien de l'Aquitaine, des Pyrénées et de l'Algérie: Bull, Soc. Géol, de France, 3d ser., tome 5, pp. 86-99, 1876.

Hebert, M., La Craie de Crimée comparée à cella de Mendon et celle de l'Aquitaine: Bull. Soc. Géol. de France, 3d ser., tome 5, pp. 99-102, 1876.

<sup>&</sup>lt;sup>58</sup>Keller, B. M., Correlation of the Upper Cretaceous deposits in eastern Mexico and in the western Caucasas: Bull, de Acad, Sei, de L'Union des Républiques Sovietiques Socialistiques, No. 5, Sér. Géol., pp. 825-838 (summary in English, pp. 836-838), 1937. See also Muir, John M., Geology of the Tampico region, Mexico: Published by Amer, Assoc. Petro. Geol., Tulsa, Oklahoma, pp. 67-92, 1936.

the basis of the common occurrence of the following Foraminifera: Pseudo-(Rzehak), textularia varians Reussia limbata (White), Planoglobulina acervulinoides (Egger), Bolivina incrassata Reuss, and several species of Gyroidina. He correlates the Tamesi formation (Velasco) with the Teitse formation, also on the evidence of Foraminifera. The correlations given, if correct, would indicate the Navarro age of the upper part of the Kotkh formation.

Northern Africa.—Marine strata of Maestrichtian age are recorded in Northern Africa here and there from Morocco on the west to Egypt on the east.<sup>54</sup> In Morocco and Algeria the beds are mainly chalk and marl and they contain faunas considered to indicate their high Upper Cretaceous age.

High Upper Cretaceous beds referred to the Maestrichtian are reported from central Tunisia.<sup>55</sup> The faunas show few close relationships with those of the Navarro group, but Scalaria calamistrata Wanner resembles Epitonium sillimani (Morton) from the Prairie Bluff chalk of A l a b a m a, and Inoceramus regularis D'Orbigny, from beds of both Maestrichtian and Campanian age, appears to be closely similar to Inoceranus vanuxemi Meek and Hayden from the Neylandville marl and the Nacatoch sand, and to the form described as Inoceranus sp.e from the Nacatoch sand.

Beds of Maestrichtian age have also been reported from Tripoli,<sup>56</sup> but the fauna as illustrated does not show close relationship with that of the Navarro.

The large fauna described by Quaas<sup>57</sup> from the Libyan Desert in northeastern Africa affords but little direct paleon-

tologic evidence for an age comparison with the Navarro group. Both upper Senonian and Danian are recognized as present in the section. However, the presence of the ammonite Libycoceras jsmaëli Zittel (related to Sphenodiscus Meek), an ostreid species referred to Exogyra overwegi Bach (a true Exogyra) throws doubt on the Danian age of the containing beds, for neither ammonites nor true Exogyras have been recorded from the Danian in Denmark: this socalled Danian is probably of either Campanian or Maestrichtian age. Turritella (Zaria) figarii Quaas appears to be a close analogue of T. trilira Conrad, a long-ranging species in the Senonian equivalents in the Atlantic and Gulf Coastal Plain.

Palestine .-- Upper Cretaceous sediments, chiefly of Campanian and Maestrichtian age, are reported from Palestine, but the faunas as pictured by Picard,58 afford slight basis for comparison with the Navarro fauna. Roudaireia undata Conrad from the base of the Maestrichtian, appears to be a Veniella Stoliczka, but it is not specifically close to our American species. A shell referred to Corbula cf. C. paracrassa Wade (questionably Maestrichtian) appears to be an analogue of C. crassiplica Gabb; it is too coarsely ribbed for *paracrassa*; the species C. subelegans Picard (Campanian) is more nearly like paracrassa. His Inoceramus regularis D'Orbigny and Pycnodonte vesicularis Lamarck are long-ranging Upper Cretaceous forms of kinds that are of world-wide distribution. Among cephalopods he recognizes Libycoceras ismaeli Zittel (related to Sphenodiscus), Sphenodiscus? spathi Picard, Sphenodiscus aff. S. stantoni Hyatt, and Baculites asper Morton. The sutures of the species referred to Sphenodiscus do not agree at all closely with those of the true Sphenodiscus, and the identification is questionable. The presence of *Baculites* of the *asper* type

<sup>&</sup>lt;sup>64</sup>Krenkel, Erich, Geologie der Erde: Geologie Afrikas, Teil 3. zweite Hälfte, pp. 1467, 1573-1578, 1681-1689, 1769, 1823-1836, several text-page maps, 1934.

<sup>&</sup>lt;sup>55</sup>Pervinquière, L., Études de paléontologie tunisienne: Pt. 1, Céphalopodes des terrains secondaires, 438 pp., 27 pls., Paris, 1907; Pt. 2, Gastropodes et lamellibranches des terrains Crétacés: 352 pp., 23 pls., Paris, 1912.

<sup>&</sup>lt;sup>50</sup>Krumbeck, L., Beiträge zur Geologie und Palaeontologie von Tripolis: Palaeontographica, Band 53, pp. 51-136, pls. 7-9, 1906.

<sup>&</sup>lt;sup>57</sup>Quaas, A., Die Fauna der Overwegischichten und der Blätterthone in der libyschen Wüste, in Beitrag zur Kenntniss der Fauna der obersten Kreidebildungen in der libyschen Wüste: Palaeontographica, Band 30, Abteil 2, Lief, 4, pp. 153-334, pls. 20-33, correlation tables, 1902.

<sup>&</sup>lt;sup>18</sup>Picard, Leo, Upper Cretaceous (chiefly Campanian and Maestrichtian) Gastropoda and Pelecypoda from Palestine: Annals and Mag. Nat. History, ser. 10, vol. 5, pp. 513-513, pls. 21-22, 1930.

Upper Cretaceous (chiefly Maestrichtian) Ammonoidea from Palestine: Annals and Mag. Nat. History, ser, 10, vol. 3, pp. 433-456, 2 pls., 1929.

with this fauna throws doubt on its Maestrichtian age, for in the Cretaceous of our Gulf region Morton's species is restricted below the lowest known range of *Sphenodiscus*.

Syria.—Upper Cretaceous fossil-bearing sandy and chalky sediments of transgressive facies in northern Syria were described by Dubertret<sup>59</sup> and others in the same volume in 1933. Vautrin<sup>60</sup> described three new species of rudistids from beds that he correlated with the Maestrichtian. They are Lapeirousia syriaca, Hippurites (Hippuritella) syriaca, and Vaccinites (Pironaea) syriaca. Keller<sup>61</sup> described one rudistid, Lapeirousia jouanneti Desmoulins, and considered it to be of Maestrichtian age. David<sup>62</sup> described several species of Foraminifera from beds of Maestrichtian age.

Persia.-Practically the whole of the Upper Cretaceous is represented in the sedimentary series of southern Persia. Douvillé63 records the ammonite species Sphenodiscus acutodorsatus Noetling  $(= Indoceras \ acutodorsatus \ (Noetling))$ Hyatt), from a source which he considers to be upper Senonian, and in the same work (pp. 285-369), describes a fauna from higher beds, which he refers to the Maestrichtian. Few of these fossils appear closely related to Navarro forms, but gastropods described as Scala proxima Douvillé, and S. persicus Douvillé are obviously closely related to Navarro species referred to *Epitonium*.

India.—Although a goodly number of molluscan genera are common to the Upper Cretaceous series of India and the Navarro group of Texas, there are no common species, and in general the faunas are not very closely related; a few species appear to be good analogues of Navarro species. The series includes the following groups: Ootatoor (Cenomanian), Trichinopoly (Turonian), Ariyalur, in-Valudayur beds (Maestrichtcluding ian).64 The Valudayur beds near Pondicherry yielded Ammonites siva Forbes,65 a species which Hyatt later transferred to the genus Sphenodiscus. Other species described by Forbes in the same paper (from the Ariyalur group, including Valudayur beds), which appear to be fairly close analogues of Navarro species, are: Strombus uncatus (p. 129, pl. 13, fig. 16), analogous to Pugnellus densatus Conrad, and Cardium lucerna (p. 145, pl. 17, fig. 10), analogous to Liopistha protexta (Conrad). Kossmat has identified Parapachydiscus gollevillensis (D'Orbigny) from the Trigonarca beds of the Ariyalur group. The paleontologic evidence appears to justify the reference to the Ariyalur group (including the Valudayur beds) to the Maestrichtian.

Upper Cretaceous sedimentary beds in the Mari Hills of Baluchistan, which Noctling<sup>66</sup> correlated with the Maestrichtian, have yielded several species bearing some resemblance to Navarro species. *Hemiaster oldhami* Noetling is similar to *H. bexari* Clark, but the ambulacral areas are larger and the tubercles are coarser. *Gryphaea vesicularis* Lamarck resembles some of the variations of *G. mutabilis* Morton. *Pugnellus crassicostatus* Noetling is somewhat like *P. densatus* Conrad, but is not a close analogue. *Sphenodiscus* 

Stoliczka, Ferdinand, Cretaceous faunas of southern India: India Geol, Survey Mem., Palacontologia Indica, 1865-1870,

Kossmat, Franz, The Cretaceous deposits of Pondicherri: Rec. Geol. Survey India, vol. 30, pt. 2, pp. 52-110, 1897, Vredenburg, E., The Cretaceous Orbitoides of India: Rec.

<sup>&</sup>lt;sup>50</sup>Dubertret, L., La Tectonique de la Syrie septentrionale à la fin du Grétacé et au debut du Tertiaire: Hant-Commissariat de la République Française en Syrie et au Liban; Service des Travaux Publics—Section D'Études Géologiques; Notes et Mémoires, tome 1, pp. 13-28, 1933.

<sup>&</sup>lt;sup>60</sup>Vautrin, H., Sur quelques formes nouvelles de Rudistes recencillies en Syrie septentrionale: Idem, pp. 29-43, pls. 1-5, text figs. 5-11, 1933.

<sup>&</sup>lt;sup>01</sup>Keller, Alexandre, Sur quelques Rudistes du Djebel Ansaryeh de l'Amanus: Idem, pp. 50-51, pls. 3 and 4, text fig. 13, 1933.

<sup>&</sup>lt;sup>62</sup>David, Mlle. E., Foraminiféres sennoniens et eocenes de la Syrie septentrionales: Idem, pp. 53-57, pls. 3 and 7, text figs. 14, 15, 1933.

<sup>&</sup>lt;sup>63</sup>Douvillé, H., Mollusques fossiles [Persia]: Mission scientifique en Perse (par. J. de Morgan), Tome 3, Études géologiques, Pt. 4, Paléontologie, p. 255, pl. 35, figs. la, 1b, 1904.

<sup>&</sup>lt;sup>64</sup>Blanford, H. F., On the Cretaceous and other rocks of the South Areat and Trichinopoly Districts, Madras: Mem. Geol. Survey India, vol. 4, pt. 1, pp. 26, 151-164, 1862.

Geol. Survey India, vol. 36. pt. 3, pp. 171 213, 1908.

Holland, T. H., and Tipper, G. H., Indian geological terminology: Mcm. Geol. Survey India, vol. 43, pt. 1, p. 121, 1913.

<sup>&</sup>lt;sup>65</sup>Forbes, Edward, Report on the fossil invertebrata from southern India, collected by Mr. Kaye and Mr. Cunliffe: Trans. Geol. Soc. London, vol. 7, pp. 97-174 (esp. p. 110, pl. 7, fig. 6), 1846.

<sup>&</sup>lt;sup>60</sup>Noetling, Fritz, Fauna of the Upper Cretaceous (Maestrichtian) beds of the Mari Hills: Geol. Survey India, Palacontologia Indica, Series 16, Fauna of Baluchistan, vol. 1, pt. 3, 79 pp., 23 pls., 1897.

acutodorsatus Noetling differs from the American species in the simplicity of its saddles, and on the basis of this feature Hyatt transferred it to the genus *Indoceras* Noetling.

Japan .---- Upper Cretaceous rocks of Senonian age are recognized as present in Japan.67 Inoceramus cf. I. regularis D'Orbigny, described by Yabe68 from Toyajo in the Province of Kii (Nippon), appears to indicate Senonian age. Among fossils described by Nagao and Otatume<sup>69</sup> from Hokkaido are several that show analogies to species in the Navarro group. Yoldia hakobutensis reminds one of Nuculana longifrons (Conrad); Periplomya elliptica resembles Laternula? robusta; and Aphrodina Conrad appears to be represented in the fauna; Spisula (Cymbophora) ezoensis var. hetonaiensis appears to be a true Cymbophora Gabb.

According to Nagao and Matumoto<sup>70</sup> strata as young as Maestrichtian (possibly including Danian) are present in Hokkaido and elsewhere in Japan. Their correlation table (Table 2) is prepared chiefly on evidence afforded by species of Inoceramus. The following geologic units are interpreted to be of Maestrichtian (or younger) age: In the Karahuto or Saghalien, the upper part of the Oyau beds, the Simaiwa beds, the upper part of the Togusi sandstone, and the upper Tirie formation; in Hokkaido, the Hakobuti sandstone, the Upper Abesinai group, the Hetonai group, and the upper part of the Sikotan formation; in the Kitakami Mountainland, the

Nagao, T., Some molluscan fossils from the Cretaceous deposits of Hokkaido and Japanese Saghalien: Pt. 1, Lamellibranchiata and Scaphopoda: ser. 4. Geology and Mineralogy, vol. 4, nos. 1-2, pp. 117-112, pls. 14-16, 1933; Pt. 2, Gastropoda: Same series and volume, Nos. 3-4, pp. 213-239, pls. 20-22, 1939.

<sup>70</sup>Nagao, T., and Matumoto, T., A monograph of the Cretaceous *Inoceranus* of Japan: Jour. Faculty Sci., Hokkaido Imperial Univ. ser. 4, Geology and Mineralogy, vol. 4, nos. 3–4, pp. 211–299, pls. 23-34, 1939; pt. 2, vol. 6, no. 1, pp. 1–61, pls. 1–22, 1940. Kadonosawa formation; and in southwest Japan, the Warazuhata sandstone and shale, the Kuzuhata sandstone and conglomerate, the Siti shale, the Kitaama sandstone, the Nada sandstone, the upper part of the Miakura beds, and questionably the upper part of the *Inoceramus* beds.

South Africa.—Upper Cretaceous faunas have been described from Natal (Zululand and Pondoland) and Angola, by Woods,<sup>71</sup> Spath,<sup>72</sup> van Hoepen,<sup>73</sup> Rennie,<sup>74</sup> and others, but there has not been agreement among these authors as to the exact age of the containing beds in terms of the standard European section. Perhaps of most interest is a large molluscan fauna from Umzamba in Pondoland.

Although the nearly horizontal fossiliferous beds at Umzamba are exposed to a height of only 30 feet above mean sea level, Spath believes that they include beds of both Campanian and Maestrichtian age and that the section should be zoned. On the other hand Rennie insists that the section belongs to one stratigraphic unit and may well have been deposited in a relatively short time. On the latter assumption the presence in the fauna of the ammonite genus Mortoniceras Meek. which appears to be correctly identified, and other ammonites referred to the genus Schloenbachia Neumeyer, would seem to limit the beds to an age not younger than early Campanian; van Hoepen concludes that they are of upper Santonian age.

Several other species in the Umzamba fauna that seem to be more or less closely

<sup>&</sup>lt;sup>65</sup>Yabe, H., Cretaceous stratigraphy of the Japanese Islands: Science Reports of Tôhoku Imperial University, 2d ser. (Geology), vol. 11, no. 1, 1927.

<sup>&</sup>lt;sup>68</sup>Yabe, H., Note on some Cretaceous fossils from Anaga on the 1-Jand of Awaji and Toyajo in the Province of Kii: Science Reports of the Tohoku Imperial University, 2d ser. (Geology), vol. 4, no. 1, p. 22, pl. 3, fig. 3, 1915. <sup>50</sup>Nagao, T., and Otatume, K., Molluscan fossils of the Hakobuti sandstone of Hokkaido: Jour. Faculty Sci., Hokkaido Imperial Univ., ser. 4, Geology and Mineralogy, vol. 4, nos. 1-2, pp. 31-56, pls. 1-4, 1938.

<sup>&</sup>lt;sup>71</sup>Woods, Henry, The Cretaceous fauna of Pondoland: Ann. South African Museum, vol. 4, pt. 7, pp. 275-350, pls. 33-44, 1906.

<sup>&</sup>lt;sup>72</sup>Spath, L. F., On Cretaceous Cephalopoda from Zululand: Ann, South African Museum, vol. 12, pp. 217-321, pls. 19-26, 1921.

<sup>-----,</sup> On the Senonian ammonite fauna of Pondoland: Trans. Roy. Soc. South Africa, vol. 10, pp. 113-147, pls. 5-9, 1922.

<sup>&</sup>lt;sup>73</sup>Van Hoepen, E. C. N., Descriptions of some Cretaceous ammonites from Pondoland: Ann, Transval Museum, vol. 7, pp. 142-147, pls. 24-26, 1920.

\_\_\_\_\_, Cretaceous Cephalopods from Pondoland: Ann. Transvaal Museum, vol. 8, pp. 1-48, 11 pls., 1921.

<sup>&</sup>lt;sup>74</sup>Rennie, John V. L., Cretaceous fossils from Angola (Lamellibranchia and Gastropoda): Ann, South African Museum, vol. 28, pt. 1, pp. 1-54, 5 pls., 1929.

rom the Upper Cretaceous of Pondoland (with an appendix on some species from the Cretaceous of Zululand): Ann. South African Museum, vol. 28, pt. 2, pp. 159-260, pls. 16-31, 1930.

analogous to species from beds of Senonian age in the Atlantic and Gulf Coastal Plain are listed in the following table:

Umzamba species	Analogous Coastal Plain species
Pecten (Camptonectes)	Pecten (Camptonectes)
kaffraria Rennie	bellisculptus Conrad
Veniella forbesiana	Veniella conradi
(Stoliczka)	(Morton)
Palaeomorea haughtoni	Linearia carolinensis
Rennie	Conrad
Gyrodes tenellus	Gyrodes abyssinus
Stoliczka	Morton
Dicroloma (Perissop- tera) bailyi (R. Etheridge, Jr.)	Anchura? lobata Wade
Pyropsis geversi Rennie	Sargana stantoni (Weller)
Paleopsephaea scalaris	Paleopsephaea mutabilis
Rennie	Wade
Mortoniceras strange i	Mortoniceras dela-
(Bailey)	watense (Morton)

Two of the Umzamba gastropod species listed appear to be remarkably close analogues of Coastal Plain species. As pictured Pyropsis geversi differs from Sargana stantoni only in minor details, and Dicroloma (Perissoptera) bailvi differs from Anchura? lobata only in its smaller size and slightly shorter body whorl. These similar species and others in the fauna not quite so closely matched point to intercommunication between the Cretaceous sea of the Atlantic and Gulf Coastal Plain and that of southern Africa. Since the geographic separation is very wide and since most of the analogous species in the Coastal Plain appear to be (late younger than early Campanian Campanian and early Maestrichtian), it may be that migration of these closely related elements proceeded at a leisurely pace from the south African region to the Atlantic and Gulf region during Campanian time. The route along which the migration took place can be a matter of speculation only, in our present state of knowledge, but the paucity of Indian elements in our Taylor and Navarro (Campanian and Maestrichtian) faunas seems to offer a serious objection to their having come by way of the Indian Ocean and the Mediterranean sea; a direct route by way of the Atlantic would seem the more plausible, though the means by which they succeeded in crossing the belt of tropical waters (Tethys) and from the east to the west side of the ocean depths is not yet apparent.

Madagascar. — Fossiliferous sediments of high Upper Cretaceous age (upper Senonian and Maestrichtian) are present in southwestern Madagascar.<sup>75</sup> The ammonite species *Parapachydiscus gollevill*ensis (D'Orbigny) is reported by all of the authors cited, and is believed to indicate the Maestrichtian age of the beds containing it. Among the fossils described by Cottreau the ones listed below have fairly close analogues in the Navarro, or in beds of Navarro age, in the Gulf region.

Madagascar species	Analogous species in Gulf region
Hemiaster madagas-	Hemiaster slocumi
carensis Cottreau	Lambert
Inoceramus regularis	Inoceramus vanuxemi
D'Orbigny	Meek and Hayden
Crassatella zitteliana	Crassatella vadosa
(Stoliczka) Cottreau	Morton
Parapachydiscus golle- villensis (D'Orbigny)	Parapachydiscus (an un- described species re- lated to D'Orbigny's species)

New Zealand.—Strata of upper Senonian age, resting unconformably on older Cretaccous sediments, have been recognized on the South Island of New Zealand<sup>76</sup> at Amuri Bluff, Selwyn Falls on Selwyn River, and several other localities. Some of the fossils, as illustrated, reveal only rather distant generic relationships with those of the Navarro group, and are of little value in correlation. On the evidence of three gastropod species, identified as belonging to the genus *Pugnellus* 

<sup>75</sup>Cottreau, J., Paléontologie de Madagascar, X. Fossiles crétacés de la côte Orientale: Ann. Paléont., tome 11, 83 pp., 11 pls., 1 text fig., 1922.

Basse, Élaine, Du crétacé de la Province de Maintirano, Madagascar: Service des Mines, 86 pp., 13 pls., 1931.

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<sup>76</sup>Trechmann, C. T., Cretaceous Mollusca from New Zealand: Geol. Mag. N. S., Decado 6, vol. 4, pp. 294-305, 337-342, pls. 19-21, 1917.

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Wilckens, Otto, The Upper Cretaceous gastropods of New Zealand: Dept. of Mines, Geol, Survey Branch, Palacont, Bull. 9, 42 pp., 5 pls., 1922. Conrad, Trechmann concludes that the containing beds are of Danian or Maestrichtian age. In their young stages these shells exhibit strong axial nodes and fine revolving lines, in contrast to the smooth early stages of the typical Pugnellus from the Upper Cretaceous (Maestrichtian) of the Gulf region of the United States. Their congeneric relationship to Pugnellus is doubtful, as is also their significance in determining the Maestrichtian age of the beds.

## NAVARRO FOSSIL LOCALITIES IN TEXAS

#### (Numbers are collection numbers of United States Geological Survey except as otherwise indicated.)

#### FOSSILS FROM THE NEVLANDVILLE MARL

4064. Near Cooper (probably ½ mile north of), Delta County, C. H. Gordon, 1902. (Sce 7509.).

5318. Same as No. 7509. Mr. Russ, 1907. 7509. Cut of Texas Midland R.R., ½ mile north of the station at Cooper, Delta County; 10 feet of greenish-gray, more or less weathered, calcareous clay (marl) containing small whitish calcium carbonate concretions. T. W. Stanton and L. W. Stephenson, 1911.

7510. Cut of Texas Midland R.R., about 1 mile north of the station at Cooper, Delta County; greenish-gray calcareous clay (marl) in ditch near track. T. W. Stanton and L. W. Stephenson, 1911.

7511. Bed of Doctors Creek, just south of the Texas Midland R.R., 2 miles southwest of Cooper, Delta County; weathered greenish-gray calcareous clay (marl). T. W. Stanton and L. W. Stephenson, 1911.

7512. From ditch along the Texas Midland R.R., west of a small creek, 41/2 miles southwest of Cooper, Delta County; 2 feet of greenish-gray calcareous clay (marl). T. W. Stanton and L. W. Stephenson, 1911.

**7549**. Cut of Texas & New Orleans R.R., 1½ miles east of Gastonia, 4½ miles east of Crandall, Kaufman County: 8 feet of yellowish calcareous clay (marl). L. W. Stephenson, 1911.

7550. Cut of Texas & New Orleans R.R., 1 mile east of Gastonia, 4 miles east of Crandall, Kaufman County; 12 feet of greenish-gray cal-careous clay (marl), weathering to yellowish subsoil. L. W. Stephenson, 1911.

9717. Road ditch at the southeast corner of the Fair Grounds, 112 miles southcast of the post office, Greenville, Hunt County: 3 feet of gray calcareous clay (marl), weathering yellowish, with soft white calcium carbonate concretions. L. W. Stephenson, 1916.

9718. Ditch along the Dixon road, 2 miles southeast of the post office at Greenville, Hunt County: 3 feet of dark greenish-gray sandy clay with large calcium carbonate septaria. L. W. Stephenson, 1916.

9719. Ditch along the Dixon road, 2 1/8 miles southeast of the post office at Greenville,

Hunt County; a few feet of greenish-gray clay with calcium carbonate septaria. L. W. Stephenson, 1916.

11251. East Caddo Fork of Sabine River, left bank, just west of north-south road, 3/4 mile north of Van Sickle (store and school), 3½ miles northwest of Cash, 8 miles southwest of Greenville, Hunt County; 5 feet of sandy calcareous clay (marl). Mr. and Mrs. D. A. Saunders, 1922.

**13831.** In ditch along the Terrell road, 11 4/5 miles southeast of Rockwall, 2<sup>1</sup>/<sub>2</sub> miles southeast of Chisholm, in Kaufman County: gray sandy calcareous clay (marl), lower part of formation. C. H. Dane, 1927.

13833. Dallas road, 2 4/5 miles northeast of Royce City, in Hunt County; calcareous clay (ma-1) exposed in ditch, lower part of formation.

L. W. Stephenson and W. P. Popenoe, 1927. 13834. Dallas road, 2½ miles northeast of Royce City, Collin County; glauconitic calcareous (a) (marl) in ditch, lower part of formation.
 L. W. Stephenson and W. P. Popenoe, 1927.
 13835. Dallas road, 3/5 mile northeast of

Royce City, Rockwall County; 5 or 6 feet of calcareous clay (marl), lower part of formation. L. W. Stephenson and W. P. Popenoe, 1927.

13836. Field south of the Fair Grounds near the Dixon road at the southcast edge of Greenville, Hunt County; calcareous clay (marl) poorly exposed in shallow washes. L. W. Stephenson and W. P. Popenoe, 1927.

13849. Secondary road past Eureka school, just west of Big Creek bottom, 5 miles (6 1/10 miles by road) northeast of McClanahan, Falls County: sandy calcareous marl in ditch near foot of slope. C. H. Dane, 1927. 13851. Dallas highway, 4 3/5 miles west of

Terrell, Kaufman County; sandy clay (marl), near base of formation. C. H. Dane, 1927.

13852. Dallas highway, eastward-facing slope Big Brushy Creek valley, 3 7/10 miles west of of Kaufman, Kaufman County: road cut exposes 25 or 30 feet of sandy, calcareous clay (marl), with a layer of large fossiliferous calcium carbonate concretions containing large shells of Placenticeras meeki Böhm, 30 feet above level of bottom land; the layer of concretions is in lower half of the formation but is well above the base. C. H. Dane, 1927. 13855. Road to Corbet, 3 4/5 miles south-

east of Drane, Navarro County; sandy calcareous clay (marl), near base of formation. C. H. Dane, 1927.

13856. Gully a few hundred feet east of the Crandall road, 4 2/5 miles west of Kaufman, Kaufman County; 8 or 10 feet of strongly glauconitic, sandy clay (marl) with phosphatic nod-ules and internal molds of fossil organisms; this is the basal bed of the formation. C. H. Dane, 1927.

13864. Burlington road, 10 miles north of Cameron, Milam County; a few feet of sandy calcareous clay (marl) in ditch. C. H. Dane, 1927.

14062. Same as No. 7509. L. W. Stephenson, 1928.

14063. Branch east of Texas Midland R.R., 2/5 mile north of Cooper, Delta County; greenishgray calcareous clay (marl) with calcium car-bonate concretions, L. W. Stephenson, 1928. **14083.** Gully west of Paris road, 7 1/10

miles (by the road) northeast of Cooper, Delta

County; a few feet of gray calcareous clay (marl) weathering yellowish. L. W. Stephenson, 1928.

**14084.** Gully west of Paris highway, 7 1/4 miles (by the road) northeast of Cooper, Delta County; gray calcareous clay (marl) weathering yellowish. L. W. Stephenson, 1928.

**14087.** Bankhead highway, 4 3/10 miles (air line) northeast of the public square at Greenville, Hunt County; 4 or 5 feet of gray calcareous clay (marl) in ditch. L. W. Stephenson, 1928.

14088. Bankhead highway, 5 3/10 miles (air line) no:theast of Greenville, Hunt County; gray calcareous clay (marl) in ditch. L. W. Stephenson, 1928.

14089. Cut of Texas Midland R.R. (abandoned), 6 2/5 miles (air line) northeast of the public square at Greenville, ¼ mile southwest of Neylandville flag station, Hunt County; gray calcareous clay (marl), type locality of formation. L. W. Stephenson, 1928.

14091. East-west public road, about 5 miles southwest of Caddo Mills, Hunt County; calcium carbonate septaria in ditch. lower part of formation. L. W. Stephenson, 1928.

14101. Same as No. 13852. L. W. Stephenson, 1928.

14102. Dallas highway, 5 miles west of Kaufman, Kaufman County; loose in ditch, probably from phosphatic bed at base of Neylandville marl. L. W. Stephenson, 1928.

14104. Gully in field northeast of Rockwall road, 5 miles (air line) northwest of Terrell, Kaufman County: strongly glauconitic, argillaceous sand, poorly exposed. L. W. Stephenson, 1928.

14119. Gullies southwest of the Drane road, 1½ to 2 miles northwest of Corbet, Navarro County; calcareous clay (marl) with many large calcium carbonate concretions. L. W. Stephenson, 1928.

14132. Gully 100 yards north of the Cameron-Buckholtz road, 7 miles west of Cameron, 1 mile west of Pettibone station, Milam County; 15 feet of glauconitic sandy clay (marl), L. W. Stephenson, 1928.

14133. Cameron road, 1 7/10 miles south of Burlington, Milam County; sandy clay (marl) in ditch. L. W. Stephenson, 1928.

**15539.** Ditch on Cameron-Buckholtz road, % mile west of Petibone station. Milam County; 5 feet of glauconitic clay (marl) in ditch, unconformably overlain by Corsicana marl. L. W. Stephenson, 1930.

**15540.** Same as 14132. L. W. Stephenson, 1930.

**15541.** Public road ditch about 1 mile westnorthwest of Ben Arnold, Milam County; 5 or 6 feet of calcareous clay (marl) with a few soft whitish calcium carbonate concretions. L. W. Stephenson, 1930.

**15543.** Ditch at roadside, 2½ miles south of Ben Hur, Limestone County: sandy clay (marl) with large soft fossiliferous calcium carbonate concretions, unconformably overlain by Corsicana marl; the section is complicated by faulting, but the concretions lie within 40 feet below the contact. L. W. Stephenson, 1930.

16157. Same as 13834. L. W. Stephenson, 1932.

16158. Greenville to Paris highway, 3½ miles northeast of Greenville, ½ mile northeast

of Liberty School, Hunt County; gray calcareous, finely sandy clay (marl), in ditches in field south of highway. L. W. Stephenson, 1932.

**16164.** Corsicanal to Drane road, 5 miles west-southwest of the courthouse at Corsicana, 3 miles northeast of Drane, Navarro County; calcareous, slightly sandy clay (marl) with flattish calcum carbonate concretions, lower part of formation. L. W. Stephenson, 1932.

**16166.** Gullies in field south of northeastsouthwest road, 1 3/5 miles east-northeast of Black Hills school, 3½ miles west-northwest of the courthouse at Corsicana, Navarro County; 25 or 30 feet of gray calcareous, sandy clay (marl) with whitish soft fossiliferous concretions. L. W. Stephenson, 1932.

**16169.** Ditch between Trinity and Brazos Valley R.R. and road to Hubbard, 2 7/10 miles northwest of Cooledge, Limestone County; 8 or 10 feet of sandy, calcareous clay (marl). L. W. Stephenson, 1932.

16170. Corsicana road, westward-facing slope of Cedar Creek valley, 2½ miles north of Corbet, Navarro County: 15 feet of gray sandy, calcareous clay (marl), with medium to large, soft fossiliferous septarian concretions. L. W. Stephenson, 1932.

17119. Same as 13852. L. W. Stephenson, 1935.

17365. Same as 16170. L. W. Stephenson, 1936.

17369. Branch of Briar Creek, 4/5 mile east of Black Hills school, 4 miles west by north of the courthouse at Corsicana, Navarro County; sandy, calcareous clay (marl) with calcium carbonate concretions, exposed in road ditch and bank of branch. L. W. Stephenson, 1936.

**17379.** U. S. Highway 80, ditch just east of Terry Branch, 3/10 mile east of Lawrence, 3 9/10 miles west of the Texas and Pacific R.R. station at Terrell, Kaufman County: 6 feet of gray sandy clay (marl). L. W. Stephenson, 1936.

17382. Same as 11251. L. W. Stephenson, 1936.

**Texas Bureau coll. 17300.** Corbet road, 5 7/10 miles west-southwest of the Houston & Texas Central R.R. station at Corsicana, Navarro County. Miss Gene Ross, 1932. (This locality is the same as U.S.Geol.Survey coll. 16170.)

#### FOSSILS FROM THE NACATOCH SAND

**518.** Bank of Postoak Creek at north edge of Corsicana, Navarro County. C. A. White and C. B. Boyle, 1887. (See 17012.)

**761.** Near Kaufman on westward-facing slope of Kings Creek valley, ½ mile from courthouse where wagon road goes down to Kings Creek, and along east side of creek for 3 miles south of Kaufman. Kaufman County. T. W. Stanton, 1890. (See 7545 below.)

**762.** Near Chatfield, from fossiliferous concretions in the village and in fields and ravines to the west, Navarro County. T. W. Stanton, 1890.

**763.** Near section house on Houston & Texas Central R.R.,  $2\frac{1}{2}$  miles north of Corsicana; also in banks of creek near northern edge of town, and on Beatoris farm,  $\frac{1}{2}$  mile south of Corsicana. T. W. Stanton, 1890.

**5322.** Sulphur Bluff on Sulphur River, 3 miles no th of the town of Sulphur Bluff, Hopkins County, Mr. Russ, 1907.

kins County. Mr. Russ, 1907. 5323. From sand 1½ miles west of Commerce, Hunt County. Mr. Russ, 1907.

**7545.** Dallas highway, Pyles Hill, westwardfacing slope of Kings Creek valley, 3/5 mile west of the courthouse at Kaufman, Kaufman County: about 50 feet of greenish-gray massive slightly glauconitic sand with concretionary masses of calcareous sandstone containing fossils: concretions in a layer about 15 feet above the base are very fossiliferous, and are estimated to be near the middle of the formation; p obably most of the fossils collected near Kaufman by Dr. T. W. Stanton in 1890 (see 761) came from within the limits of this 50-foot section. *L.* W. Stephenson, 1911.

**7546.** Simpson's Hill, public road, westwardfacing slope of Kings Creek valley, about 2 miles southwest of the courthouse at Kaufman, Kaufman County; 20 feet of greenish-gray massive slightly glauconitic sand locally indurated to large masses of fossiliferous sandstone, probably near middle of formation, L. W. Stephenson, 1911. **7547.** Field north of road on Simpson's

**7547.** Field north of road on Simpson's place, 2 miles southwest of the courthouse at Kaufman, Kaufman County: large calcareous fossiliferous concretions belonging to same zone as 7546. L. W. Stephenson, 1911.

**7567.** Public road, Corsicana to Chatfield, south of Dry Creek (= Rush Creek), 7½ to 8½ miles north by east of Corsicana, Navarro County; exposures in road and in a small branch east of the road; fine gray calcareous, glauconitic sand, locally indurated, probably above middle of formation. L. W. Stephenson, 1911.

**7568.** Calcareous concretions loose in the street at Chatfield, but probably brought from some nearby field, Navarro County, L. W. Stephenson, 1911.

**7569.** Residual concretions of calcareous sandstone in a field just south of Chatfield, Navarro County; from upper part of formation. L. W. Stephenson, 1911.

**7570.** Calcareous sandstone concretions in public road, 1/2 mile east of Chatfield, Navarro County; from upper part of formation. L. W. Stephenson, 1911.

**7571.** Calcareous sandstone concretions in public road,  $\frac{3}{4}$  mile east of Chatfield, Navarro County: from upper part of formation. L. W. Stephenson, 1911.

**7572.** Calcarcous, argillaceous sandstone concretions in public road, 3/5 to 4/5 mile northeast of Chatfield, Navarro County; from upper part of formation, L. W. Stephenson, 1911.

**7573.** Public road just south of the St. Louis and Southwestern R.R., 5 miles south-southwest of Corsicana. Navarro County: loose chunks of sandy fossilife-ous limestone at road-side, but similar rock is in place in nearby fields. L. W. Stephenson, 1911.

**9544.** Ledge in side of Chatfield road, 8½ miles north of Corsicana, on south side of Rush Creek, Navarro County. O. B. Hopkins, 1915. (See 7567.)

9545. Rock Branch of Walton lease of Houston Oil Company, 1/2 mile north of Corsicana-Chatfield road, 3 miles northeast of Corsicana, Navarro County, O. B. Hopkins, 1915. 9549. Rock Branch, 3 miles north of Corsicana, Navarro County. O. B. Hopkins, 1915.
9552. Property of J. B. Watkins, 3 miles

**9552.** Property of J. B. Watkins, 3 miles in an air line north of Corsicana, Navarro County. O. B. Hopkins, 1915.

**9553.** From a small branch a mile west of the Corsicana-Chatfield road, at the north end of M. R. & M. J. Thompson's property, 2 miles north of Corsicana, Navarro County. O. B. Hopkins, 1916.

**9554.** Same as 9553. O. B. Hopkins, 1915. **9555.** Same as 9553. O. B. Hopkins, 1915. **9557.** Same as 9553. O. B. Hopkins, 1915. **9558.** Bluff on south side of Briar Creck, 4 miles (air line) north of Corsicana, Navarro County. O. B. Hopkins, 1915.

**9559.** Side of Chatfield road, 8 miles north of Corsicana, <sup>1</sup>/<sub>3</sub> mile south of Rush Creek, Navarro County, O. B. Hopkins, 1915. (See 7567.)

**9560.** Three-fourths mile north of Corsicana-Chatfield road, and <sup>1</sup>/<sub>4</sub> mile north of Rock Branch, 3 miles in an air line northeast of Corsicana, Navarro County. O. B. Hopkins, 1915.

12923. Same as 7545. L. W. Stephenson, 1924.

12925. Calcareous sandstone from the northeast corner of the R. Ragsdale Survey on the W. N. Guthrie place, 1½ miles west-southwest of Campbell, Hunt County. L. W. Stephenson and C. E. Cook, 1924.

**12926.** From public road near a negro school, on the Levi Lloyd Survey, about 3 7/10 miles east of Greenville, Hunt County; loose gray massive sand in ditch. L. W. Stephenson and C. E. Cook, 1924.

**12929.** Calcareous sandstone on east-west road on Hurricane Ridge, Will Martin farm, George Wetmore Survey, 6 miles southeast of Cooper, in Hopkins County, L. W. Stephenson and C. E. Cook, 1924.

**12931.** From weathered sandstone on the northward-facing slope of Sulphur Creek valley, in the northwestern corner of Franklin County. Julia Gardner, 1924.

**12935.** Right bank of Red River, 200 yards west of Lewis Ferry, about 8 miles north of New Boston, Bowie County; 5 feet of massive irregularly indurated glauconitic sand with a regularly indurated layer 1 foot thick along top. L. W. Stephenson and R. L. Cannon, 1924.

13093. Fifteen feet of strongly glauconitic sand at dam at Crystal Lake. 5 miles south of Annona, Red River County, L. W. Stephenson, 1925.

**13534.** Branch near Texarkana road, at north edge of Avery, Red River County; a few feet of fine glauconitic, slightly argillaccous sand, partly indurated at base. L. W. Stephenson and C. H. Dane, 1926.

**14061.** Cut in Clarksville-Rosali r o a d, northward-facing slope of Cuthand Creek valley,  $4\frac{1}{2}$  miles east by north of Rosali, Red River County: from calcareous fossiliferous concretionary sandstone 6 to 10 feet below top of a 50-foot section of gray marine sand. L. W. Stephenson, 1928.

14098. Same as 7545. L. W. Stephenson, 1928.

14099. Same as 7546. L. W. Stephenson, 1928.

14103. Sandstone concretions in westward-sloping field, north of the Dallas road, 3 mile west of Kaufman, Kaufman County; these concretions occupy same stratigraphic position as those 15 feet above base of section described under 7545. L. W. Stephenson, 1928.

14114. Public road east of Houston & Texas Central R.R., near section house, about 212 miles north of the courthouse at Corsicana, Navarro County; 15 feet of gray argillaceous sand with calcareous fossiliferous concretions attaining 3 feet in greatest dimension, probably middle or lower part of formation: Dr. T. W. Stanton col-lected at or near this locality (see 763). L. W. Stephenson, 1928.

14115. Same as 7567. L. W. Stephenson, 1928.

14116. Same as 7567. L. W. Stephenson, 1928.

14117. Concretions in ditches and in field near road, 3% to 4% mile northeast of Chatfield. Navarro County. L. W. Stephenson, 1928. (See 7572.)

15548. Same as 12926. L. W. Stephenson, 1931.

16162. Land of E. A. Stevens, northeastward-facing slope of Big Caddo Creek valley, 145 miles northeast of Quinlan, Hunt County; calcareous fossiliferous concretions derived from marine sand, on slope about 20 feet above level of bottom land, probably above middle of formation. L. W. Stephenson, 1932. 16163. Road ditch 3 3/10 miles west-south-

west of the courthouse at Corsicana, 4/5 mile south by west of Whites Chapel, Navarro County; large roundish light gray fossiliferous calcareous, sandy concretions in sandy clay, lower part of formation. L. W. Stephenson, 1932.
16168. U. S. Highway 75, 3 1/5 miles north

of the courthouse at Corsicana, Navarro County; 90 feet of fine argillaceous, more or less glauconitic sand with calcareous concretions in layers at 40, 50, 55, 65, and 85 feet above base; the fossils in this collection came from concretions 50 to 65 feet above base of exposure, and are estimated to be above the middle of the formation. L. W. Stephenson, 1932.

16171. Same as 16162. F. B. Plummer, 1932. 16930. In the breaks of Big Caddo Creek valley about 2 miles northeast of Ouinlan, Hunt County. Gayle Scott, 1932, (See 16162.)

17012. In bed of Postoak Creek along the old Dallas highway, half a mile north of Corsicana, Navarro County; approximately same locality as 518. Gayle Scott, 1935.

17236. An artificial cut 7 miles north of Chatfield, Navarro County. W. A. Bramlette, 1934.

17366. Borrow pit east of U.S. Highway 75 at foot of no thward-facing slope of Chambers Creek valley, 12 mile northwest of Oil Ridge School, 4 miles north of the courthouse at Corsicana, Navarro County; 10 feet of dark argillaceous sand and sandy clay with a layer of calcareous fossilife ous concretions at base, esti-mated to lie less than 50 feet above the base of the formation. L. W. Stephenson, 1936.

17368. Concretions in ditch on State Highway 22, 1/4 mile east of Whites Chapel School, 2½ miles west by south of the courthouse at Corsicana, Navarro, County; large calcareous fossiliferous concretions in argillaceous sand, about middle of formation. L. W. Stephenson, 1936.

17371. Concretions in field south of road, 2 1/10 miles east by north of Eureka School, 5 miles (6 1/10 miles by road) northeast of McClanahan, Falls County; sandy, slightly cal-careous clay (marl) with calcaceous fossiliferous septarian concretions. L. W. Stephenson, 1936.

Texas Bureau coll. 17302. 2 1/10 miles northeast of the Methodist Church at Chatfield on the road to Hervey Lake, Navarro County. Gene Ross, 1932.

Texas Bureau coll. 17303. Road ditch 21/2 miles north or northwest of Chatfield, Navarro County. Gene Ross, 1932.

Texas Bureau coll. 17304. Same as U.S. G.S.coll. 17366. Gene Ross, 1932.

Texas Bureau coll. 17306. 4/5 mile north of Hester, Navarro County. Gene Ross, 1932. Texas Bureau coll. 17307. 1 1/10 miles

no th-northwest of Chatfield near a negro cemetery. Gene Ross, 1932.

Texas Bureau coll. 17310. 4 miles southwest of Corsicana. Gene Ross, 1932.

U. S. National Museum cat. no. 77121. Vicinity of Terrell, Doctor Loughridge, 1884.

#### FOSSILS FROM THE CORSICANA MARL

5310. Clay above sand on the Frieze place, 2% miles north of Malta, Bowie County. Mr. Russ, 1907. (See 12933.)

5321. Half a mile north of the village of Sulphur Bluff, Hopkins County, Mr. Russ, 1907.
 5432. Same as 5310. C. H. Gordon, 1907.
 7548. Dallas road, on the west edge of Kauf-

man, weathered out on the crest of the slope leading down to Kings Creek, Kaufman County. L. W. Stephenson, 1911.

7604. Weathered from calcareous clay in public road on westward-facing slope of Onion Creek valley, 21/2 miles west of old Garfield, Travis County, L. W. Stephenson, 1911.

7605. Bluff on right bank of Onion Creek, 1/4 mile below the crossing of the Austin-Garfield road, 21/2 miles west of old Garfield, Travis County; about 100 feet of dark-gray calcareous clay (marl), chalky in lower 20 or 30 feet; probably represents most of the formation, but neither base nor top exposed; most of the fossils are from the lower 40 or 50 feet. L. W. Stephenson, 1911.

7621. San Marcos River, left bank, 1/2 mile below Martindale, just below a ford, Caldwell County: 11 feet of gray calcareous clay (marl) indurated to earthy limestone in upper 6 to 12 inches. L. W. Stephenson, 1911.

7622. Cottonwood Creek, at a public road crossing, 11/2 miles southeast of Redwood, Guadalupe County; several feet of greenish-gray sandy, slightly glauconitic clay in bed of creek. L. W. Stephenson, 1911.

7637. Westward-facing bluff on Guadalupe River, about 1 3/10 miles north of McQueeney, Guadalupe County; 50 feet of greenish-gray calcareous clay with numerous calcareous fossiliferous concretions. L. W. Stephenson, 1911.

7643. Loose in bed of Cottonwood Creek, 1/8 mile south of the stores at Redwood, Guadalupe County. L. W. Stephenson, 1911.

**7665.** Medina River at the ford of the Lacoste-Castroville road, ½ mile below the highway bridge at Castroville, Medina County; earthy, sandy limestone in bed of river. L. W. Stephenson, 1911.

**7796.** Same as 7665. Alexander Deussen, 1911.

**10627.** Crest of bluff at edge of terrace plain just west of Medina River, at a crossing of a private road on land of Louie Bendeler, 4 or 5 miles north by west of Castroville, Medina County; a layer 40 to 50 feet above water level, composed mainly of shells of *Gryphaea mutabilis* Morton, with a few other fossils. L. W. Stephenson. 1918.

10870. San Geronimo Creek, left bank, about 2 miles south of Cliff, 10 miles northeast of Castroville, Medina County: poorly exposed shale and interbedded fine platy sandstone, with a layer several feet thick containing many shells of *Gryphaea*, *Exogyra* and other fossils, L. W. Stephenson, 1921. 10886. Bed of a creek, 3½ or 4 miles east-

10886. Bed of a creek, 3½ or 4 miles eastnortheast of Greenville, a short distance down the creek (south) and around a bend from the tracks of the Missouri, Kansas & Texas R.R., Hunt County, W. S. Adkins, 1921. 11248. Old Greenville-Quinlan road, about

11248. Old Greenville-Quinlan road, about halfway up the northward-facing slope of Caddo Creek valley, 1<sup>4</sup>/<sub>2</sub> miles northeast of Quinlan, Hunt County. Mr. and Mrs. D. A. Saunders, 1922.

**11250.** About 7 miles south, 3 miles east, of Greenville, on east side of Cedar Creek, opposite the farm of Frank Hasselfield, Hunt County, Mr. and Mrs. D. A. Saunders, 1922.

12920. Same as 7605. L. W. Stephenson, 1924.

12924. From a small branch flowing south on the Wm. H. Moore Survey, 100 yards south of the Missouri, Kansas & Texas R.R., <sup>1</sup>/<sub>4</sub> mile east of the west line of this Survey, about 5 miles east by north of Greenville, Hunt County; strongly calcareous, chalky sand in bed of creek, basal bed of formation. L. W. Stephenson and C. E. Cook, 1924.

**12927.** From the E. R. Ridley 30-acre tract, in the northwest corner of the W. G. Lee Survey, about 3 miles south-southwest of Campbell, Hunt County; calcarcous, chalky sand at base of formation. L. W. Stephenson and C. E. Cook, 1924.

12928. From a locality 1¼ miles northeast of Quinlan, Hunt County. Shary Thompson, 1924. 12932. Two miles south of Oak Grove,

Bowie County. Julia Gardner, 1924.

12933. Northward-facing slope of Daniels Creek valley, near the old Frieze well of the Morgan Oil Company, 2% miles north by east of Malta, Bowie County; calcareous, chalky sand near base of formation. L. W. Stephenson and R. L. Cannon, 1924. (See 5310.)

12934. Same as 12933. Julia Gardner, 1924. 13389. Branch of small creek, 1½ miles south-southeast of Marion, Guadalupe County. Julia Gardner, 1925.

**13568.** East-west public road, 1¼ miles south by east of Oak Grove. Bowie County; 5 feet of sandy, chalky marl and chalky sandstone, basal bed of formation. L. W. Stephenson and C. H. Dane, 1926.

13832. Mexia road at fork of Wortham road, 2% miles east of Cooledge on eastward-facing slope of Elm Creek valley, Limestone County: 10 feet of chalky marl in road ditch. L. W. Stephenson and C. H. Dane, 1927.

**13844.** Witherspoon Oil Company Redus Well No. 1, at a depth of 1045 feet, on G. A. Harper 92-acre Survey, Medina County, J. M. Dawson, 1927.

13865. Burlington road, 8½ miles north of Cameron, Milam County; sandy, calcareous clay (marl) in ditch. C. H. Dane, 1927.

14049. Same as 7605. L. W. Stephenson, 1911.

**14100.** East-west secondary road, 4 miles south by west of Kaufman, Kaufman County; calcareous clay (marl) in ditch. L. W. Stephenson, 1928.

14118. Pit of Corsicana Brick Company, 2 miles south of the courthouse at Corsicana, Navaro County; several feet of strongly calcareous clav (marl) in bottom of pit. L. W. Stephenson, 1928.

14127. Weathered out in field east of the Austin-Elgin highway, on the Burke place, 3¼ miles east by north of Manor, Travis County. L. W. Stephenson, 1928.

14129. Gully in westward-facing slope of Cottonwood Creek valley, <sup>1</sup>/<sub>4</sub> mile west of Kimbro, 2 miles south of Manda, Travis County: 25 feet of chalky marl becoming partly indurated to nodular chalky limestone at base, unconformably overlying Taylor marl: fossils were collected from near base of the chalky marl. L. W. Stephenson, 1928.

14131. Ditch on Buckheltz road, 7 7/10 miles west of Cameron (34 mile west of Pettibone station). Milam County; from above unconformable contact with Neylandville marl; 15 feet of chalky marl with phosphatic nodules and phosphatic internal molds of mollusks, unconformably overlying Neylandville marl. L. W. Stephenson, 1928.

14137. Same as 13832. L. W. Stephenson, 1928.

14156. Same as 7605. L. W. Stephenson, 1928.

**15502.** Cut in San Antonio road, 6 miles east of Castroville, Bexar County: 20 feet of greenish-gray sandy marl in part indurated to sandy limestone, resting unconformably on Taylor marl. L. W. Stephenson, 1930.

15520. Abandoned pit of Standard Fuller's Earth Company, ½ mile north of the Castroville road, 1½ miles south by east of Padrone Hill, 14 miles west of San Antonio, Bexar County; 15 feet of ealcareous sandy clay (marl) with layers of earthy, concretionary limestone, forming upper part of section and resting unconformably on Taylor marl. L. W. Stephenson, 1930.

15522. Abandoned earth tank north of Castroville road, 1½ miles west of the crossing of Leon Creek, Bexar County; fossiliferous marl thrown out from bed of tank. L. W. Stephenson, 1930.

**15523.** Crest of hill south of Seguin-San Antonio highway, 212 miles west of McQueeney, Guadalupe County: 12 or 15 feet of earthy marl and limestone poorly exposed 20 to 35 feet above level of highway; contains many shells of Gryphaea, Exogyra, and other fossils. L. W. Stephenson, 1930.

15524. Same as 7637. L. W. Stephenson, 1930

15526. Same as 7621. From indurated layer at top of Cretaceous portion of section. L. W. Stephenson, 1930.

15527. Same as 7621. Four feet below in-durated layer. L. W. Stephenson, 1930.

15531. Same as 7605. L. W. Stephenson, 1930

15532. Same as 7605. L. W. Stephenson, 1930.

15538. Same as 14131. L. W. Stephenson, 1930.

15544. Greenville road just outside the town limits of Terrell, Kaufman County; strongly calcareous, chalky marl containing phosphatic nodules and internal molds of mollusks and other organisms, probably the basal bed of the forma-tion. L. W. Stephenson, 1930. 15545. Road ditch in northward-facing

northward-facing slope of branch, 1% miles north of Tona siding, Hunt County; 5 feet of st ongly calcareous, sandy marl with phosphatic nodules and internal molds of mollusks and other organisms. L. W. Stephenson, 1930.

15546. Small branch just below road, 21/2 miles north of Tona siding, about 5 miles southwest of Quinlan, Hunt County: 21/2 feet of bluish-gray chalky marl, overlain by 9 feet of Kemp clay; contact fairly sharp but not ob-viously an unconformity. L. W. Stephenson, 1930.

15547. Road ditch in westward-facing slope of Lynne Creek valley, 3 7/10 miles southwest of Campbell, Hunt County; 4 feet of light-gray, very calcareous, slightly indurated sand with chalky matrix; contains phosphatic molds of mollusks and other organisms, and is the basal bed of the formation. L. W. Stephenson, 1930.

15621. Ravine in westward-facing slope of Medio Creck valley, '& mile southeast of Castro-ville road crossing, Bexar County; 8 or 9 feet of shell marl with *Gryphaca*, *Exogyra* and other fossils. L. W. Stephenson and A. N. Sayre, 1931.

15622. Low bluff on east side of Medio Creek, 0.85 mile below the Castroville road crossing, Bexar County: about 9 feet of shell mail with Gryphaea, Exogyra and other fossils. L. W. Stephenson and A. N. Sayre, 1931.

15623. Eight-tenths mile south of the Cas-troville road, on Cagnon Road leading due south, just east of abandoned fuller's earth pits, about 14 miles west by south of San Antonio, Bexar County; shell marl poorly exposed with Gryphaea, Exogyra and other fossils. L. W. Stephenson and A. N. Sayre, 1931.
 15624. Same as 15520. L. W. Stephenson

and A. N. Sayre, 1931.

16148. Northeast-southwest road on northward-facing slope of an eastward-flowing branch of Dry Creek, 1<sup>4</sup>/<sub>5</sub> miles south by west of bridge over Onion Creek, near Moore & Berry's store, Travis County: fossils found weathered out on slope. L. W. Stephenson, 1932.

16156. Same as 15502. L. W. Stephenson, 1932.

16159. Same as 12933. L. W. Stephenson, 1932.

16160. Same as 13568. L. W. Stephenson, 1932.

16161. In bed of branch 100 yards south of Missouri, Kansas & Texas R.R. (Shreveport Branch), 5 3/10 miles east by north of Geenville, Hunt County; small exposure of calcareous, chalky sandstone. L. W. Stephenson, 1932.

16165. Second class road, 11/2 miles south-southeast of Pleasant Grove Church, 1/2 mile southwest of a small cemetery, 4 miles southwest of the courthouse at Cossicana, Navarro County; weathered sandy marl with phosphatic nodules and internal molds of mollusks; this is the basal

hed of the formation. L. W. Stephenson, 1932. 16167. Same as 14118. L. W. Stephenson, 1932.

16352. Salsamora Creek, 1 mile south of B. M. 746 on Culebra Road, and 1.9 miles southwest of St. Mary's University, Bexar County. A. N. Sayre, 1933.

16353. Chalky marl from a dug well at a windmill south of Culebra Road, 7/20 mile south by west of St. Mary's University, Bexar County. A. N. Sayre, 1933.

16354. South bank of a small arroyo, 2/5 mile south by west of St. Mary's University, Bexar County. A. N. Sayre, 1933. 16408. Same as 16353. L. W. Stephenson

and C. B. Renick, 1933.

16490. Bottom of gravel pit on south side of the new U.S. Highway 90, 3 miles west-southwest of the crossing of Cibolo Creek, 11/2 miles west of Woman Hollow Creek, Bexar County. A. N. Sayre, 1933.

16491. Green Road in ditch, 3/4 mile southwest of the new U.S. Highway 90, East San Antonio quad angle, Bexar County. A. N. Sayre, 1933.

16492. West bank of Salado Creek, 100 feet south of St. Hedwig Road crossing, Bexar County. A. N. Sayre, 1933.

16494. High hill ½ mile north of Redwing road and 2 miles west of Medina Lake toll road, 3 miles west of Cliff, Medina County. A. N. Sayre, 1933.

16667. Same as 15502. L. W. Stephenson, 1934.

16669. Same as 16492. Philip B. King, 1934. 16670. Same as 16492. L. W. Stephenson, 1934.

16671. Salado Creek at east edge of San Antonio, about 500 feet upstream, from the crossing of the new U.S. Highway 90, Bexar County: from chalky marl poorly exposed 15 or 20 feet above water level, and probably within 15 feet of base of formation. L. W. Stephenson, 1934.

16719. Probably same as 10870 (2 miles south of Cliff). H. C. Fountain, 1934.

16924. In the breaks of Big Caddo Creck valley, about 2 miles northeast of Quinlan, Hunt County. Probably same as 17381. Gayle Scott, 1932.

17381. Field 800 feet east of a second-class road, 1 9/10 miles northeast of Quinlan. Hunt County; weathered poorly exposed marl with many phosphatic nodules, some 3 or 4 inches in length, and many phosphatic internal molds of mollusks and other organisms; this is the basal bed of the formation overlying the Nacatoch sand, and it lies about 50 feet above the level of the bottom land of Caddo Fork of Sabine River. L. W. Stephenson, 1936.

17384. Same as 15517. L. W. Stephenson, 1936.

17385. Brow of hill at bend in road from west to south, 4 miles southwest of Quinlan, Hunt County; ditch reveals 9 feet of light-gray compact sandy, chalky marl, most sandy at base, containing a few phosphatic nodules and internal molds of mollusks; this is the basal bed of the formation unconformably overlying the Nacatoch sand. L. W. Stephenson, 1936.

17450. San Geronimo Creek 1/2 mile west of the Bexar County line, about 2 miles south of Cliff, Medina County, P. B. King, 1934. (See 10870.)

Texas Bureau coll. 39. Slope northwest of Camp Travis Hospital, near northeast corner of San Antonio, Bexar County. E. H. Sellards.

Texas Bureau coll. 43. Same as U.S.G.S. coll. 15623.

Texas Bureau coll. 53. Same as U.S.G.S. coll. 15502. E. H. Sellards.

Texas Bureau coll. 625. Same as U.S.G.S. coll. 7605. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 742. Same as U.S.C.S. coll. 15623. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 743. Same as U.S.G.S. coll. 15520. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 744. Same as U.S.G.S. coll. 16351. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 746. Same as U.S.G.S. coll. 15522. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 747. Same as U.S.G.S. coll. 10627. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 756. Same as U.S.G.S. coll. 15502. E. H. Sellards and R. L. Cannon, 1922.

Texas Bureau coll. 2320. Same as U.S.G.S. coll. 14129.

Texas Bureau coll. 2395. Otto Dreyer's farm, 2 miles east of Marion. Guadalupe County.

Texas Bureau coll. 3033. Carlson farm, Kimbro Survey, Travis County.

Texas Bureau coll. 3282. Same as U.S. G.S.coll. 15502.

Hill coll. 46, in U.S. Nat. Museum. South of Moore's crossing over Onion Creek, 1 mile southeast of Moore's store, Travis County. R. T. Hill, 1894.

Hill coll. 47, in U.S. Nat. Museum. West end of Simpsons Hill on road leading up from Onion Creek ford, Travis County. T. W. Vaughan, 1894.

Hill coll. 48, in U.S. Nat. Museum. Onion Creek at crossing below Moore's ford, Travis County. T. W. Vaughan, 1894.

#### FOSSILS FROM THE KEMP CLAY

764. Austin road, near Deatsville, 2 miles no thwest of Webberville, Travis County; yellowish-brown calcareous concretions, poorly exposed in westward-facing slope, upper part of formation. T. W. Stanton, 1890.

765. Near Littig, Travis County, upper part

of formation. T. W. Stanton, 1890. 1641. Tom Thrasher's well at depth of 65-73 feet, road from Bastrop to Delvalle, 3/4 mile from old Garfield, Travis County. T. W. Vaughan, 1894.

1642. Near Webberville, Travis County. See 7601. T. W. Vaughan, 1894.

7085. Right bank of Cibolo Creek, about 11/2 miles west of Zuehl, in Bexar County; greenishgray clay with interbedded masses of crossbedded fine calcareous fossiliferous sandstone, some of which are found washed out into the bed of the creek nearby. Alexander Deussen, 1910.

7601. Bluff on Colorado River, left bank, at Webberville, Travis County; 6 feet of dark bluish-gray slightly calcareous clay, probably near or above middle of formation. L. W. Stephenson and Alexander Deussen, 1911.

7602. Colorado River, 1/4 mile below Webberville, Travis Couny; dark clay as at 7601. L. W. Stephenson and Alexander Deussen, 1911.

7603. From a gully in slope north of old Garfield, Travis County; greenish calcareous clay with concretions of calcareous sandstone meagerly fossiliferous, near middle of formation. L. W. Stephenson and Alexander Deussen, 1911.

7631. Guadalupe River, right bank, 1/3 mile above the Southern Pacific (G.H.&S.A.) R.R. bridge near McQueeney, Guadalupe County: 30 feet of dark bluish-gray calcareous shale with a few thin sandstone lenses, and a layer of hard fine sandstone 10 feet above base at upstream end of bluff, dipping downstream; probably near middle of formation; fossils are from just below and just above the sandstone. L. W. Stephenson, 1911.

7632. Same locality as 7631; from sandstone lens 20 or 25 feet above base of section. L. W. Stephenson, 1911.

7633. Same locality as 7631: found loose on face of bluff. L. W. Stephenson, 1911.

7638. Pit of Seguin Vitrified Paving & Face Brick Company, 1/5 mile south of McQueeney, Guadalupe County; dark-gray calcareous clay, upper part of formation. L. W. Stephenson, 1911. 7720. Same as No. 7085. L. W. Stephenson,

1911.

7721. Boulders of calcareous fossiliferous sandstone loose in bed of Cibolo Creek near 7720. L. W. Stephenson, 1911.

9550. Elm Creek at bridge on Corsicana-Angus road, about 4 miles south of Corsicana. Navarro County. O. B. Hopkins, 1915.

9556. Three and a half miles north of Powell, 10 miles northeast of Corsicana, Navarro County; from a fresh exposure of clay along a creek bend on the east side of the road. O. B. Hopkins, 1915.

**10877.** Bluff on a small creek entering York Creek from the south, <sup>4</sup>/<sub>5</sub> mile northwest of Wade school, 4 miles southeast of Zorn, Guadalupe County; 50 feet of gray shale with interbedded layers of fine calcareous sandstone: fossils are from a layer of shell marl 4 to 12 inches thick. 5 to 8 feet above base; section is estimated to be above middle of formation. L. W. Stephenson, 1921.

10878. Ditch along public road, 2 7/8 miles west-southwest of Staples, Guadalupe County;

pieces of greenish-gray fossiliferous sandstone in ditch, upper part of formation. L. W. Stephenson, 1921.

11247. About 50 yards northeast of the Lone Oak Pike, on the east side of Cowleech Fork of Sabine River, about 12 miles southeast of Greenville, Hunt County; Navarro fossils reworked in base of Kincaid formation (Paleocene). Mr. and Mrs. D. A. Sannders, 1922. 12865. West center of David Morgan Sur-

12865. West center of David Morgan Survey, in a ditch at the northwest corner of the J. N. Smith 37-acre tract, 2 miles southeast of Tira, 13½ miles north of Sulphur Springs, Hopkins County, C. E. Cook, 1924.

12921. About 500 feet south of the northeast corner of the W. M. Marshall 121-acre tract in the H. Little Survey, about 4½ miles northeast of Roane, Navarro County; a coquina-like layer several inches thick, upper part of formation. L. W. Stephenson and C. E. Cook, 1924. 12922. North corner of the John A. Thomp-

12922. North corner of the John A. Thompson estate, 1550 feet east of the west line of the Wm. Fisher Survey, about 3½ miles northwest of Bazette, 4 miles northeast of Roane, Navarro County: upper part of formation. L. W. Stephenson and C. E. Cook, 1924.

12930. Northwest corner of the G. W. Chapman 31-acre tract, Daniel Morgan Survey, 1½ miles southeast of Tira and about 14 miles north of Sulphur Springs, Hopkins County; upper part of formation. L. W. Stephenson and C. E. Cook, 1924.

**13124.** Well of Robinson Oil & Gas Company, Cargile No. 1, 2 miles west of Groesbeck, Limestone County; at depth of 800 feet. G. C. Matson, 1915.

13131. Same as the preceding. At depth of 675-700 feet.

13132. Same as the preceding. At depth of 730 feet.

13776. Black Bluff on Brazos River in Falls County, about 2 miles above the Milam County line. upper part of formation. Julia Gardner, 1925.

13777. From a draw, ½ mile west of the Austin-Lockhart road, 6 miles north of Lockhart, Caldwell County. Julia Gardner and C. E. Cook, 1926.

13861. Earthy 'calcium carbonate concretions in field east of the Austin-Elgin road, 3<sup>1</sup>/<sub>4</sub> miles east by north of Manor, Travis County, L. W. Stephenson and W. P. Popenoe, 1927.
13910. Same as 7601. Julia Gardner, 1927.

13910. Same as 7601. Julia Gardner, 1927. 14125. Same as 764. L. W. Stephenson, 1928.

14126. Public road, 1¼ miles north-northwest of Deatsville, Travis County; dark gypsiferous clay with interbedded thin, platy calcareous sandstone layers, upper part of formation. L. W. Stephenson, 1928.

Stephenson, 1928.
14128. Gully west of road, 2 miles northnorthwest of Deatsville, Travis County; gray calcareous clay with a bed of earthy fossiliferous limestone 6 to 10 inches thick, upper part of formation. L. W. Stephenson, 1928.

14130. San Gabriel River, right bank, about % mile above the San Gabriel-Thorndale road crossing, Milam County; dark glauconitic, calcareous sand with phosphatic nodules and molds of fossils, basal bed of formation. L. W. Stephenson, 1928.

14136. Field near the Wortham road, 5 miles east of Cooledge, Limestone County; yellowish fossiliferous limestone concretions, upper part of formation. L. W. Stephenson, 1928.

14138. Weathered out of upper part of formation in field near oil-prospecting well of Moss & Keeling, W. D. Moody No. 1, ½ mile south-southwest of McLeod School, about 6½ miles southeest of Currie, Navarro County. L. W. Stephenson, 1928.

**14139.** Branch ½ mile south of McLeod School, 6½ miles southwest of Currie, Navarro County; 15 feet of dark shaly clay with fossils in lower 4 to 6 feet, upper part of formation. L. W. Stephenson, 1928.

14158. Deep ditch north of railroad, 3<sup>1</sup>/<sub>4</sub> miles east of Manor, Travis County; earthy, very impure soft limestone. L. W. Stephenson, 1928.

**14162.** Willow Creck, below the Austin highway, 5 miles west by north of Elgin, Travis County; 10 feet of dark calcareous clay, about middle of formation. L. W. Stephenson, 1928.

15434. Half a mile west of Odds, Limestone County. Julia Gardner, 1930.

15518. Eastward-facing slope of Leon Creek valley, about <sup>1</sup>/<sub>2</sub> mile above the Southern Pacific (G.H.&S.A.) R.R. bridge, Bexar County; greenish-gray calcareous clay, upper part of formation. L. W. Stephenson, 1930.

15519. Ravine on eastward-facing slope of Leon Creek valley, a mile above the Southern Pacific (G.H.&S.A.) R.R. bridge, Bexar County; greenish-gray calcareous clay, upper part of formation. L. W. Stephenson, 1930.

15525. Same as 7638. L. W. Stephenson, 1930.

15528. Deep roadside gully, 3/5 mile west of Elm Creek school, 4½ miles northwest of Lockhart, Caldwell County; calcareous, ferruginous fossiliferous concretions in dark clay, upper part of formation. L. W. Stephenson, 1930. 15529. Gully west of Austin-Lockhart road,

15529. Gully west of Austin-Lockhart road, 1 3/10 miles south of Mendoza, 4% miles west of Lytton Springs, in Caldwell County; 6 feet of gray calcareous clay forming the uppermost bed of the formation, unconformably overlain by the Kincaid formation (Paleocene). L. W. Stephenson, 1930.

15533. Yellowish concretions in a field 2 miles south of new Garfield store, 1½ miles northwest of Texas Hill, Travis County: upper part of formation. L. W. Stephenson, 1930.

15534. Same as 14158. L. W. Stephenson, 1930.

15537. Branch of Mustang Creek above and below the Taylor-Noack road, 3 miles south, 30° west of Thrall, Williamson County; 6 to 10 inches of cream-colored soft earthy limestone with many dark phosphatic pubbles, phosphatic molds of gastropods and pelecypods, and a few non-phosphatic gastropods and corals; forms hasal hed of the formation, and rests unconformably on the Taylor marl. L. W. Stephenson, 1930.

**16141.** From a wash in a field 3 miles southeast of Manor, Travis County; yellow calcareous concretions in upper part of formation; the horizon is less than 20 feet above a bed carrying an abundance of *Idonearca deatsrillensis* Stephenson. L. W. Stephenson and F. L. Whitney, 1932.

16142. Earth tank in a draw, 3<sup>1</sup>/<sub>4</sub> miles southeast of Manor, Travis County; earthy lime-

stone in upper part of formation. L. W. Stephenson and F. L. Whitney, 1932.

16146. Near head of small branch, 2/5 mile west of public road, 21/4 miles north by west of Deatsville, Travis County; dark clay in middle or upper part of formation. L. W. Stephenson and C. E. Cook, 1932.

16149. Washes in field east of Luling-San Marcos highway, 3½ miles north-northwest of Fentress, Caldwell County; gray shaly clay with calcareous, ferruginous fossiliferous concretions,

arcous, Fringmons Tossinterous Folieferious, upper part of formation. L. W. Stephenson, 1932.
16151. Same as 15528. L. W. Stephenson and E. V. Woolsey, 1932.
16489. Small arroyo east of Cibolo Creek,

% mile north of the crossing of the Zuehl road, Guadalupe County, A. N. Sayre, 1933. 16668. Earth tank west of public road, about 2 miles south-southeast of Schumansville,

9/10 mile south-southeast of the crossing of Long Creek, Guadalupe County; calcareous concretions in dark clay, near base of formation. L. W. Stephenson, 1934. 17367. State Highway 22, east of Beaton

tank, 3 miles southeast of the courthouse at Corsicana, Navarro County; gray shaly clay, upper part of formation. L. W. Stephenson, 1936. 17370. Same as 15537. L. W. Stephenson,

1936.

17372. Westward-facing slope of Big Creek valley, 3 miles southwest of Stranger, 1 3/10 miles southeast of Parsons Bridge, Falls County; yellowish septarian concretions in field 40 feet above Big Creck hottom, upper part of formation. L. W. Stephenson, 1936.

17373. Light-yellowish concretions in field north of road, 1 mile west by south of Odds (Limestone County), in Falls County; 15 to 20 feet above Big Creek bottom; upper part of formation. L. W. Stephenson, 1936. **17374.** Field east of the old Wortham road,

2% miles northeast of the junction with U.S. Highway 84, about 4½ miles east of Cooledge, Limestone County; orange-colored septarian concretions in dark shaly clay, upper part of forma-

tion. L. W. Stephenson, 1936. 17375. Public road 3¼ miles north-north-west of Bazette, 1½ miles north-northwest of Buffalo School, Navarro County; poor exposure of dark clay with an interbedded 6 inch shell layer composed mainly of Crassatella in fragmentary condition but including a goodly number of complete valves; this bed lies within 15 or 20 feet of the top of the formation, and about 52 feet lower than the crest of the hill to the south; this locality was discovered by F. B. Plummer, who called attention to it. L. W. Stephenson, 1936.

17376. Field east of public road, 3 4/5 miles north-northwest of Bazette, 11/2 miles north-northwest of Buffalo School, Navarro County; shells of the Crassatella bed described under 17375, weathered out in northwestward-facing slope. L. W. Stephenson, 1936.

17377. Same as 14139. L. W. Stephenson, 1936.

18196. On a hillside by a road 2 2/5 miles southeast of Manor, Travis County. This collection was received too late to be included in the table of distribution and range (Table 4). John W. Wells, about 1936.

Texas Bureau coll. 739. Dam on Cedar Creek 10 miles south-southeast of Greenville, Hunt County, E. H. Sellards, 1922.

Texas Bureau coll. 903. 1 mile east of Kimbro, Travis County.

Texas Bureau coll. 1170. 4 miles northwest of Lockhart, Caldwell County,

Texas Bureau coll. 1173. 3 miles northwest of Lockhart, Caldwell County.

Texas Bureau coll. 1174. 3 miles northwest of Lockhart, 1/2 mile southwest of well on

Plum Creek, Caldwell County, Texas Bureau coll. 2398. Edd Myer's place 2 miles [?] cast of Manor, Travis County, Texas Bureau coll. 2399. Near Gilleland

Creek, Buckman Survey 4 miles south of Manor, Travis County.

Hill coll. 8, in U.S. Nat. Museum. "Glauconitic division" in the vicinity of Webber-ville, Travis County, See 7601, R. T. Hill and T. W. Vaughan, 1894.

#### SYSTEMATIC PALEONTOLOGY

### Phylum PORIFERA

#### Class SPONGIAE

#### Subclass SILICISPONGIAE

#### Order MONACTINELLIDA

#### Family CLIONIDAE

#### Genus CLIONA Grant

The genus *Cliona* is based on a boring sponge inhabiting the waters of the Firth of Forth, Scotland. The name was introduced by Grant<sup>77</sup> in 1826, who in the same article named and described the type species, Cliona celata.

The casts of sponge borings, commonly referred to Cliona, occur abundantly in certain beds, usually calcareous, in the upper part of the Upper Cretaceous (Exogyra costata zone) of the Atlantic and Gulf Coastal Plain. The borings are in thick-shelled mollusks, the forms of which may be faithfully preserved by the network of casts even after the shell substance has been completely dissolved away (pl. 3, figs. 1, 4, 5). The casts are as a rule phosphatic. A few casts of Cliona have been found in the Navarro group of Texas.

#### CLIONA MICROTUBERUM Stephenson, n.sp.

#### Pl. 3, figs. 1-5: pl. 5, figs. 1, 2

A boring sponge preserved as sandy phosphatic casts in the thick shells of

<sup>77</sup>Grant. R. E., Notice of a new zoophyte (Cliona celata, Grant) from the Firth of Forth: Edinburgh New Philosophical Jour., vol. 1, pp. 78-81, 1826.

mollusks. The specimens are often found with the inclosing shell dissolved away, leaving the casts freely exposed. The openings through which the sponge enters the shell range in diameter up to 2 mm. or more, and the excavations made within the shell are in the form of more or less irregular interconnecting channels ranging up to 5 mm. or more in cross section. In some specimens the channels are turnipshaped, flattish jug-shaped, or irregularly ovate, and they may be aligned in rows interconnecting one with another by means of smaller channels (pl. 3, fig. 3), or they may be irregularly distributed within the shell. The casts are generally hard and firm but may be in any degree of induration from soft to hard. The material filling the borings is generally phosphatic and more or less sandy. The surface of the cast is densely stippled with tiny tubercles (pl. 3, fig. 2). No spicules have been detected in the material forming the casts.

Intermingled in intimate association with the *Cliona* casts are problematical casts of slender, smooth, or very finely granular, intercommunicating cavities, which probably pertain to an undetermined organism, perhaps a sponge (pl. 5, fig. 1); they are mostly less than a millimeter in diameter and tend to be straight or gently curved for stretches as great as 7 or 8 mm., but in places they are very irregular in trend; they have a twisted appearance and may be irregularly furrowed in a general longitudinal direction. In one small shell fragment from the Kemp clay (7601) the borings and their associated casts are mainly of this slender sort (pl. 3, fig. 6, U.S.N.M. no. 76269).

Casts of borings regarded as belonging to *Cliona*, from the Navesink marl of New Jersey, were described as new in 1932 by Fenton and Fenton,<sup>78</sup> under the name *C. cretacica*. The authors were doubtless unaware that a nearly identical name, *Cliona cretacea* (Portlock) had previously been applied to a species of boring sponge from the Upper Cretaceous chalk of England.<sup>79</sup> The later name is valid, however, if the recommendation of the International Commission on Zoological Nomenclature is accepted, namely, that names once introduced are not to be rejected because of a slight variation in spelling.

The holotype of *Cliona cretacica* (New Jersey State Museum No. 8184) should be preserved in the State Museum at Trenton, New Jersey, but it can not be found there and is apparently lost. The figured paratype (New Jersey State Museum No. 8185, fig. 8) is preserved, but it shows only the openings into the shell and does not show the form of the cast. Since the published figure of the holotype of the New Jersey species does not show stippling on the surface of the casts, and no mention is made of this feature in the author's description, the Texas material can not be safely referred to it.

In the New Jersey State Museum colis an unnumbered shell lection of Gryphaea from the type locality of Cliona cretacica, which has been thoroughly perforated by boring sponges and the strongly phosphatic casts are well exposed by subsequent deep corrosion. These casts, labelled Cliona sp. by the Fentons, appear to represent two organisms, one of which has the irregular form and surface stippling of Cliona microtuberum, and may be that species, although the average diameter of the casts is somewhat less. The other organism is represented by long smooth, more or less curved casts having about the same average diameter as the *Cliona*; these casts are much larger and lack the twisted form of the slender species associated with the type of C. microtuberum. The Fentons examined this specimen, compared it with the holotype of C. cretacica, and did not consider either of the two kinds of casts as representing their new species.

Types.—Holotype, U.S.N.M. no. 76266; two figured paratypes, U.S.N.M. no.

<sup>&</sup>lt;sup>78</sup>Fenton, Carroll Lane, and Fenton, Mildred Adams, A new species of *Cliona* from the Cretaceous of New Jersey: Amer. Midland Naturalist, vol. 13, no. 2, p. 55, pl. 7, figs. 8, 9.

<sup>&</sup>lt;sup>70</sup>Fischer, M. P., Recherches sur les éponges perforantes fessiles: Mus. histoire nat. Paris, Nouvelles, Archies, tome 4, p. 167, pl. 25, figs. 5a-d, 1868. (See synonymy.)

Portlock originally called the species Entobia cretacea. (See J. E. Portlock, Report on the geology of the County of Londonderry, p. 360, 1843.)

76267; 1 figured paratype, U.S.N.M. no. 76268; 1 figured paratype, U.S.N.M. no. 76270.

Distribution in Texas.—Navarro group, Corsicana marl: 11/4 miles south by cast of Oak Grove (13568, figured; 16160); 7 miles south, 3 miles east of Greenville (11250, holotype); well on G. A. Harper Survey (at a depth of 1045 feet), Medina County (13844).

Navarro group, Kemp clay: 12 miles southeast of Greenville (11247).

*Outside distribution.* — Mississippi: Prairie Bluff chalk.

Alabama: Prairie Bluff chalk.

New Jersey: Navesink marl (represented in New Jersey State Museum by a specimen labeled *Cliona* sp.)

Range.—The phosphatic remains of boring sponges closely similar to *Cliona microtuberum* are common in the upper part of the Upper Cretaceous series of the Atlantic and Gulf Coastal Plain; they are particularly abundant in the Prairie Bluff chalk of Mississippi and Alabama. These organisms have never been systematically studied.

Phylum VERMES

## **Class CHAETOPODA**

## Order TUBICOLA

## Family SERPULIDAE

## Genus SERPULA Linné

#### SERPULA CRETACEA (Conrad)

#### Pl. 4, figs. 1-3

- 1875. Diploconcha cretacea Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 12, pl. 2, fig. 26.
- Kerr), App. A, p. 12, pl. 2, fig. 26.
  1892. Diploconcha (Serpula?) cretacea (Conrad)?. Whitfield, U.S.Geol. Survey Mon., vol. 18, p. 170, pl. 20, fig. 25. (Geol. Survey New Jersey, Paleontology, vol. 2, p. 170, pl. 20, fig. 25.)
- 1892. Dentalium (Falcula) falcatum (Conrad).
  Whitfield, U.S.Geol. Survey Mon., vol. 18, p. 169, pl. 20, figs. 15–17 (not figs. 12–14, 18). (Geol.Survey New Jersey, Palcontology, vol. 2, p. 169, pl. 20, figs. 15–17.)
- 1907. Serpula whitfieldi Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 308, pl. 19, fig. 2.
- 1916. Serpula whitfieldi Weller. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 746.
- 1923. Serpula cretacea (Conrad). Stephenson, North Carolina Geol. and Econ. Survey,

vol. 5, p. 67, pl. 9, figs. 1-7, 10, 11 (questionably figs. 8, 9, 12).

1928. Serpula cretacea (Conrad). Adkins, Univ. Texas Bull. 2838, p. 78.

?1929. Serpula cretacea (Conrad). Trechmann, Geol. Mag., vol. 66, no. 785, p. 486.

Calcareous sinuous, gradually tapering tubes, occurring singly, in pairs or in colonies. Tube wall thin and fragile in the early stages, becoming gradually thicker to moderate thickness in later stages; structurally the walls are composed of a series of thin layers in the form of gradually enlarging truncated cones, one fitting snugly within the other, and ending orally in a thin edge; these layers are secreted by the animal as it grows larger and moves gradually outward in the tube. Fine transverse growth lines cover the outer surface on the younger stages; these tend to grow coarser away from the small end and may become quite coarse or undulating on large tubes. The species is characterized by its extreme sinuosity which may be any sort of irregalarity, may simulate a coiled gastropod, or may form a closely adhering or intertwining colony of numerous tubes. The tubes are circular in cross section and range in diameter from a millimeter or less at the small end to 9 millimeters at the large end of the largest tube in the Texas material; in the latter the tube wall attains a maximum measured thickness of about 1.5 mm.

One tube about 2.2 mm. in diameter contains a fragment of a calcareous operculum which is slightly concave on its outer surface and is ornamented with 10 or 12 (estimated) radiating primary ribs and perhaps as many intercalated secondaries; the point of radiation appears to be acentric. The broken edge of the prong which extends inward from the inner side of the operculum is visible, but is too imperfectly exposed for description. The ornamentation on this operculum is similar to that on the operculum described by Wade<sup>so</sup> under the name Hamulus sp., but the specimen is smaller and the ornamentation is not quite so pronounced. The operculum described by Gardner<sup>\$1</sup>

<sup>&</sup>lt;sup>80</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 31, pl. 2, figs. 9-11, 1926.

<sup>&</sup>lt;sup>81</sup>Gardner, Julia, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 748, pl. 47, figs. 16-19, 1916.

under the name Ornataporta marylandica is very much more finely ornamented. Both Wade's and Gardner's specimens probably pertain to Serpula; in both the Texas specimen and the Maryland specimens, the opercula are obviously situated far down in the tubes below the outer apertures.

In the simple tubes here referred to Serpula cretacea (Conrad) there are no characters to enable one to differentiate species. Were opercula preserved in all the tubes they might afford a basis for specific separation, for the three opercula here mentioned (from Texas, Tennessee, and Maryland) are differently ornamented and may represent as many species.

Types.—The specimen from Snow Hill, North Carolina, originally figured by Conrad, is probably lost. A specimen from the same locality labelled in Conrad's handwriting may be considered a cotype (U.S.N.M. no.  $31905)^{s_2}$ ; it consists of a pair of attached strongly curved tubes about 35 mm. long. Two plesiotypes from Texas, U.S.N.M. no. 21001; 1 plesiotype from Texas, U.S.N.M. no. 76294.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, 17365).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761, and U.S.N.M. no. 21001); field 2 miles southwest of Kaufman (7547); road 2 miles southwest of Kaufman (7546); field south of Chatfield (7569); Watkins' place 3 miles north of Corsicana (9552).

Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924); well 7/20 mile south by west of St. Mary's University, Bexar County (16353).

Navarro group, Kemp clay: near old Garfield (7603); west of Zuehl (7721).

Outside distribution.—Mississippi: Ripley and Owl Creek formations.

North Carolina: Snow Hill member of Black Creck formation and upper part of Peedee formation.

Maryland: Monmouth formation.

New Jersey: Navesink marl.

Jamaica, B.W.I.: Questionably in shales of Blue Mountain summit.

Range. --Calcareous tubes of Serpula, which can not be distinguished from S. cretacea (Conrad), are common in the upper part of the Exogyra ponderosa zone and in the Exogyra costata zone, in the Atlantic and Gulf Coastal Plain.

## SERPULA? LINEATA (Weller)

## Pl. 4, figs. 4–6

1907. Hamulus lineatus Weller, New Jersey Geol. Survey, Paleontology, vol. 4, p. 310, pl. 19, fig. 7.

1923. Serpula lineata (Weller). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 70, pl. 9, figs. 13, 14.

Calcareous tubes of small diameter, nearly straight or slightly sinuous, very gradually tapering. In the Texas material the smallest diameter measured is about 1.5 mm. and the largest diameter 4.5 mm.; shell wall at small end about 0.25 mm. thick and at large end 1 mm. thick. The figured specimen (pl. 4, fig. 5) is a fragment 29 mm. long, 4 mm. in diameter at the small end and 4.5 mm. in diameter at the large end.

The tubes of this species are more gently tapering, thicker-walled, and in general more nearly straight than are the tubes of *Serpula cretacea* (Conrad); the truncated cone-shaped layers which make up the tube wall are more gradually tapering.

Types.—Holotype; an internal mold from the Merchantville clay at Lenola, New Jersey; preserved in the State Muscum at Trenton, New Jersey. Four plesiotypes from Texas, U.S.N.M. no. 20891.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518).

Navarro group, Kemp clay: Webberville (7601).

Outside distribution. — Mississippi: Coon Creek tongue of Ripley formation, and Owl Creek formation.

Chattahoochee region (Alabama-Georgia): Blufftown formation and Ripley formation.

North Carolina: Snow Hill member of Black Creek formation.

<sup>&</sup>lt;sup>83</sup>Figured in North Carolina Geol. and Econ. Survey, vol. 5, pl. 9, fig. 3, 1923.

New Jersey: Merchantville clay and Navesink marl.

Range.-Ranges through the zones of Exogyra ponderosa and E. costata in the Atlantic and Culf Coastal Plain.

# SERPULA BOWIENSIS Stephenson, n.sp.

Pl. 4, fig. 7

Tube irregularly sinuous, tapering rapidly, attached on one side to a fragment of an oyster shell; tube wall thin except along the area of attachment where it thickens and flares irregularly outward, producing a broad base. Upper surface ornamented with three sharp, rather prominent, gently and finely fluted longitudinal ridges. The tube is imperfect at both ends, but as preserved is about 28 mm. long, and increases in diameter from about 3 mm. at the small end to nearly 10 mm. at the large end. The transverse growth lines are very fine. The inner surface is partly exposed at the large end and, though somewhat corroded, is noticeably undulating.

This species is similar to Serpula barbata Morton,<sup>sa</sup> but the longitudinal ribs on the latter are more widely separated and the tube tapers less rapidly; because of these differences and the lack of information as to the locality and geologic position of the Alabama material, it seems best to apply a new name to the Texas specimen.

Serpula bowiensis appears to be closely allied to Serpula fluctata Sowerby,<sup>84</sup> a small slender species with 3 fluted ribs on the attached part of the tube, and 5 on the free part, from the Upper Chalk (Maestrichtian) at Norwich, England.

Holotype.-U.S.N.M. no. 76271.

Distribution in Texas.-Navarro group, Corsicana marl:  $1\frac{1}{4}$  miles south by east of Oak Grove (16160); ?7/20 mile south by west of St. Mary's University, Bexar County (16353).

# Genus HAMULUS Morton HAMULUS ONYX Morton

Pl. 4, figs. 8, 9

- 1834. Hamulus onyx Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 73, pl. 2, fig. 8; pl. 16, fig. 5. 1905. Hamulus onyx Morton. Johnson, Acad. Nat.
- Sci. Philadelphia Proc., vol. 57, p. 4.
- 1916. Hamulus onyx Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 747.
- 1921. Hamulus onyx Morton. Wade, U.S.Nat. Mus. Proc., vol. 59, p. 43, pl. 9, figs. 1-3, 5, 6.
- 1923. Hamulus onyx Morton. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 76, pl. 10, fig. 11.
- 1926. Hamulus onyx Morton. Stephenson, Geol. Survey Alabama, Special Rept. No. 14, p. 250, pl. 92, fig. 2.
- 1926. Hamulus onyx Morton. Wade, U.S.Geol. Survey Prof. Paper 137, p. 30, pl. 2, figs. 4-7, 12.
- 1929. Hamulus onyx Morton. Dane, Arkansas Geol, Survey Bull. 1, p. 150, pl. 27, fig. 2.

Tube small, regularly tapering, curved more or less in the early stages, with a tendency to straighten out in the adult stages; the degree of curvature is variable in different individuals and the curvature may or may not be exactly in one plane. Six strong, subequal longitudinal ribs extend the entire length of the tube; the ribs are smoothest at the small end, but become irregularly rugged and subangular to rounded on the crest toward the large end; the interspaces are broadly V-shaped on the bottoms.

One fragment of a tube contains an operculum, the inner tooth-like projection of which is embedded in the matrix filling the tube; the outer surface of the operculum is slightly corroded, but is similar to the one described by Wade, being slightly concave, acentric, and nearly smooth.

The approximate dimensions of the best preserved Texas specimen (pl. 4, fig. 8) are: Length measured centrally around the curve of the tube 16 mm.; diameter at small end which is not quite complete, 1.1 mm.; diameter at large end measured on the outer crests of the ribs, 3.8 mm.; diameter of aperture 2 mm.

The shell structure of Hamulus tubes was described by the present writer in volume 5 of the North Carolina Geological and Economic Survey (p. 71, pl. 10, figs.

<sup>&</sup>lt;sup>83</sup>Morton, S. G., Synopsis of the organic remains of the Cretaceous Group of the United States, p. 73, pl. 15, fig. 12, 1834.

<sup>84</sup>Sowerby, James, Min. Conchol., vol. 6, p. 228, figs. 5, 6, 1829.

5, 9a). The tubes are generally found free in their containing matrix. Among hundreds of specimens examined only two have been found definitely cemented to objects. One of these, a tube about 8 mm. long, is attached throughout its length to the shell of *Anomia argentaria* Morton; the other, a curved tube about 11 mm. long, from the Ozan formation of Arkansas, is attached along about 8 mm. of its length to the curved surface of a small novaculite pebble.

Most of the ribbed worm tubes having the general form of *Hamulus*, from the European Cretaceous, have a number of ribs other than six (4, 5, 7), but two species having that number are recorded by Goldfuss.<sup>85</sup> Serpula sexangularis Münster is from "blauen Kreidmergel zu Rinkode bei Munster," and Serpula sexsulcata is from "einer kalkhaltigen Schist über dem Eisensande bei Amberg." Both of these species appear to be rather closely related to *H. onyx* Morton.

Types.—Collection of the Academy of Natural Sciences of Philadelphia. Morton cited the species from Lynchs Creek, South Carolina, and from the "older Cretaceous deposits" at Erie, Alabama, and figured one specimen from each locality. In the collections at the Academy are four specimens from the Tombigbee sand member of the Eutaw formation at Erie Bluff, Warrior River, Hale County, Alabama. The word "type" is not present on Morton's original label, but appears on two later labels. The Lynchs Creek material is probably lost and old Erie, Hale County, Alabama, may therefore appropriately be regarded as the type locality. Plesiotypes from Texas, U.S.N.M. nos. 76272, 76273.

Distribution in Texas.—Austin chalk: Excavation for a sidewalk on Webster Avenue, between 19th and 20th Streets, Waco, McLennan County (7560).

Bonham clay (Austin age): Randolph road, 6 miles (by the road) southwest of Bonham, Fannin County (10557).

Taylor marl: Old highway, westwardfacing slope of Little Walnut Creek valley, about 2 miles southwest of Sprinkle, Travis County (14160); Guadalupe River, 4 miles below New Braunfels, Guadalupe County (U.S.N.M. no. 21205); private road, eastward-facing slope of Salado Creek valley, about 2 miles above the crossing of the Missouri, Kansas & Texas R.R., Bexar County (7648).

Pecan Gap chalk (Taylor age): About 200 yards south of the Branson Brick Company's plant, at southwest edge of Marlin, Falls County (12915); Cedar Springs road, 5 3/10 miles south by east of Deer Creek crossing, about 5 miles east of Lott, Falls County (12916); same road, 5 4/5 miles south by east of Deer Creek crossing (12917).

Navarro group, Nacatoch sand: Field 3/5 mile west of Kaufman (14103, 1 specimen figured).

Navarro group, Corsicana marl: 2 1/5 miles north by east of Malta (12933, 16159, 1 specimen figured); <sup>1</sup>/<sub>4</sub> mile west of Kimbro (14129); Onion Creek, 2<sup>1</sup>/<sub>2</sub> miles east of old Garfield (7605, 14156); 2 miles east of Marion (Tex. Bu. 2395); near Camp Travis Hospital northeast of San Antonio (Tex. Bu. 39); arroyo 2/5 mile south by west of St. Mary's University, Bexar County (Tex. Bu. 744); Castroville road, 1 1/5 miles west of Leon Creek, Bexar County (15522); 6 miles east of Castroville (15502).

Outside distribution. --- Arkansas: Brownstown marl, Ozan formation, Annona chalk, Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Selma chalk, Coffee sand, Ripley formation, Owl Creek formation, Prairie Bluff chalk.

Alabama: Tombigee sand member of Eutaw formation; Selma chalk (lower part).

East-central Alabama and Chattahoochee region (Alabama-Georgia): Blufftown formation, Ripley formation (upper part), and Providence sand.

South Carolina: Peedce formation (upper part).

Maryland: Questionably in the Matawan and Monmouth formations.

Mexico: Cardenas beds, near Cardenas, State of San Luis Potosi.

<sup>&</sup>lt;sup>85</sup>Goldfuss, August, Petrefacta Germaniae, p. 238, pl. 70, figs. 12, 13, 1826.

Range.--Ranges through the zones of Exogyra ponderosa and E. costata; geographically ranges throughout the Atlantic and Gulf Coastal Plain and into Mexico.

### HAMULUS SQUAMOSUS Gabb

## Pl. 4, fig. 10

- 1859. Hamulus squamosus Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 11, p. 3. 1860. Hamulus squamosus Gabb, Acad. Nat. Sci.
- Philadelphia Jour., 2d ser., vol. 4, p. 398, pl. 68, fig. 45.
- 1921. Hamulus squamosus Gabb. Wade, U.S.Nat.
- Mus.Proc., vol. 59, p. 45, pl. 10, figs. 6, 7, 1926. Hamulus squamosus Gabb. Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 250, pl. 92, fig. 1.
- 1926. Hamulus squamosus Gabb. Wade, U.S. Geol. Survey Prof. Paper 137, p. 31, pl. 2, figs. 8, 13.
- 1929. Hamulus squamosus Gabb. Dane, Arkansas Geol. Survey Bull. 1, p. 150, pl. 27, fig. 1.

Gabb's original description of this species is as follows: "H. squamosus n. s. This is a hamulus from Prairie Bluff [Alabama River, Wilcox County, Alabama], very closely allied to *H. onyx*, but differing in having a strongly marked raphe, which nearly doubles the width of the shell. It is placed on both sides and in the plane of the curve. Museum of Acad. of Nat. Sci."

Tube small, regularly tapering, generally strongly curved in early stages, straightening out in the adult stages; individual variation in curvature marked; curvature generally in one plane, but the tube may twist slightly out of the plane. Each tube bears 6 strong longitudinal ribs, two of which are modified to form thin broadly expanding more or less wavy wings or flanges with irregularly serrated outer edges; these may extend to the aperture, or may end, as such, one or more millimeters back of the aperture; in the latter case, the continuation of the wings is represented by low ribs of normal aspect which extend to the aperture. The winged ribs divide the other four ribs into two pairs; the ribs of each pair are moderately strong, with subangular to sharply rounded crests which may be irregularly nodular, and the ribs of each pair are separated by a broadly V-shaped interspace of moderate depth.

Approximate dimensions of a mediumsize Texas specimen: Length measured along the center of the tube around the curve, about 26 mm.; diameter at small end 1 mm.; diameter at large end  $4 \pm$  mm.; maximum wing-spread 6.5 mm.

The species is not common in the formations of the Navarro group in Texas, but it occurs in great numbers in places in the Upper Cretaceous deposits of the Gulf Although always easily Coastal Plain. recognizable the species exhibits considerable individual variation in size, form, sculpture, degree of ruggedness, and degree of curvature.

Types.—The original material, recorded as having come from Prairie Bluff, Alabama River, Wilcox County, Alabama, should be preserved in the Academy of Natural Sciences of Philadelphia, but is apparently lost. One lot in the Academy, labeled "types?" is recorded as having been received from "Dr. Spillman, Mississippi"; the lot includes 5 tubes, 4 of which are referable to Hamulus squamosus Gabb, and one to H. onyx Morton. Plesiotype from Texas, U.S.N.M. no. 76274.

Distribution in Texas.—Taylor marl: Burlington road, 2 3/10 miles west-southwest of Rosebud, Falls County (14135): old highway, westward-facing slope of Little Walnut Creek valley, about 2 miles southwest of Sprinkle, Travis County (14160); right bank of a small arroyo,  $2\frac{1}{2}$  miles south of San Marcos, 1/3 mile east of the San Marcos-Staples store road, Hays County (7617).

Upson clay: ?Core sample taken at a depth of 2450 feet in a test well in section 116, Maverick County (10286).

Navarro group, Corsicana marl: 2 3/5 miles north by east of Malta (16159); 5 miles southwest of Quinlan (15546); Onion Creek 21/2 miles west of old Garfield (14156, 15532); Castroville road, 1 1/5 miles west of Leon Creek, Bexar County (15522); 14 miles west of San Antonio (15520).

Navarro group, Kemp clay: 2 miles northwest of Deatsville (14128).

Outside distribution. --- Arkansas: Brownstown marl, Ozan formation, Annona chalk.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Coffee sand, Selma chalk (lower part and *Exogyra cancellata* zone), Ripley formation, and Prairie Bluff chalk.

West-central Alabama: Selma chalk (lower part).

East-central Alabama and Chattahoochee region (Alabama-Georgia): Blufftown formation, Ripley formation (upper part), and Providence sand.

Range.--Exogyra ponderosa and Exogyra costata zones of Gulf Coastal Plain.

## HAMULUS? HUNTENSIS Stephenson, n.sp.

## Pl. 4, figs. 11-16

Tube large, thick-walled, tapering gradually. Surface badly corroded in the available material, the jagged edges of the growth layers forming irregular transverse lines about the tube. The tube is made up of a succession of gradually enlarging, truncated cone-shaped layers, the outer ends of which bend back as in the genus Hamulus; the bent-back ends of these layers were largely destroyed by corrosion, apparently before fossilization, but enough of the tube has been preserved to show this feature in places. There is no suggestion of longitudinal ridges.

The small end of the tube is not preserved, but all of the longer fragments show curvature in one plane, which increases toward the small end. The smallest measured diameter is 4.2 mm., and the largest diameter 19 mm. The dimensions of the longest fragment are: Length 62 mm.; diameter at small end 8 mm.; diameter at large end 12.4 mm.; maximum thickness of tube wall 3 mm. The maximum thickness of shell wall noted in the collection is about 4 mm.

The reference of this species questionably to *Hamulus* is based on the reflected outer ends of the growth layers, the gentle curvature, and the gradual tapering of the tubes.

The species appears to be closely related to the large species, *Hamulus walkerensis* Stephenson, from the Snow Hill member of the Black Creek formation of North Carolina, but it lacks the 6 faint longitudinal swells which on the North Carolina species correspond to the 6 ribs of other species of the genus.

Too much dependence should perhaps not be placed on the reflected growth layers in the determination of the genus *Hamulus*, for this feature is known to occur in irregularly sinuous, unribbed marine tubes, as for example, in the Recent *Crucigera formosa* Bush. which inhabits the waters of Japan.

*Types.*—Five figured cotypes, U.S.N.M. no. 76275; 13 unfigured cotypes, U.S.N.M. no. 76276.

Distribution in Texas. -- Navarro group, Nacatoch sand: 1½ miles west of Campbell (12925).

Navarro group, Corsicana marl: ? Field 1 9/10 miles northeast of Quinlan (17381).

## Phylum ECHINODERMATA

## Subphylum PELMATOZOA

# Class CRINOIDEA

# Order ARTICULATA

#### Family BOURGUETICRINIDAE

This group of organisms is represented by two small segments of stems or roots, from the Corsicana marl in a dug well at a windmill, 0.35 mile south by west of St. Mary's University, just south of Culebra road, Bexar County (16353, U.S.N.M. no. 76277). One fragment is 3.7 mm. long, 2 mm. in diameter, and is composed of three segments: the sides of the segments are smooth but are slightly and broadly concave between the joints; the joint surfaces are circular with a small central perforation; they appear smooth but under a lens are slightly undulating in detail and are very finely granular. The other fragment is similar to the first and appears to be one segment 3 mm. long and 2.3 mm. in diameter. These fragments have been examined by Dr. Edwin Kirk, who furnishes the following note:

The fragments are identical in appearance with material from the Prairie Bluff chalk in Chickasaw County, Mississippi, where a remarkably complete lot of crinoid remains was obtained in June 1936 by L. W. Stephenson and W. H. Monroe. The material from Mississippi includes complete roots and crowns. together with a large amount of fragmentary columns. The crinoid represents a new genus, the nearest affinities of which seem to be with *Mesocrinus* from the Cretaceous of Sweden.

# Subphylum ECHINOZOA Class ECHINOIDEA Order CIDAROIDEA Family CIDARIDAE

One well preserved spine, probably a cidarid (pl. 5, fig. 3), was found in the Nacatoch sand in a bluff on Red River, 200 yards west of Lewis Ferry, 8 miles north of New Boston, Bowie County (12935, U.S.N.M. no. 76278). The spine is long, slender, and tapering above, and the shaft is ornamented with longitudinal rows of prominent closely spaced tubercles; on the lower part of the shaft the rows number 8, but toward the top there are 10 rows due to the intercalation of two additional rows in two of the interspaces; a few small to medium sized tubercles occur at scattered intervals elsewhere in the interspaces. The base of the spine is incised where it was seated on its tubercle: a sharp finely serrated ridge girdles the spine about one millimeter above the basal terminus, and below the ridge the base is strongly beveled: just above the ridge a slightly sunken, finely cross-striated band, about half a millimeter wide, encircles the lower end of the shaft.

A small fragment of a cidarid test found in the Corsicana marl in a dug well at a windmill, 0.35 mile south by west of St. Mary's University (16353), is not adequate for generic and specific identification.

#### Order EXOCYCLOIDA

## Suborder SPATANGINA

# Tribe SPATANGOIDEA

## Family ANANCHYTIDAE

#### Genus CARDIASTER Forbes

## CARDIASTER LEONENSIS Stephenson, n.sp.

# Pl. 5, figs. 4-7; pl. 6, figs. 5, 6

Test small, cordate, of medium height, a little flattened in the apical region; a lateral cross section through the apex presents a nearly uniformly curved arch, slightly flattened, however, at the top. The test is widest anteriorly, becoming slightly constricted posteriorly. Base concave anteriorly with a broadly arched plastron extending with increasing width from the peristome to the posterior margin, which is slightly truncated; the posterior ambulacra occupy the shallow, radiating depressions on either side of the plastron. The ambulacra are of only moderate width and are subpetaloid, the pore-pairs dying out well above the ambitus; the pores are small, slightly elongate, uniserial in arrangement, and the pores of each pair are subequal and closely spaced; the porepairs appear to be nonconjugate. Only the anterior ambulacrum occupies a sulcus. The ambulacral plates are small and narrow and each pore-pair is situated centrally with respect to the length of the plate, but nearer the lower edge. The sulcus occupied by the anterior ambulacrum is shallow, is widest and deepest at the ambitus, and narrows and practically disappears before reaching the apical system; it is bordered by rounded edges; the pore-pairs can only be faintly seen in this ambulacrum. The anterolateral pair of ambulacra are slightly longer than the posterolateral pair, and they bend slightly forward toward their dorsal ends; at the outer end of the petals the pore-pairs in the two series are about equal in size, but dorsally the pores in the anterior row become progressively smaller than those in the posterior row, and practically disappear before reaching the dorsal end of the ambulacrum. The posterolateral pair of ambulacra is similar to the anterolateral pair; in this case also the dorsal end of each ambulacrum bends slightly forward, and the pores in the anterior row become smaller toward the dorsal end. The interambulacral plates are proportionately large, their height being two to four times that of the nearest adjacent ambulacral plates; the height of the larger ones ranges from one-fourth to one-third the length.

The apical system is situated at about the center of the test, and has the elongate arrangement of the plates characteristic of the genus. From back to front the succession of plates is: (1) The two oculars of the posterolateral ambulacra, with inner sides in contact; (2) two genitals in contact; (3) the two oculars of the anterolateral ambulacra, with sides in contact; (4) two genitals in contact, the larger one on the right being the madreporite;
and (5) the oculars of the anterior ambulacrum. The pores of these plates are not visible in the one available specimen. The surface of the madreporite is slightly The peristome is rather small, tumid. and broadly ovate, and is situated well toward the front of the base. The base is largely covered with matrix in which are embedded numerous small slender, prostrate spines, one of which is 4 mm. long. The other features of the base are concealed by the matrix. The periproct is of medium size, nearly circular, and situated somewhat above the ambitus on the upper end of a small, nearly vertical, triangular. truncate terminal surface of the test. The surface of the test bears scattered small primary and secondary tubercles and many tiny, intermediate miliaries; each primary consists of a narrow, slightly raised boss, surmounted by a proportionately large, broadly rounded mamelon; slightly sunken scrobicules may be detected encircling some of the tubercles; microscopic granulations cover the intermediate surface; a faintly developed fasciole passes horizontally beneath the periproct, and dies out 7 or 8 mm. on either side of that opening; this is the principal character which distinguishes this genus from Holaster.

Dimensions of the holotype: Length 16 mm., width 16 mm., height 8.25 mm.

Cardiaster curtus Clark,<sup>86</sup> from the Fox Hills sandstone, 25 miles southwest of Mingusville, Montana, is a nearly related species, but it appears to be proportionately higher, the sulcus occupied by the anterior ambulacrum is deeper and more sharply outlined, and the ambulaeral areas are proportionately larger.

Cardiaster smocki Clark.<sup>87</sup> from the Merchantville clay near Matawan, New Jersey, is comparable in size and general form to C. leonensis, but its poor state of preservation scarcely permits a critical comparison.

Cardiaster marylandica Clark,<sup>ss</sup> from the Monmouth formation at Brightseat, Maryland, although imperfectly preserved,

appears to have a deeper anterior ambulacral sulcus, and wider ambulacral areas, and the pores in each pair are wider apart than in the Texas species.

Holotype.-U.S.N.M. no. 76279.

Distribution in Texas. - Navarro group. Corsicana marl: Castroville road, 1 1/5 miles west of Leon Creek, Bexar County (15522).

## Family SPATANGIDAE

#### Genus HEMIASTER Desor\*\*

Type species, by subsequent designation.90-Spatangus bufo Brongniart."1

As used by the present author the genus Hemiaster Desor includes those species of the family Spatangidae having a peripetalous fasciole and lacking other fascioles. The genus has been divided by authors into subgenera and sections, and some of the subgenera have even been raised to the rank of genus, but for the present no attempt will be made to place the Navarro representatives of Hemiaster in these subdivisions.

## HEMIASTER DALLI Clark

## Pl. 6, figs. 1-4

- 1891. Hemiaster dalli Clark, Johns Hopkins Univ. Circ., vol. 10, no. 87, p. 77.
- 1893. Hemiaster dalli Clark, Johns Hopkins Univ.
- Circ., vol. 12, no. 103, p. 52.
  1893. Hemiaster dalli Clark, U.S.Geol. Survey Bull. 97, p. 89, pl. 48, figs. 2a-c.
  1915. Hemiaster dalli Clark, U.S.Geol. Survey
- Mon., vol. 54, p. 90, pl. 47, figs. 1a-f.
- 1924. Hemiaster (Proraster) dalli (Clark). Lam-bert and Thiéry. Essai de nomenclature raisonnée des échinides, Fasc. 6 et 7, p. 506.
- 1926. Proraster dalli (Clark). Lambe t, Bull. Soc. Géol. France, 4th ser., Tome 26, p. 273.
- 1928. Proraster dalli (Clark). Adkins, Univ. Texas Bull. 2838, p. 300.

Test of medium size and height, broadly subovate in ambital outline, slightly subtruncated on the posterior and posterolateral sides; the test is widest in a cross

<sup>86</sup>Clark, W. B., U. S. Geol. Survey Mon., vol. 54, p. 84, pl. 37, figs. la-h, 1915.

<sup>87</sup>Clark, W. B. (in Weller), Geol. Survey New Jersey, Paleontology, vol. 4. p. 298, pl. 13, figs. 9-11, 1907.

SClark, W. B. ('n Gardner's chapter), Maryland Geol, Survey, Upper Crotaceous (2 vols.), p. 750, pl. 47, figs. 6-10, 1916,

<sup>89</sup> Agassiz, M. M. L. et Desor, E., Catalogue raisonné des espèces des genres et des familles d'échinides; Ann. sci. nat., troisième série, Partie Zoologique, Tome 8, p. 16, pl. 16 (in Tome 6), fig. 7, 1817.

<sup>90</sup> Lambert, J., and Thiéry, P., Essai de nomenclature raisonnée des échinides, Fascioles 6 et 7, p. 499, 1924.

<sup>&</sup>lt;sup>91</sup>Cuvier, G., and Brongniart, A., Description geologique des environs de Paris-Description des végétaux du terrain de sediment supérieur, cités dans la description géologique du bassin de Paris, par A. Brougniart, p. 389, pl. 5, figs. 4A-C, 1822.

section slightly in front of the apex. The apex is strongly acentric, the ambulacra very unequal, the petals set in deep depressions between prominent ridges. A rather prominent keel rises back of the apex between the right and left posterolateral ambulacra. Base broadly convex, peristome far to the front. Anterior ambulacrum profoundly sunken, subpetaloid, the petal long and broad; the furrow produces a deep notch in the anterior margin. Plates of petal long, narrow, numerous, with pore-pairs within less than a millimeter of the ends, producing a very wide interporiferous area; pore-pairs strongly inclined, arranged in uniserial rows; the pores of each pair are small, circular to ovate, and only about half a millimeter apart; the two rows of pore-pairs seem to end at the edge of the ambital notch.

The anterolateral ambulacra are petaloid, the petals extending about two-thirds of the distance to the ambitus; the petals are moderately broad and bend strongly forward as they approach the apex; the plates of the petals are narrow; the porepairs are uniserial, the pores of each pair being elongate, wide apart and conjugate; the interporiferous area is a little wider than the length of one pore-pair; the anterior row of pore-pairs becomes much narrower than the posterior one as it approaches the apex. The posterolateral ambulacra are like the anterolateral ones, but the petals are only a little more than half as long, are scarcely curved, and the rows of pore-pairs are nearly equal in width. The plates of the ambulacra between the lower ends of the petals and the peristome are much larger and more irregular than those in the petals themselves, and pore-pairs are obscure or absent: pore-pairs in longitudinal instead of transverse arrangement can be seen on several plates of the anterolateral ambulacra on the ventral side of the test near the mouth. The interambulacral plates are proportionately very large. The peripetalous fasciole is complete and narrow, with a noticeable subangular sinuosity just back of each anterolateral ambulacrum, and with minor sinuosities elsewhere.

The plates of the apical system are not clearly exposed, but the genital pores are large, the two on either side being close

together, and the pairs thus formed are widely separated from each other. The peristome is small, transversely oval, situated far forward in a shallow depression just below the ambital notch, and is bordered on the posterior side by a prominent, overhanging, carinoid lip. Periproct small, ovate, situated high above the ambitus at the upper end of a broad shallow nearly vertical concavity. The surface is irregularly covered with tubercles, including primaries, secondaries and miliaries. The primaries are coarsest and most densely spaced on the ambitus on either side of the notch formed by the anterior ambulacrum; the fewest and smallest tubercles are on the posterolateral ambulacra both on the lower and upper side of the test; the actinal portions of the posterolateral ambulacra are finely granulated with only a few scattered tubercles: the under side of the test at the center of each side just below the ambitus is also nearly bare of tubercles. A fully developed primary consists of a rather prominent crenulated boss, surmounted by a tiny perforated mamelon, and sur-rounded by a more or less completely developed, slightly sunken scrobicule.

Dimensions of the specimen shown in plate 6, figures 1-4: Length 25 mm., width 25 mm., height 14 mm.

Hemiaster dalli Clark is recorded as having been found in the Washita group of the Comanche series in Bexar County, Texas. The description given above is based on a smaller but more complete specimen from the Corsicana marl in Bexar County. No essential difference can be detected between this specimen and the holotype of Hemiaster dalli, and this close correspondence strongly suggests that the reported occurrence of the latter in the Washita group is an error. Additional data tending to confirm this error are contained in the report of Mr. L. G. Henbest, micropaleontologist of the Geological Survey, on a sample of matrix dug from within the test of the holotype. He says:

I removed a small amount of chalky matrix from the holotype of *Hemiaster dalli* Clark (U.S. N.M.no. 19114) and disintegrated the chalk as well as 1 could, but was not successful in obtaining well-cleaned specimens of Foraminifera. As a consequence, considerable uncertainty enters my specific identifications and the conclusions as to the real age of the *Hemiaster* specimen. In proportion to the size of the sample, Anomalina and Guembelina are numerous. All of the Anomalinas are minute. One of the largest specimens agrees rather closely in size and also in form with A. involuta (Reuss). The Guembelina are probably G. globulosa (Ehrenberg) and G. striata (Ehrenberg). The two specimens which were assigned to the latter species were plainly striated and had the general size and form of G. striata, but I could not determine whether the striae are continuous or interrupted at the sutures. A few specimens of Globigerina and one of Frondicularia archiaciana D'Orbigny were found.

This micro-fauna strongly suggests Upper Cretaceous age and most probably is Austin or younger.

In the first of Lambert's two papers (1924) cited in the synonymy he listed this species as an example of *Proraster*, treating *Proraster* as a subgenus of *Hemiaster*, and in the second paper (1926), he treated *Proraster* as a genus.

*Proraster* was first proposed as a genus by Lambert<sup>62</sup> in 1895, at which time he listed as examples the three species, *Spatangus lacunosus* Goldfuss, *Schizaster antiquus* Cotteau, and *Schizaster atavus* Arnaud. In 1924, Lambert and Thiéry (see synonymy) state that the first two of these three species were shown by Schlüter and Gouthier to possess lateral fascioles, which would rule them out of *Proraster*, leaving *Schizaster atavus* Arnaud as the sole type of *Proraster*.

Hemiaster dalli Clark is strikingly like Schizaster atavus Arnaud,<sup>93</sup> as the latter is figured in the original description and the two species appear to belong to the same group. Since Hemiaster forms a compact group characterized by a peripetalous fasciole, it seems desirable, for the present, at least, to retain that name for the group as a whole and to classify its subgroups, if any, as subgenera. If *Proraster* is to be recognized as a distinct group, it would therefore seem appropriate to treat it as a subgenus of *Hemiaster*, and *H. dalli* Clark would seem to be a good example of the subgenus.

<sup>93</sup>Cotteau, M. G., Echinides Jurassiques, Crétacés et Tertiaires du sud-onest de la France: Ann. Soc. Sci. nat. de la Rochelle, p. 223, pl. 12, figs, 5-9, 1883, (The authorship of *Schizaster atavas* is attributed to Arnaud.) Schizaster atavus Arnaud is recorded from the upper Senonian of western France.

*Types.*—Holotype, U.S.N.M. no. 19114; the new material includes one nearly perfect specimen (plesiotype, pl. 6, figs. 1-4), and two imperfect, unfigured specimens (U.S.N.M. no. 76280).

Distribution in Texas. Navarro group, Corsicana marl: 6 miles east of Castroville (15502, one specimen figured); the holotype came from somewhere in Bexar County.

#### HEMIASTER BEXARI Clark

Pl. 6, figs. 7, 8; pl. 7, figs. 5-7

- 1915. Hemiaster bexari Clark, U.S.Geol. Survey Mon., vol. 54, p. 89, pl. 46, figs. 1a-e.
- 1924. Hemiaster (Leymeriaster) bexari (Clark). Lambert and Thiéry, Essai de nomenclature raisonnée des échinides, Fasc. 6 et 7, p. 500.
- 1926. Hemiaster (Leymeriaster) bexari (Clark). Lambert, Bull. Soc. Géol. France, 4th ser., Tome 26, p. 273.
- 1928. Hemiaster (Leymeriaster) bexari (Clark). Adkins, Univ. Texas Bull. 2838, p. 298.

Test of medium size, rather high posteriorly, a little flattened anteriorly, broadly subovate in ambital outline, widest centrally. Apex acentric, situated about three-fifths the length of the shell from the anterior end. Ambulacra unequal, all set in shallow furrows. Base broadly convex with the posterolateral ambulacra occupying shallow depressions on either side of the plastron. Petal of anterior ambulacrum long, broad, and occupying a flat-bottomed furrow which fades out anteriorly. and is only faintly reflected in the ambitus; plates of petal of medium length and height; pore-pairs oblique, situated near the ends of the plates in uniserial rows, the pores of each pair small and separated by a prominent tubercle, thus producing a row of tubercles on either side of the petal; the plates of this ambulacrum between the petal and the peristome are about 16 in number, are proportionately larger, irregularly 5 or 6-sided, with their greatest elongation in the linear direction of the ambulacrum. The petals of the anterolateral ambulacra are wide, about as long as that of the anterior ambulacrum, and are composed of numerous long narrow

<sup>&</sup>lt;sup>102</sup>Lambert, M. J., Ersui d'une monographie du genre micraster et notes sur quelques áchinides. Publ'shed in Grossouvre, A. de, Recherches sur la Craie Supérieure: Mémoires pour servir à l'Explication de la Carte Géologique Detaillée de la France, Fascicule 1, pp. 177, 256, 1895.

plates, each only about half as wide as a corresponding plate on the anterior ambulacrum. The pore-pairs are uniserial, the pores of each pair being circular to broadly ovate, widely separated, and connected by a narrow ridge instead of a furrow; the interporiferous area is about one-fourth the total width of the petal; the anterior row of pore-pairs in each petal becomes very narrow as it approaches the apex. The plates of an anterolateral ambulacrum between the petal and the peristome are proportionately large, 5 to 6-sided, with a tendency to elongation in the linear direction of the ambulacrum: the ambulacral band is strongly constricted and the plates are small just below the end of the petal, but the band quickly widens downward and at the ambitus is about as wide as the petal: the band narrows a little as it approaches the peristome. On 7 or 8 of the plates nearest the peristome small porepairs appear near the center of the forward end of each plate; the pores of each pair are aligned in a direction linear to the band. The petals of the posterolateral ambulacra are similar to those of the anterolateral pair, but are only a little more than half as long and the rows of pore-pairs are nearly equal. The plates of the ambulacral band between the petal and the peristome differ markedly in size and shape; the band is sharply constricted just below the end of the petal, where the plates are small; between this constriction and the ambitus the plates are larger and the band widens out, becoming at the ambitus a little wider than the petal; between the ambitus and the peristome the band becomes narrower and the plates larger, fewer, and greatly elongated. The interambulacral plates range from small near the apex and peristome to very large at the ambitus; they are relatively few in number.

The apical system is typical of the genus. The oculars are perforated; the two oculars adjacent to the posterolateral pair of ambulacra are in contact with each other but the other three oculars are isolated by the genital plates. The four genital plates are conspicuously perforated and form a compact system; the

madreporite is larger than the other three genitals and is in contact with all of them and with all the oculars except the one adjacent to the left anterolateral ambulacrum. Peristome small, situated well forward in a slight depression, reniform, with a prominent, carinated, slightly overhanging posterior lip. Periproct small, ovate, situated high on a nearly vertical, posterior truncation. Peripetalous fasciole complete, narrow, slightly sinuous between the ends of the antero- and posterolateral petals. Surface densely covered with tubercles including primaries, secondaries, and miliaries; these are fewest on the petals and on the actinal portions of the posterolateral ambulacra, which are granulated from the mouth about two-thirds of the way to the ambitus. Each of the well preserved primaries and secondaries exhibits a prominent crenu-lated boss surmounted by a small perforated mamelon, and surrounded by a deep, narrow scrobicule.

Dimensions of the specimen shown in plate 6, figures 7, 8: Length 22.5 mm., width 21.5 mm., height 16 mm.

The locality of the holotype of *Hemiaster bexari* Clark, as inadequately recorded in the original description, is "Bexar County, Tex., Washita group of Comanche series." The numerous specimens, here referred to this species, were found in the Corsicana marl in Bexar and adjacent counties; they appear to differ in no essential respect from the holotype, and the original assignment of the holotype to the Washita group is believed to be an error. There is no other record of this species, or a similar species, having been found in the Washita group.

Hemiaster (Integraster) slocumi Lambert<sup>0+</sup> (=-Hemiaster lacunosus Slocum, preoccupied), from the Prairie Bluff chalk near Pontotoc, Mississippi, is closely allied to the Bexar County species, but a comparison of numerous specimens of the latter with the five cotypes of H. slocumi (Lambert) shows that the antero- and posterolateral ambulacra of H. bexari are slightly shorter and narrower, and less

<sup>&</sup>lt;sup>194</sup>Lambert, J., and Thiéry, P., Essai de nomenclature raisonnée des Échinides, p. 504, 1927.

deeply sunken, and may be treated as specifically different, at least until more specimens are available for comparison.

A closely related, undescribed species occurs in the Nacatoch sand of Arkansas. It has a deeper, wider and longer anterior ambulacrum, finer tubercles, and differs in other details.

Hemiaster delawarensis Clark.<sup>95</sup> from the "Matawan formation" [emend, Mount Laurel sand of Monmouth group] in a marl pit on the south side of the Chesapeake & Delaware Canal, a mile east of St. Georges, Delaware, is a very similar species, but its surface is crowded with much smaller tubercles, the sulcus occupied by the petal of the anterior ambulacrum is narrower and more rounded on the bottom, the test is somewhat higher, and there are other minor differences.

In Europe the species Hemiaster gauthieri Peron,<sup>96</sup> from the Senonian of southern France, and H. maestrichtensis Schlüter,<sup>97</sup> "aus dem Kreide-Tuff von Maestricht," Netherlands appear to be close analogues of H. bexari.

Lambert and Thiéry<sup>98</sup> listed this species as an example of the section of *Hemiaster* which they named *Leymeriaster*. The fact that these authors cited *Hemiaster bexari* Clark as an example of *Leymeriaster*, and *H. lacunosus* Slocum as an example of *Integraster*, when these two forms are so closely related that they differ only in minor details that are of questionable specific importance, throws doubt on the usefulness of these proposed sections.

Types.—Holotypes, U.S.N.M. no. 8830, from Bexar County, Texas; 2 plesiotypes from Texas, U.S.N.M. no. 76281.

Distribution in Texas.—Navarro group, Corsicana marl: 21/2 miles west of Mc-Queeney (15523); 2 miles east of Marion (Texas Bu. 2395); Castroville road, 1 1/5 miles west of Leon Creek, Bexar County (15522); 14 miles west by south of San Antonio (15623; Texas Bu. 743); fuller's earth pit 14 miles west of San Antonio (15520 and 15624); 6 miles east of Castroville (15502, 16156, 16667, Texas Bu. 3282).

## HEMIASTER BENHURENSIS Stephenson, n.sp.

# Pl. 7, figs. 8-10

One specimen found in Limestone County and one in Falls County, are similar in size and form to Hemiaster bexari Clark, but differ sufficiently in detail to be regarded as a separate species. The test is proportionately a little higher, and the average size of the densely crowded tubercles is smaller: the pores of each pair are closer together, making the pore bands narrower, and the interporifereous band is proportionately wider; the anus is more elongated in the vertical direction. The apical system of the holotype is broken and obscured and the test is badly crushed on the actinal side between the peristome and the ambitus at the posterior end.

Dimensions of the holotype: Length 20 mm., width 19.5 mm., height 15 mm.

Holotype.--- U.S.N.M. no. 76282.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles south of Ben Hur (15543, type locality).

Navarro group, Nacatoch sand: 5 miles northeast of McClanahan (17371).

## HEMIASTER sp.

The impression of a badly crushed echinoid which may be a *Hemiaster* was found in the Kemp clay in the pit of the Seguin Brick and Tile Company, 4/5 mile south of McQuceney, Guadalupe County (7638).

# Genus LINTHIA Desor<sup>99</sup>

Type species by subsequent designation.<sup>100</sup>—Linthia insignis Mérian,<sup>101</sup> from the Eocene of the Swiss Alps.

<sup>&</sup>lt;sup>95</sup>Clark, Wm. Bullock, Maryland Geol. Survey. Upper Cretaceous (2 vols.), p. 751, pl. 47, figs. 11-14, 1916.

<sup>&</sup>lt;sup>96</sup>Peron, M. A., Bull. Soc. Géol. France, 3d ser., vol. 5, p. 522, pl. 7, figs. 6a-c, 1877.

<sup>&</sup>lt;sup>07</sup>Schlüter, Clements, Deutsch. gcol. Gesell. Zeitschr., Band 49, p. 32, pl. 2, figs. 3, 4, 1897.

<sup>18</sup> Lambert, J., and Thiery, P., op cit., p. 500, 1927.

<sup>&</sup>lt;sup>po</sup>Desor, E., Notice sur les échinides du terra'n nummulitique des Alpes avec les diagnoses de plusieurs espèces et genre nouveaux: Soc. helvétique sci. nat. Actes, à Porrentruy, p. 278, 1853.

<sup>100</sup>Lambert, J., and Thiéry, P., Essai de nomenclature raisonnée des echinides. Fasc. 8 et 9, p. 518, 1924.

<sup>&</sup>lt;sup>101</sup>Loriol, P. de, Description des échinides tertiaires de la Suisse: Mém. Soc. Paléon, Suisse, vol. 2, p. 101, pl. 15. fig. 1; pl. 16, fig. 1; pl. 17, figs. 1, 2, 1875.

## LINTHIA VARIABILIS Slocum?

## Pl. 8, figs. 1–5

- 1909. Linthia variabilis Slocum, Field Mus. Nat. Hist. Pub. 134, Geol. ser., vol. 4, no. 1, pp. 12–14, pl. 3, figs. 1–11.
- 1915. Linthia variabilis Slocum. Clark, U.S.Geol. Survey Mon., vol. 54, pp. 99-100, pl. 54, figs. 1a-1.
- 1927. Linthia variabilis Slocum. Stephenson, U.S. Nat.Mus.Proc., vol. 72, art. 10, p. 10, pl. 5, figs. 1-7.

The available adult Texas specimens include 7 crushed and more or less incomplete tests. The features which are well enough preserved for comparison appear to agree closely with typical specimens from Pontotoc, Mississippi, the type locality of the species. These features include size, character. and distribution of tubercles. length, width, and depth of ambulacral furrows, character and arrangement of the porc-pairs, position of peripetalous and lateral fascioles, and height and form of the ridge separating the posterolateral ambulacra. As all these adult Texas specimens have been badly crushed it is not possible to make a critical comparison of form. Although the Texas specimens can not be accurately measured, the average size is probably about the same as those from Mississippi. which range up to a length of nearly 32 mm.

One small fairly well preserved specimen, shown in plate 8, figs. 3-5, may be the young of this species. It measures: Length 16 mm., width 16.5 mm., height 11 mm.

Slocum's description of this species is quoted by Clark in U.S. Geol. Survey Mon., vol. 54, pp. 99-100, 1915.

A closely related undescribed species occurs in the Nacatoch sand of Arkansas.

Types. – Nine existing cotypes are in the custody of the Field Museum of Natural History, Chicago. These bear the following catalogue numbers: P10457A, P10457D, P10457H(?), P10457K(?) P10458L (Slocum's plate 3, figs. 5-8), P10458M, P10458N, P10458 (?letter). Other cotypes mentioned by Slocum are apparently no longer preserved in the Fäeld Museum. One plesiotype? from Texas, U.S.N.M. no. 76283; 2 plesiotypes? from Texas, U.S.N.M. no. 76284.

Slocum says: "This species is from the Ripley group [Prairie Bluff chalk] and is quite abundant both on the bluffs of One Mile Run and near the southern edge of the village of Pontotoc, Mississippi." He does not indicate at which of the two localities the different numbered specimens were collected.

Distribution in Texas.—Navarro group, Corsicana marl: 2½ miles west of Mc-Queeney (15523); 6 miles east of Castroville (16156).

Outside distribution. — Mississippi: Prairie Bluff chalk and Owl Creek formation.

North Carolina: Upper part of Peedee formation.

#### LINTHIA? sp.

The Kemp clay exposed on Colorado River at Webberville. Travis County (7601), yielded several small fragments of an echinoid which may be a *Linthia*.

# Genus MICRASTER Agassiz<sup>102</sup>

Type species .- Spatangus coranguinum Klein.103

# Subgenus PLESIASTER Pomel

The subgenus *Plesiaster* Pomel<sup>104</sup> (genotype, *Micraster peinei* Coquand),<sup>105</sup> differs from the typical *Micraster* in the possession of a peripetalous fasciole, in addition to the characteristic subanal fasciole.

Agassiz, L., et Desor, E., Anns, sei, nat., 3d ser., Zoologie, tome 8, p. 23, pl. 16, fig. 5 (in tome 6), Paris, 1817.

Pomel, N. A., Classification méthodique et Cenera des echinides vivants et fossiles: Thèses présentées a la Faculté des Sciences de Paris, p. 42, Alger, 1883.

Lambert, J., and Thiéry, P., Essai de nomenclature raisonnée des echinides, Fase, 6 et 7, p. 479, 1924.

<sup>103</sup>Klein, Jacobi T., Naturalis dispositio echinodermatum, p. 28. tome 23, figs. A.D, 1734.

Gall., p. 100, pl. 12, figs. E. F; pl. 13, fig. C, 1754.

(edited and expanded by Nathanaele G. Leske): pp. 28, 221, pl. 23, figs. A-D; pl. 23x, fig. C; pl. 45, fig. 12, 1778. <sup>104</sup>Pomel, N. A., op. cit., p. 42.

<sup>105</sup>Coquand, H., Synopsis des fossiles de la région sud de la province de Constantine, Algeria: Soc. d'Émulation de Constantine Mém., p. 245, pl. 27, figs. 1-3, 1862.

<sup>&</sup>lt;sup>102</sup>Agassiz, L., Prodrome d'une monographie des radiaires ou echinodermes: Soc. sci. nat. de Neuchatel Mem., tome 1, p. 184, 1836.

## MICRASTER (PLESIASTER) AMERICANUS Stephenson, n.sp.

## Pl. 7, figs. 1-4

Test of medium size, rather high, clongate-cordate, truncated on the posterior end, widest a little in advance of the midlength, highest posteriorly. Apical system situated slightly back of the midlength. Petals moderately sunken, the anterior one making a broad, shallow notch in the ambitus. The elevation between the posterolateral ambulacra is rounded and a little higher than the other interambulacral areas. Base slightly convex, the plastron being plumply swollen toward the rear, with several low nodes near the ambitus: a nearly vertical row of three obscure nodes borders either side of the posterior truncation. The peristome is situated well forward, and the periproct is high on the porterior truncation. Anterior ambulacrum subpetaloid, sunken to form a broad sulcus of moderate depth, broadly rounded on the bottom; plates of petal elongated and less than half as wide as long; the rows of porc-pairs are uniserial and wide apart; the pores of each pair are close together, oblique, separated by a node, the outer one apparently larger than the inner one; the pores appear to die out about two-thirds of the distance from the apical system to the ambitus. The anterolateral ambulacra are subpetaloid, the petals being about as long as that of the anterior ambulacrum, but they are narrower; the plates are numerous, long and narrow, being only about half as wide as those of the anterior petal; the pores of each pair are elongate and wide apart, and the pairs are arranged uniserially: although the surface is damaged by cleaning, the pores appear to be conjugated; the interporiferous area is a little wider than either pore zone; the pore zones are unequal, the anterior one becoming narrower toward the apex than the posterior one. The petals of the posterolateral ambulacra are similar to those of the anterolateral pair except that they are shorter and narrower, and the pores are more nearly equal; the posterior pore zone is, however, straighter than the anterior one. The plates of the ambulacra below the ends of the petals are scarcely well enough exposed for accurate description, but the posterolateral ambulaeral bands are sinuous and of unequal width between the ends of the petals and the peristome, and the plates are consequently of irregular size and shape. A characteristic subanal fasciole forms an ovate ring, half of which is on the actinal surface, and the other half on the posterior end of the test above the ambitus. There is in addition a fairly distinct and complete peripetalous fasciole, a feature which seems to place this species in the subgenus *Plesiaster* Pomel.

The apical system is not well exposed, but the four genital pores are large and closely grouped, and the madreporite is proportionately small. The peristome is small, transversely elongated, bears a rather prominent carinated under lip, and occupies a shallow depression in the base. Periproct small, ovate, situated high on a nearly vertical posterior truncation. The surface of the test bears a rather scattered assemblage of tubercles including primaries, secondaries, and miliaries. The better preserved tubercles consist of a prominent boss finely crenulated above. surmounted by a small perforated mamelon, and surrounded by a narrow, sharply outlined, but scarcely sunken scrobicule. The tubercles are coarsest on the anterior end of the test and on the forward part of the under surface; they are finest on the posterior end of the test; on the under surface the irregular bands marking the position of the posterolateral ambulacra are granulated and nearly devoid of tubercles. The whole surface of the test, where well preserved, is seen to be covered with microscopic granules.

Dimensions of the holotype: Length 30 mm., width 26.5 mm., height 19.5 mm.

This species is represented in Texas by one well preserved specimen, and by one other questionably identified specimen which appears to be abnormally swollen by oxidized marcasite within the test. A related, but large, undescribed species occurs in considerable numbers at several localities in the Saratoga chalk of Arkansas. These, the Alabama locality, and the two Texas localities recorded below are the only known occurrences of *Micraster* in the Americas.

*Micraster maestrichtensis* Lambert from "la Craie de Macstricht," in the Maestricht district, Netherlands, is more broadly ovate in outline, lacks a peripetalous fasciole, and only 3 of the 4 genital plates are perforated.

Holotype.-U.S.N.M. no. 76285.

Distribution in Texas. Navarro group, Corsicana marl: 6 miles east of Castroville (15502, type locality); 2 miles south of Cliff (10870).

Outside distribution.—Alabama: Questionably in the Prairie Bluff chalk at Prairie Bluff, Wilcox County, Alabama.

# Phylum MOLLUSCOIDEA

## Class BRACHIOPODA

Order ATREMATA

## Superfamily LINGULACEA

## Genus LINGULA Bruguière

# LINGULA aff. L. SUBSPATULATA Hall and Meek

# Pl. 3, figs. 7-9

Shell small, elongated, compressed, polished. Posterior extremity sharply rounded, scarcely pointed. The growth lines indicate that in its earliest stage the outline of the shell is nearly circular, but as growth proceeds new shell substance is added more rapidly on the anterior margin than on the sides, causing the sides to become proportionately elongated, subparallel, and nearly straight; the growth lines remain broadly rounded anteriorly for 4 or 5 mm. from the beak, beyond which they gradually become straighter, producing a subtruncated anterior extremity in the adult. The shell is very broadly subangular on each side where the posterior margin passes into the lateral margins. The 5 available specimens from Navarro County indicate considerable individual variation in outline, some specimens being proportionately broader than others; of two specimens, each about 5 mm. long, one is 2.5 and the other 3.1 mm. The beak appears as a low, obwide. scure, somewhat irregular knob, very slightly in advance of the posterior extremity. In addition to the fine growth lines the polished surface is further

marked with very faint, fine radiating striae.

Approximate dismensions of the largest specimen: Length 7.5 mm.; width 3.7 mm.

The original description of the species is based on an incomplete shell from the Pierre shale near Red Cedar Island, Missouri River, 35 miles below Fort Pierre, South Dakota. The beak is wanting and the margins are broken away in this specimen. The shell is similar but is proportionately broader than the ones from Texas and is more than twice as large.

The shells described by Weller, under this name, from the Woodbury clay, New Jersey, are nearly identical in outline with the Texas specimens, but they attain a maximum measured length of 19 mm.

Types.—The types of Hall and Meek's species, Lingula subspatulata, were originally the personal property of Hall, and were later purchased from him by the American Museum of Natural History, New York, where they are now preserved (No.  $\frac{9340}{2}$ ). Three plesiotypes from Texas,

# U.S.N.M. no. 76286.

Distribution in Texas.--Navarro group, Nacatoch sand: Road 2 miles southwest of Kaufman (7546).

Navarro group, Kemp clay: 3½ miles northwest of Bazette (12922, loc. of plesiotypes).

## Order TELOTREMATA

Superfamily TEREBRATULACEA

# Family TEREBRATULIDAE

## Genus TEREBRATULINA d'Orbigny

## TEREBRATULINA NOAKENSIS Stephenson, n.sp.

# Pl. 3, figs. 10-12

Shell small, longer than wide, moderately thick, dorsal valve flatter than ventral valve, median sinus wanting. Posterior extremity subpointed with posterior margins nearly straight and diverging at an angle of about 72 degrees. Anterior extremity evenly rounded forming a semicircle. Beak of ventral valve rising well above the posterior margin of the dorsal valve. Foramen circular, moderately large, slightly open on the hinge line. Surface of both valves crowded

with fine, distinct but nonprominent, closely spaced ribs of somewhat irregular sizes; ribs few near the beak, increasing in number by intercalation at differing distances away from the beak in such a manner that about the same degree of crowding is maintained, and permitting little if any increase in the size of individual ribs in the anterior direction. The holotype, the only available specimen, is mechanically slightly compressed and is partly broken away on one side. Enough of the loop is in view to show that it is short as it should be in this genus, but it can not be observed in detail.

Dimensions: Length 15.4 mm., width 12 + mm., thickness 5.6 mm.

Compared with Terebratulina brewsterensis Adkins<sup>106</sup> from a clay bed of Taylor age, on the Alpine-Brewster road 14 miles north of Terlingua, Brewster County, Texas, this species is larger, proportionately longer, has noticeably coarser ribbing, and lacks a median sinus. The species is much larger and proportionately longer than T. filosa Conrad, described from the Selma chalk (Exogyra ponderosa zone), Alabama, and common in the Pecan Gap chalk member of the Taylor marl in Texas.

Holotype.-U.S.N.M. no. 76287.

Distribution in Texas.-Navarro group, Kemp clay: 3 miles S. 30° W. of Thrall (17370).

# Phylum MOLLUSCA

## Class PELECYPODA

# Order PRIONODESMACEA

# Superfamily SOLEMYACEA

# Family SOLEMYACIDAE

# Genus SOLEMYA Lamarck

## SOLEMYA BILIX White?

## Pl. 8, fig. 6

- 1880. Solemya bilix White, U.S.Nat.Mus.Proc.,
- vol. 3, p. 158.
  1881. Solemya bilix White, U.S.Nat.Mus.Proc., vol. 4, p. 139, pl. 1, fig. 9.
  1920. Solemya bilix White. Stanton, U.S.Geol.
- Survey Prof. Paper 128, p. 19, pl. 1, figs. 1a, 1b.

106Adkins, W. S., Some Upper Cretaceous Taylor ammonites from Texas: Univ. Texas Bull. 2901, p. 211, pl. 6, figs. 1-6, 1929.

This rare genus is represented in the Nacatoch sand by one internal mold which lacks the surface ornamentation necessary for certain specific determination; it is referred questionably to White's species Solemya bilix.

The shell is greatly elongated, moderately convex, strongly inequilateral, with the anterior end much the longer. Beak broad, low, apparently opisthogyrate, situated about one-fourth the length of the shell in advance of the posterior extremity. Hinge not revealed. Anterior adductor scar obscure. Posterior adductor scar of moderate size, subtrigonal, bordered in front on the mold by a radial groove representing an internal rib. Anterodorsal margin long, very broadly arched, closely paralleled by a relatively broad, shallow groove; anterior margin sharply rounded; ventral margin nearly straight, rising a little posteriorly; posterior margin more sharply rounded than the anterior; posterodorsal margin short, arched. Surface slightly obscurely marked by fine radiating lines which become coarser anteriorly. The doublethreaded character of the radial ornamentation expressed in the specific name *bilix* is only obscurely suggested by the Texas specimen in its imperfect state of preservation.

Dimensions: Length 12.6 mm., height 5 mm., convexity about 1.5 mm.

Compared with the holotype this mold is smaller, more slender, and proportionately not quite so high in the anterior portion. However, it appears to be essentially like some of the specimens in a large suite, from the Narrows of South Platte River, 50 miles east of Greeley, Colorado (U.S.N.M. no. 9973), which White himself identified with his species; this lot includes both internal molds and nearly perfectly preserved shells.

Types.-Holotype, U.S.N.M. no. 8913; from the upper part of the Pierre shale, or the Fox Hills sandstone, 4 miles north of Golden, Colorado. One plesiotype? from Texas, U.S.N.M. no. 76283.

Distribution in Texas. - Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

Outside distribution.—Western Interior: Upper part of Pierre shale, or Fox Hills sandstone, of Colorado. Cannonball marine member of Lance formation of the Dakotas.

## Superfamily NUCULACEA

## Family NUCULIDAE

# Genus NUCULA Lamarck

## NUCULA PEREQUALIS Conrad

### Pl. 8, figs. 7-9

- 1860. Nucula perequalis Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 281.
- 1860. Nucula eufalensis Gabb, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 397, pl. 68, fig. 35.
- 1861. Nucula perequalis Conrad. Gabb, Am. Philos. Soc. Proc., vol. 8, p. 204. Reprint, p. 149, 1861.
- 1905. Nucula eufalensis Gabb. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 7.

Shell of medium size for the genus, thin, subovate elongate in outline, equivalve, slightly inequilateral, moderately convex, with greatest inflation below the beak. Beaks moderately prominent, incurved, approximate, nearly direct. Hinge not well exposed but apparently essentially like that of shells from near Eufaula, Alabama, the type locality of the species. In the latter the teeth are numerous (about 40) and in each valve are about equally divided into an anterior and posterior series by a deeply sunken, triangular chondrophore situated directly beneath the beak; the anterior row is slightly arched upward, and the posterior row slightly concave upward; the teeth are prominent and are separated by deep sockets; each tooth is angulated in its trend across the hinge plate, the angulation directed toward the beak in both the anterior and posterior series. The inner margin appears to be smooth. The anterior and posterior margins are sharply rounded and the basal margin broadly rounded; the anterodorsal margin is broadly arched, and the posterodorsal margin broadly concave, these two margins slope away from the beak at an angle of about 135 degrees. Escutcheon elongated, bounded by a moderately distinct ridge, which is bordered without by a shallow, rather broad, radiating sulcus.

The lunule is very faintly outlined and is also bordered by a similar, shallow radiating sulcus. Surface marked by numerous rather faint, compactly arranged, flattish concentric ridges.

Dimensions of the largest specimen, shown in plate 8, fig. 7: Length 19.5 mm., height 11.7 mm., convexity about 4 mm.

The Texas material is not as well preserved as that from near Eufaula, the type locality, but appears to differ in no essential respect from typical specimens.

Types.—Conrad's holotype is not listed among the Cretaceous types in the Academy of Natural Sciences of Philadelphia, and is probably lost. Gabb's type of Nucula eufaulensis, which he later regarded as synonymous with Conrad's species, is present in the collections of the Academy and appears to be essentially like the Texas shell except that the latter is larger (about 5 mm. longer). Although the exect locality near Eufaula, Alabama, at which the holotype was obtained, is not known, the left valve (857) from Chattahooc'ee River, about 2 miles below Eufault, shown in plate 8, figs. 9, 10, may be reasonably regarded as a neotype (U.S.N.M. no. 76289). One plesiotype from Texas, U.S.N.M. no. 76290.

Dist bution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, loc. of plesiotype; Texas Bu. 17300).

Navarro group, Nacatoch sand: 1 4/5 miles northcast of Quinlan (16162).

Outside distribution.-- Mississippi: Ripley formation and Prairie Bluff chalk.

Chattahoochee region (Alabama-Georgia): Blufftown formation, Ripley formation (upper part), and Providence sand.

Range.—In general in the Coastal Plain the range is through the *E. ponderosa* and *E. costata* zones.

## NUCULA CIBOLOENSIS Stephenson, n.sp.

## Pl. 8, fig. 10

Shell large, thick, subevate-clongate, beak situated three-fourths the length of the shell from the anterior extremity. The hinge is very imperfectly exposed, but the teeth, which number 10 or 11 to the

centimeter, appear to be normal for the group of large, elongated, Upper Cretaceous representatives of Nucula. Inner margin finely crenulated, but other internal characters concealed by hard matrix. Anterodorsal margin broadly convex; posterodoisal margin moderately steep; anterior margin sharply rounded midway of the height; ventral margin broadly and regularly rounded, finely crenulated, the crenulations corresponding to the external ribs; posterior margin sharply rounded midway of the height. Lunule indistinct, escutcheon moderately well defined. Surface marked by rather faint concentric growth lines, with irregularly spaced resting stages, and, where uncorroded, by numerous low, fine, faintly developed, radiating ribs separated by wider, very shallow interspaces; the marginal denticulations correspond to the interspaces; corrosion reveals a strong internal radiating shell structure. The larger shells exhibit the sharp inbending of the posteroventral margin, which is indicative of a senile stage in many bivalve mollusks.

Dimensions of the holotype: Length 37.5 mm., height 25 mm., convexity 9.3 (?) mm.; the shell has been slightly crushed in the umbonal region.

This species belongs to an elongated, thick-shelled group of Nuculas which is typified by the nearly perfectly preserved Nucula percrassa Conrad from the Ripley formation of Mississippi. The latter is typically smaller, more elongated, correspondingly sharper both front and back, assumes old-age characters at an earlier stage, and possesses a faint posterior radiating sulcus which is lacking in N. ciboloensis. Nucula stantoni Stephenson another member of the group from the Snow Hill marl member of the Black Creek formation of North Carolina, is a smaller, shorter species with a steeper posterodorsal slope. Nucula slackiana (Gabb) from the North Atlantic Coastal Plain, which is based on an internal mold, appears to be proportionately higher and more bluntly rounded on the extremities, than the Texas species.

With poorly preserved material it is difficult to differentiate the species of this group.

*Types.*—Holotype, U.S.N.M. no. 76291; 6 selected unfigured paratypes, U.S.N.M. no. 76292.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuchl (7720; 7721, type loc.); Webberville (7601, 13910); near Deatsville (764, 14125); 2 miles northwest of Deatsville (14128); branch 6½ miles southwest of Currie (17377); 3½ miles northwest of Bazette (12922).

# NUCULA CHATFIELDENSIS Stephenson, n.sp.

# Pl. 8, figs. 11, 12

This species is similar in all its generic characters, and in most of its specific characters, to Nucula ciboloensis Stephenson but differs in its greater convexity and in its apparently steeper posterodorsal slope. The available material is not very well preserved and the best specimens have been subjected to slight mechanical deformation. There is a faint suggestion of a posterior radiating sulcation such as characterizes Nucula percrassa Conrad, which is a more elongated species with sharper terminations. The lower stratigraphic position together with the differences noted, justify separating N. chatfieldensis from the other species of the group.

Dimensions of the holotype: Length 38 mm., height 24.4 mm., convexity 11 mm,

Types.—Holotype, U.S.N.M. no. 76293; 1 unfigured paratype, U.S.N.M. no. 21057. Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); field south of Chatfield (7569); 3/5 to 4/5 mile northeast of Chatfield (14117); vicinity of Kaufman (761); 1 4/5 miles northeast of Quinlan (16162).

Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924); west of Kaufman (7548); 2 3/5 miles north by east of Malta (16159);  $1\frac{1}{4}$  miles south by east of Oak Grove (16160).

# NUCULA MICROSTRIATA Gardner

## Pl. 8, figs. 13, 14

1916. Nucula microstriata Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 515, pl. 19, fig. 7.

This simple little nutshell is smooth with the exception of fine incremental lines and fine, closely spaced radiating lines; it is ovate, moderately clongated, and has a steep posterodorsal slope. The lunule is indistinct, but the escutcheon is sharply defined, extends to the angular posterior extremity, and is moderately excavated in each half. The anterior part of the shell is rather high, and a shallow sulcation extends from in front of the beak to the short, truncated anterodorsal margin.

Dimensions of the nearly complete individual shown in the figures: Length 8.5 mm., height 7 mm., thickness 4 mm. A specimen from near Chatfield is slightly more elongated than the typical form and is questionably regarded as an individual variant.

This species is similar to *Nucula* cuneifrons Conrad, from the Ripley formation at Eufaula, Alabama, but is a decidedly more elongated form.

*Type.*—Collection of the Maryland Geological Survey, on deposit in the U.S. National Museum. One plesiotype from Texas. U.S.N.M. no. 20887.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, 1 specimen figured); Watkins' place, 3 miles north of Corsicana (9552); road 5 miles south southwest of Corsicana (7573.)

Outside distribution.---Maryland: Monmouth formation.

#### NUCULA WALTONENSIS Stephenson, n.sp.

# Pl. 8, figs. 15, 16

Shell small, subtrigonal in outline, a little longer than high, moderately convex, greatest inflation well above the midheight about at the midlength. Beaks prominent, incurved, opisthogyrate, approximate, situated about 0.7 the length of the shell from the anterior extremity. Hinge and internal features not uncovered. Lunule obscure; escutcheon relatively wide, deeply excavated, edges rounded. Anterodorsal margin inclined, broadly arched; anterior extremity sharply rounded a little below the midheight; ventral margin broadly rounded; posterior extremity sharply rounded below the midheight; posterodorsal margin steep, concave. Surface marked by very small, closely spaced, low radiating ribs numbering 9 or 10 to the millimeter, separated by mere lines; growth lines very fine.

Dimensions of the holotype, a nearly complete shell with both valves attached: Length 6.8 mm., height 5 mm., thickness 3.8 mm.

Compared with Nucula amica Gardner, from the Monmouth formation of Maryland, this species has very much finer concentric and radial sculpture, and the radial ribs are stronger than the growth lines.

Type.—Holotype, U.S.N.M. no. 76295. Distribution in Texas.—Navarro group, Nacatoch sand: 3 miles northeast of Corsicana (9545, type loc.); road 5 miles south-southwest of Corsicana (7573).

# NUCULA NACATOCHANA Stephenson, n.sp.

# Pl. 8, figs. 17, 18

Shell small, subelliptical in outline, much longer than high, moderately convex, greatest inflation above the midheight and a little back of the midlength. Beaks moderately prominent, incurved, opisthogyrate, approximate, situated about threefourths the length of the shell from the anterior extremity. A broad shallow excavation extends from the beak to the posterior margin above the sharply rounded extremity. Hinge and internal features not uncovered. Lunule long, very narrow, distinctly outlined; escutcheon wide, distinct, slightly excavated. Anterodorsal margin long, broadly arched, keeled anteriorly, with parallel excavations on either side of the keel; anterior margin sharply rounded, slightly truncated above; ventral margin broadly rounded, rising more steeply toward the rear; posterior margin angular at the extremity; posterodorsal margin slightly keeled, slightly arched, steep. Surface marked only by fine, but somewhat irregular growth lines.

Dimensions of the nearly complete holotype: Length 7 mm., height 5 mm., thickness 3.25 mm.

The species is similar to *Nucula microstriata* Gardner, but is proportionately more elongated.

# Holotype.--U.S.N.M. no. 21058.

Distribution in Texas.—Navarro group, Neylandville marl: Corsicana road  $2\frac{1}{2}$ miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); vicinity of Corsicana (763); 3 miles northeast of Corsicana (9545); 4 miles north of Corsicana (17366).

Range.---Neylandville marl and Nacatoch sand in Texas.

## Unidentified specimens of NUCULA

One medium sized internal mold of a *Nucula*, with part of the shell attached to the right valve, was found in the Neylandville marl in a field 1 3/5 miles eastnortheast of Black Hills School,  $3\frac{1}{2}$  miles north-northwest of Corsicana, Navarro County (16166). This specimen is rather short, moderately inflated, with the beak well back of the midlength; the posterodorsal slope is steep and the anterior end is sharply rounded; the surface is marked by faint concentric growth lines, and by numerous weak compactly spaced radiating ribs; the ventral margin is crenulated.

The specimen is not suitable to serve as a type. U.S.N.M. no. 76296.

An internal mold, probably from the Nacatoch sand is recorded as having come from near Terrell, Kaufman County (U.S.N.M. no. 76385, replacing old no. 12246).

An internal mold of a left valve of a rather convex *Nucula*, 13 mm. long and 7 mm. high, with beak a little back of the midlength, found in the Kemp clay, 4 miles southeast of Zorn, Guadalupe County (10877), is too imperfect for specific identification. U.S.N.M. no. 76297.

In the same formation in a field 3 miles southeast of Manor, Travis County (16141), were found two small internal molds of a *Nucula*, with the external mold of the larger one incompletely preserved. This species is only moderately inflated and is subtriangular in outline with the beak a little back of the midlength; the margin is finely crenulated; the surface, as shown by a squeeze, exhibits numerous, distinct concentric ribs, and fainter, compactly arranged radiating ribs. U.S.N.M. no. 76298.

Two internal molds of *Nucula* from a locality in the upper part of the Kemp clay of the Navarro group, about 50 yards from the Lone Oak pike, on the east side of Cowleech Fork of Sabine River, 12 miles southeast of Greenville, Hunt County (11247), although well preserved as molds, do not agree closely enough in form with described species to permit their safe identification. U.S.N.M. no. 76299.

# Family NUCULANIDAE

# Genus NUCULANA Link, sensu lato

The Nuculanidae are not as well represented in the collections from the Navarro group as might be expected, for the living conditions appear to have been favorable for organisms of this kind during the deposition of the formations. Future collecting may bring to light a much better representation of this family. Seven named species are described from the Navarro group. Nuculana longifrons (Conrad) is represented by a goodly number of individuals, mostly imperfectly preserved, from several localities; Nuculana corsicana by 5 individuals from one locality; and the other 5 species each by only 1 or 2 individuals. Half a dozen species, recognized as distinct, but too imperfect for naming, are given letter designations.

# NUCULANA CORSICANA Stephenson, n.sp.

## Pl. 8, figs. 19, 20

Shell rather short, moderately convex below the beaks, compressed posteriorly by a broad, radiating sulcation on each valve. Beaks approximate, moderately prominent, nearly direct, situated about 2/5 the length of the shell from the anterior extremity. Angle of the anterowith the posterodorsal slope 135 degrees. Posterodorsal margin nearly straight. Escutcheon distinct, long and narrow,

and nearly equally divided on each valve by a faint ridge. Anterodorsal margin broadly arched. Lunule moderately distinct, narrow. Lunule and escutcheon each divided longitudinally by a low, sharp keel formed by the raised margins of the two valves. Anterior margin sharply rounded; ventral margin broadly rounded, slightly truncated posteriorly; posterior extremity sharply rounded, almost bluntly Surface marked by numerous pointed. distinct. uniform concentric ridges which fade out on the posterior sulcations where they are replaced by fine growth lines.

Dimensions of the holotype: Length 7.2 mm., height 4 mm., thickness 3 mm.; length of largest cotype 11 mm.

This species is not very close to any of the described species of the Coastal Plain.

It is similar in form to Nuculana pinnaforma (Gabb) from the Woodbury clay, Haddonfield, New Jersey, but is not so pointed posteriorly, and is much more finely ornamented.

*Types.*—Holotype, U.S.N.M. no. 76300; 4 unfigured paratypes, U.S.N.M. no. 20884.

Distribution in Texas. --Navarro group, Neylandville marl: ?2½ miles north of Corbet (16170; Texas Bu. 17300).

Navarro group, Nacatoch sand: North edge of Corsicana (518); vicinity of Corsicana (763, type loc.).

# NUCULANA COLORADOENSIS Stephenson, n.sp.

# Pl. 8, fig. 21

The description is based on the holotype only, which is broken about the umbone. Shell small, short, moderately convex, slightly compressed posteriorly. Beaks direct, rather prominent, tips deeply incurved, approximate, situated about two-fifths the length of the shell from the anterior extremity. Posterodorsal margin high and nearly straight. Lunule narrow, bounded by a sharp ridge which is paralleled on the outer side by a faint narrow Escutcheon long, channel. narrow, bounded by a prominent sharp ridge which is paralleled on the outer side by a distinct channel a little wider than the left half of the escutcheon, and extending to the end of the shell. Anterior margin

sharply rounded, ventral margin broadly rounded, with a slight truncation posteriorly, posterior margin more sharply rounded than the anterior. Internal shell features not uncovered. Surface glossy and smooth except for very fine faint incremental lines.

Dimensions of the holotype: Length 5.2 mm., height about 3.9 mm., convexity about 1.1 mm.

*Type.*—Holotype, a left valve, U.S.N.M. no. 76301.

Distribution in Texas.—Navarro group, Kemp clay: Webberville (7601).

# NUCULANA TRAVISANA Stephenson, n.sp.

# Pl. 8, fig. 22

The description is based on two imperfect right valves. Shell small, short, subelliptical in outline, moderately convex. greatest inflation under the beak, slightly compressed posteriorly. A subangular umbonal ridge extends from the beak to the posterior extremity, in front of which is a broad shallow depression extending to the margin. The posterodorsal slope is steep. Beak broken. Hinge and internal characters not uncovered. Anterodorsal margin slightly arched; anterior margin rather sharply rounded; ventral margin broadly rounded: posterior extremity subpointed a little above the midheight; posterodorsal margin nearly straight, gently inclined. The surface is covered with strong, sharp, asymmetric, concentric ridges, the upper slope of each of which is short and steep, and the lower long and gentle: these number about 5 to the millimeter near the margin, but become smaller and more closely spaced toward the beak.

Dimensions of the holotype, a right valve: Length about 5 mm., height about 3.25 mm.

The form of this species is similar to that of *N. coloradoensis*, from the same locality, but its strong sculpture is in marked contrast to that smooth species. *N. whitfieldi* (Gardner) is similarly sculptured, and is proportionately more elongated and more ventricose.

Types.---Holotype, U.S.N.M. no. 76302; 1 unfigured paratype, U.S.N.M. no. 76303. Distribution in Texas.—Navarro group, Kemp clay: Webberville (13910, holotype; 7601, paratype).

# NUCULANA HOUSTONI Stephenson, n.sp.

## Pl. 8, fig. 23

Shell of medium size, moderately convex, compressed posteriorly, with a broad shallow sulcation extending from the beak radially to the posteroventral margin. Beaks approximate, but not well preserved in the available material. situated about two-fifths the length of the shell from the anterior extremity. Anterodorsal margin rounding down into the rather sharply rounded anterior extremity; ventral margin broadly rounded becoming slightly truncated posteriorly; posterior extremity modified by a short vertical truncation. Lunule narrow and not sharply outlined; escutcheon long narrow, bounded on the outer side by a round-crested ridge which is paralleled on the outside by a distinct narrow channel, the width of which increases slightly toward the extremity. Surface marked by 20 or more sharply defined subconcentric, asymmetric ridges whose upper slopes are short and steep and whose lower slopes are relatively broad and gently inclined. These ridges do not conform strictly to the growth lines which they cross obliquely toward the posterior extremity. The ridges do not extend to the posterodorsal margin, but end at the edge of a narrow. smooth hand which parallels on the outside the posterodorsal channel already described; the band has a maximum width at the extremity of about 0.6 mm. and is crossed by fine straight, vertical growth lines. The internal characters are not uncovered, but on one internal mold from the same locality, which probably belongs to this species, the teeth are numerous and normal for the genus, the pallial line is near the ventral margin, and the faintly impressed pallial sinus is of moderate length, and broadly rounded anteriorly.

Dimensions of the holotype, a left valve: Length 8 mm., height 4 mm., convexity 1.5 mm.

*Type.*—Holotype, U.S.N.M. no. 21036; 1 paratype, U.S.N.M. no. 76304. Named for the Hon. Sam Houston, President of the Republic of Texas, 1836-1838.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); ?vicinity of Chatfield (762).

# NUCULANA CORBETENSIS Stephenson, n.sp.

## Pl. 8, fig. 24

Shell of medium size, strongly inflated centrally below the beak, more compressed posteriorly than anteriorly. The inflation is emphasized by a broad, very shallow, radiating depression which passes from behind the beak down to the posteroventral margin. Beaks prominent rising high above the dorsal margin, nearly direct, strongly incurved, approximate, situated slightly in advance of the midlength. Angle of the antero- and posterodorsal slopes about 120 degrees. Anterodorsal margin broadly arched; anterior margin rather sharply rounded; ventral margin broadly and evenly rounded; posterior extremity subpointed; posterodorsal margin nearly straight, gently inclined. Lunule of moderate length and faintly outlined; escutcheon long, broad, rather sharply outlined, each half subdivided by a faint median longitudinal ridge. Surface ornamented with numerous rather sharp concentric ribs which vary in width and strength, apparently reflecting favorable and less favorable conditions of growth.

Dimensions of the incomplete holotype, a right value: Length 7 + mm., height 5.1 mm., convexity about 2.5 mm.

The species is represented by the holotype, a medium sized right valve with the posterior partly broken away, and by two small, incomplete individuals, one with the two valves attached, and the other a left valve. The species resembles N. *corsicana*, but is proportionately higher, and more inflated, has a more prominent beak, and is more coarsely sculptured.

*Types.*—Holotype, U.S.N.M. no. 76305; 2 paratypes, U.S.N.M. no. 76306.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles due north of Corbet (17365; 16170, type lot; Texas Bu. 17300). Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

*Range.*—Ranges from the Neylandville marl into the lower part of the Nacatoch sand.

## NUCULANA LONGIFRONS (Conrad)

## Pl. 8, fig. 25

- 1860. Leda longifrons Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 281, pl. 46, fig. 18.
- 1864. Nuculana longifrons (Conrad). Meek, Check list of the invertebrate fossils of North America, Cretaceous and Jurassic, Smithsonian Misc. Coll., vol. 7, no. 177, p. 8.
- 1885. Nuculana longi/rons (Conrad). Whitfield, U.S. Geol, Survey Mon., vol. 9, p. 107, pl. 11, figs. 16, 17. (Geol. Survey New Jersey, Palcontology, vol. 1, p. 107, pl. 11, figs. 16, 17, 1866.)
- 1905. Yoldia longifrons (Conrad). Johnson. Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 8.
  1907. Yoldia longifrons (Conrad). Weller, Geol.
- 1907. Yoldia longifrons (Conrad). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 381, pl. 30, fig. 5.
- 1916. Yoldia longifrons (Conrad). Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 518, pl. 19, fig. 13.
- 1926. Yoldia longifrons (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 41, pl. 8, figs. 13, 14.

Shell large, elongated, high for the genus, moderately convex, becoming gradually compressed toward the posterior extremity, bluntly rounded on both ends, with dorsal and ventral margins subparallel. Beaks approximate, small, nonprominent, situated about 0.35 the length of the shell from the anterior extremity. The anterodorsal margin rounds off rather uniformly to the bluntly rounded anterior extremity; the ventral margin is broadly rounded with a faint truncation toward the front, and rounds steeply up both in the front and rear into the rounded extremities; posterodorsal margin long, straight, and nearly horizontal at the rear, rounding rather steeply down to the posterior extremity. Lunule very narrow and weakly developed, paralleled on the outside by a shallow, faint, narrow depression on each valve. Escutcheon long, narrow and sharply outlined. Surface smooth and polished, but revealing fine, distinct growth lines.

Dimensions of the moderate sized internal mold shown in plate 8, fig. 25: Length 18 mm., height 9.5 mm., convexity 2.5 mm. The largest Texas specimen is 30 mm. long.

Several authors have referred this species to Yoldia but the species lacks several of the important characters which Dall<sup>107</sup> ascribed to that genus. The shell though smooth and compressed, is not pointed behind, has a pallial sinus which is no more deeply impressed than in ordinary Nuculanas, and the shell is scarcely gaping either at the pedal or siphonal extremity. The species differs from the more typical Nuculanas in its great posterior elongation, its unusual height, and its lack of a pointed extremity.

Types.—The holotype was obtained from the Ripley formation at Eufaula, Alabama, and is in the collection of the Academy of Natural Sciences of Philadelphia. One plesiotype, U.S.N.M. no. 76307.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762); field south of Chatfield (7569); ½ mile east of Chatfield (7570, figured).

Navarro group, Corsicana marl: 5 miles southwest of Quinlan (15546); 2 4/5 miles east of Cooledge (13832, 14137); 1/2 mile below Martindale (15527); 2 miles east of Marion (Texas Bu. 2395).

Navarro group, Kemp clay: 3½ miles north of Bazette (12922); Brazos River, 2 miles above Milam County line (13776); south of McQueeney (7638).

Outside distribution.—Mississippi: Ripley and Owl Creek formations in the northern part of the State.

Tennessee: Ripley formation (Coon Creek tongue).

Chattahoochee region (Georgia - Alabama): Blufftown and Ripley formations. Maryland: Matawan formation.

New Jersey: Woodbury clay of the Matawan group.

Range.—Although in Texas the species has not been found in formations lower than the Navarro group, elsewhere it seems to have a greater range, its lowest reported occurrence being in beds at least as old as the lower part of the Taylor marl.

<sup>&</sup>lt;sup>107</sup>Dall, Wm. H., Wagner Free Inst. Sci., vol. 3, pt. 3, p. 595, 1895.

#### NUCULANA sp.a

# Pl. 8, fig. 26

In a collection from the Nacatoch sand, in a field near Chatfield (7569), are internal molds of a right and of a left valve of a rather large, ventricose, moderately elongated species of *Nuculana* too poorly preserved to serve as type material. The dimensions of the larger specimen, a right valve, are: Length about 18 mm., height about 9 mm., convexity 3 mm. The posterior margin is rather bluntly and evenly rounded, and the ventral margin is gently rounded below, steepening a little toward both the front and rear extremities. U.S.N.M. no. 76308.

## NUCULANA? sp.b

## Pl. 8, fig. 27

There is in one of the collections from the Nacatoch sand, from the public road 3/5 to 4/5 mile northeast of Chatfield, Navarro County (7572), an imperfectly preserved internal mold of one of the Nuculanidae resembling the greatly elongated form for which Conrad<sup>108</sup> proposed the genus Perrisonota, based on a new species, P. protexta. Gabb<sup>109</sup> had in 1860 already described an elongated, though obviously different, species of the same group under the name Leda protexta, so that even if Conrad's new genus, Perrisonota, be accepted, his species protexta would seem to be preoccupied by Gabb's species, Leda protexta. A new specific name would, therefore, seem to be needed for the type species of *Perrisonota*. Nuculana pittensis (Stephenson) from the Snow Hill marl member of the Black Creek formation of North Carolina belongs to the same group of elongated Nuculanas, as does also Perrisonota littlei Gardner from the Monmouth formation of Maryland.

The Texas specimen (U.S.N.M. no. 76309), a right valve, is not well enough preserved for certain identification, but it is very much like Conrad's *Perrisonota protexta* as figured. The anterior part

of the mold is imperfect, but the shell is flattish and the beak is obviously well toward the front. The posterior part of the shell is greatly elongated and the teeth back of the beak are small and number 60 or more to the centimeter. The posterior extremity is subangular and situated near the lower margin, above which the subtruncated margin slopes strongly forward to the end of the hinge line. The ventral margin is gently and regularly probably bending up more curved. strongly toward the anterior extremity.

Dimensions: Length about 19 mm., height 6 mm., convexity apparently about 1 mm.

### NUCULANA sp.c

## Pl. 8, fig. 28

The Corsicana marl has yielded the imprint of a smooth species of Nuculana about 7.5 mm. long, 4.5 mm. high, and with the beak situated only slightly in advance of the midlength. The specimens are too poorly preserved to serve as types but the species is probably new. One internal mold questionably referred to this species is 13.5 mm. long and 8 mm. high. Specimens referred to this undescribed species are recorded from the following localities in the Corsicana marl: Branch below road 2.5 miles north of Tona siding, 5 miles southwest of Quinlan, in Hunt County (15546); ?in a pit of Corsicana Brick Company, 2 miles south of Corsicana. Navarro County (16167); Mexia highway at the forks of the Wortham road, 2.8 miles cast of Cooledge, Limestone County (14137, U.S.N.M. ino. 76310); and San Marcos River, half a mile below Martindale, Caldwell County (7621).

# NUCULANA sp.d

## Pl. 8, fig. 29

Two small left valves of *Nuculana* from the Kemp clay on Colorado River at Webberville, Travis County (7601, U.S.N.M. no. 76311; 13910), are similar in form to *Nuculana* sp. c, but each is only about 7 mm. long. Each consists of an internal mold with parts of the shell adhering. The shell is greatly elongated, depressed convex, and smooth. The beak is small

<sup>&</sup>lt;sup>108</sup>Conrad, T. A., Amer. Jour. Conch., vol. 5, p. 98, pl. 9, fig. 24, 1869.

<sup>&</sup>lt;sup>109</sup>Gabb, Win. M., Acad. Nat. Sci. Philadelphia Jour., 2d scr., vol. 4, p. 303, pl. 48, fig. 23, 1860.

and low and situated about 2/7 the length of the shell from the anterior extremity. The long dorsal margin is gently arched, the anterior margin sharply rounded, and the ventral margin long and very broadly rounded; the posterior margin is not quite complete.

# NUCULANA sp.e

# Pl. 8, fig. 30

An internal mold of a right valve, with some shell material adhering, from the Kemp clay on the John A. Thompson estate, 31/2 miles northwest of Bazette, Navarro County (12922), is 11 mm. long, 6.5 mm. high. and about 2 mm. in con-The beak is situated a little in vexity. advance of the midlength. The greatest ventricosity is below the beak and a little above the midheight, from which point the surface descends in rather steep curves toward the anterior and ventral margins; the posterior part of the shell is noticeably compressed, becoming slightly excavated on the posterodorsal slope. The ventral margin is broadly and evenly rounded, and the extremities are sharply rounded above the midheight; the dorsal margins are moderately inclined, the anterior one slightly arched, and the posterior one nearly straight. U.S.N.M. no. 76312.

# NUCULANA sp.f

One poorly preserved individual of a large, greatly elongated species, was found in the Kemp clay on Colorado River at Webberville, Travis County (13910).The specimen is estimated to be about 30 mm. long and 8 mm. high under the beak; the height decreases toward the rear until at the almost squarely truncated extremity the shell is only about 3 mm. high. The valves are compressed and fragments of the shell show the surface to be smooth except for very fine growth lines. U.S.N.M. no. 76313.

# Other unidentified specimens of NUCULANA

An internal mold from the Corsicana marl, in the pit of the Corsicana Brick Company, 2 miles south of Corsicana, Navarro County (16167), has about the same outline as the one from near Odds (see below), but is flatter, perhaps due to mechanical compression. The concentric ribs which are impressed on the mold are sharp, numerous and regular. This shell is similar in form, size, and ribbing to N. travisana, but, as preserved, is flatter. U.S.N.M. no. 76314.

A small internal mold from the Kemp clay of the Navarro group, in a branch near the oil-prospecting well of Moss & Keeling, W. D. Moody No. 1, 6½ miles southwest of Currie, Navarro County (14139), is too poorly preserved for identification or specific description. U.S.N.M. no. 76315.

A small right valve from the Kemp clay in Tom Thrasher's dug well near Garfield, Travis County (1641), is probably a young individual, and is hardly adequate to serve as a type. U.S.N.M. no. 76316.

A ferruginous, oxidized left valve from the Kemp clay in a road ditch half a mile west of Elm Creek school, 4½ miles northwest of Lockhart, Caldwell County (15528), is 14 mm. long, is moderately convex, has its beak about midway of the length, narrows nearly to a point posteriorly, and has a convex posterodorsal margin. It is too poorly preserved to serve as a type. U.S.N.M. no. 76317.

An external mold of a small right valve, from the Kemp clay, 1/2 mile west of Odds, Limestone County (15434), is a short, moderately high, moderately convex species, with numerous sharply developed concentric ridges. It is not complete enough to serve as a type. U.S.N.M. no. 76318.

# Superfamily PARALLELODONTACEA

A partial classification of the arcid Pelecypoda, recently proposed by Mac-Neil,<sup>110</sup> is here tentatively accepted, pending the decision of the International Commission as to the valid genotype of *Arca*.

<sup>&</sup>lt;sup>110</sup>MacNeil, F. Stearns, Washington Acad. Sci. Jour., vol. 27, no. 11, pp. 452-458, 1937.

## Family GRAMMATODONTIDAE111

# Subfamily NEMODONTINAE111

# Genus NEMODON Conrad

## Type species.—Nemodon conradi Johnson<sup>112</sup> ( $\equiv N$ , eufalensis Conrad<sup>113</sup>); not Area (Macrodon) eufalensis Gabh.<sup>111</sup>

Dall<sup>115</sup> considered *Nemodon* a synonym of *Cucullaria* Conrad (Eocene) but it differs from that genus in its greater elongation, its more nearly parallel dorsal and ventral margins, its long straight anterior and posterior teeth nearly parallel to the hinge line, and its coarse oblique ligamental grooves the last one or two of which on the larger species of the genus may be chevron-shaped and extend in front of as well as back of the beak.

# NEMODON GRANDIS NAVARROANUS Stephenson, n.var.

# Pl. 9, fig. 1

Shell thin, elongated, subrhomboidal in outline, moderately convex. Beaks low, broad, incurved, approximate, slightly prosogyrate, situated about 1/3the length of the shell from the anterior extremity. A broad, shallow radial depression divides the umbone and extends to about the middle of the ventral margin. The umbonal ridge is a prominent, broadly rounded swell, slightly humped about midway of the length. The anteroand posterodorsal slopes are only moderately steep. The hinge line is long, 21 mm. in the holotype, but the teeth are not exposed in the available material. The cardinal area is long and narrow, and the ligamental grooves appear to number only one or two to each valve. The anterior margin is regularly rounded, meeting the hinge line above at an obtuse angle, and rounding down evenly into the nearly straight ventral margin which is slightly . .- .

and broadly concave centrally. The posterior margin is bluntly rounded below, passing above into a broadly convex posterodorsal margin which inclines strongly forward and meets the hinge line at an angle of about 140 degrees. The surface is marked by somewhat irregularly developed incremental lines and by faint radiating ribs which, over most of the surface, are obscure, but by their intersection with the growth lines produce a faintly punctate surface.

Dimensions of the holotype, a right valve: Length 30 mm., height 13 mm., convexity 4 mm.

The few available shells of this species are imperfect and are only about half as large as the typical Nemodon grandis Wade.<sup>116</sup> They differ from Wade's species also in having a proportionately lesser height, and the umbonal ridge inclines away from the hinge line a little less steeply. The surface of the Texas variety, though faintly sculptured, is still a little more strongly marked than the type of the species. Nemodon stantoni Gardner<sup>117</sup> is also a closely related species, but differs in that the shell is proportionately higher, the umbonal ridge inclines away from the hinge line more steeply, and the sculpture is more strongly marked. The shell which Wade<sup>118</sup> identified with N. stantoni is not that species, but is more like N. eufaulensis (Gabb).

*Types.*—Holotype, a right valve, U.S.N.M. no. 20979; 1 unfigured paratype, a left valve, U.S.N.M. no. 76319.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); ?north of Rock Branch 3 miles northeast of Corsicana (9560).

## NEMODON BOWIEI Stephenson, n.sp.

## Pl. 9, figs. 2, 3

Shell elongated, rather strongly inflated, subrhomboidal in outline. Beaks low and broad, incurved, approximate, slightly prosogyrate, situated 0.38 the

<sup>&</sup>lt;sup>11</sup>(Family and subfamily names proposed by F. Stearns MacNeil in unpublished manuscript.

<sup>&</sup>lt;sup>112</sup>Johnson, C. W., Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 9, 1905. See also Stewart, Ralph, Acad. Nat. Sci. Philadelphia Special Pub. No. 3, pp. 66-67, 1930.

<sup>&</sup>lt;sup>113</sup>Conrad. T. A., Amer. Jour. Conch., vol. 5, p. 97, pl. 9. fig. 16, 1869.

<sup>&</sup>lt;sup>114</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 398, 1860.

<sup>&</sup>lt;sup>115</sup>Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 615, 1898.

<sup>&</sup>lt;sup>116</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 43, pl. 9, figs. 1, 2, 1926.

<sup>&</sup>lt;sup>115</sup>Gardner, Julia, Maryland Geol, Survey, Upper Cretaceous (2 vols.), p. 527, pl. 19, fig. 15, 1916.

<sup>118</sup>Wade, Bruce, op. cit., p. 43.

length of the shell from the anterior extremity. The beak is divided by a shallow radial depression which extends down over the shell a little in front of the midlength, broadening out and almost disappearing at the margin. The umbonal ridge is rather prominent, approaching subangularity, and continues evenly prominent to the lower posterior margin. Antero- and posterodorsal slopes moderately steep, the latter broadly excavated and well outlined. The hinge line is 11 nm. long in the holotype, but the teeth are not exposed. In one imperfect specimen the teeth are seen to be long and slender, and therefore normal for the genus. The cardinal area is long and narrow and probably bears about 2 chevron-shaped ligamental grooves. The surface of the holotype is ornamented with low, concentric, rather evenly spaced ridges 0.5 num. or less in width, separated by narrow, distinct channels, except in a smooth band 2 to 2.5 mm. wide bordering the outer margin; this band doubtless marks the stage of senility. The surface is further ornamented with obscure, fine, somewhat irregularly spaced, radiating ribs which have their strongest development in the interspaces between the concentric ridges, thus giving to most of the surface a punctate appearance.

Dimensions of the holotype, a right valve: Length 18.4 mm., height 11.5 mm., convexity 4.5 mm.

This species is represented by 10 individuals most of which are broken and imperfect. Compared with *N. grandis navarroanus* this species is shorter and higher, thicker-shelled, and has a more pronounced and more regular concentric ornamentation.

Types. --Holotype, a right valve, U.S.N.M. no. 20901; 8 unfigured paratypes, U.S.N.M. no. 76320; 1 unfigured paratype, U.S.N.M. no. 76340. Named for Col. James Bowie, who assisted in freeing Texas from Mexican rule in 1835.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, holotype and 8 unfigured paratypes); north edge of Corsicana (518, 1 unfigured paratype).

# NEMODON ADKINSI Stephenson, n.sp.

# Pl. 9, figs. 4, 5

Shell thin, of medium size, subrhomboidal in outline, moderately convex. Beaks moderately prominent, broad, incurved, a little less than 1 mm. apart in the holotype, situated about 0.35 the length of the shell from the anterior extremity; umbonal ridge broadly and The hinge as exposed evenly rounded. on one of the paratypes is narrow, and on the posterior end bears 3 narrow elongated teeth parallel to the hinge line; the teeth are not well preserved on the anterior end. Cardinal area amphidetic, 8.5 mm. long in the holotype, rather wide in front of the beak, narrow back of the beak, and longitudinally striated with fine growth lines; the area on each valve is deeply concave in front of the beak about parallel to the hinge, but this excavation shallows toward the rear and dies out a little back of the beak; the inner margins of the area on the two valves fit together in a straight line, except along a linear distance of about 2 mm. a little back of the beaks where 2 or 3 rather obscure interfitting notches may be seen. It is probable that the ligament is entirely back of the beaks. Aside from the hinge features just described, the internal features of the shell are not exposed. The anterior margin meets the hinge line at an obtuse angle above, and curves down regularly into the very broadly rounded ventral margin; the posterior margin is rather sharply rounded below, becomes broadly arched and inclined forward above. and meets the hinge line at an angle of about 133 degrees. Surface marked with 65 or 70 low, distinct radiating ribs which are a little wider than the interspaces, and which are of irregular development over the shell as follows: On the anterior slope 3 widely spaced ribs stand out more prominently than the others and each of the interspaces between the large ribs is occupied by 2 to 4 ribs of ordinary size: the ribs on the sides are closely spaced and fairly uniform in strength; the coarsest and most widely spaced ribs are on the umbonal ridge, from which on the posterodorsal slope the ribs become finer and more closely spaced toward the hinge.

Dimensions of the holotype: Length 12.7 mm., height 8.8 mm., thickness 7.7 mm.

This elegant species is represented by the holotype, a somewhat imperfect individual with both valves attached, and by two smaller right valves, one of which is moderately well preserved and the other very imperfect, all from the same locality.

*Types.*—Holotype, U.S.N.M. no. 21044; 2 unfigured paratypes, U.S.N.M. no. 76321.

Distribution in Texas. –Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

# NEMODON MARTINDALENSIS Stephenson, n.sp.

# Pl. 9, fig. 6

Shell clongated, moderately inflated, subrhomboidal in outline. The beaks are low and broad and each one is divided by a very shallow radial depression which tends to fade out as it extends centrally toward the ventral margin. The umbonal ridge is broadly rounded and not prominent, and the antero- and posterodorsal slopes are of only moderate steepness. The hinge line is long, 16 mm. in the holotype. The teeth are not exposed and the cardinal area is concealed by the broad down-crushed umbo. The anterior margin is vertical above, meeting the hinge line at a right angle, and rounds down regularly below into the nearly straight ventral margin which is subparallel with the hinge line. The ventral margin curves up a little posteriorly to the subangular extremity, above which the nearly straight posterior margin inclines strongly forward meeting the hinge line at an angle of about 120 degrees. The imprint of the sculpture shows that the surface is marked by about 43 radial ribs of irregular strength and spacing on different parts of the shell; centrally the ribs are smaller and closer together than they are either toward the front or rear; they are strongest and most widely spaced, and quite irregular, on the posterodorsal slope and on the umbonal ridge; they are a little less prominent, more closely spaced, and irregular on the anterior slope.

Dimensions of the holotype, a left valve: Length 19 mm., height 9 mm., convexity 2.5+ mm. The dimensions given are only approximate as the shell material has all been dissolved away and the specimen is in reality an internal mold, somewhat crushed and flattened, on which the sculpture of the outer surface has been impressed by mechanical compression.

There may be some question as to the advisability of founding a species on material in this state of preservation, but the outline, the form, and the ornamentation are fairly well preserved, and the type locality is easily accessible, though not a prominent exposure. The species bears a general resemblance to Nemodon eufaulensis Gabb, but differs somewhat in outline and in form, and is much more strongly and coarsely ribbed.

*Type.*—Holotype, U.S.N.M. no. 76322; 4 unfigured paratypes, U.S.N.M. no. 76323.

Distribution in Texas.—Navarro group, Corsicana marl: ½ mile below Martindale (7621, 15526, type lots; 15527); 1 3/10 miles north of McQueency (7637, 15524); 2½ miles west of McQueency (15523).

# NEMODON EUFAULENSIS LINEATUS Stephenson, n.var.

# Pl. 9, fig. 7

Shell of medium size, thin, elongated, moderately inflated, subrhomboidal in Beaks low, broad, prosogyrate, cutline. partly divided by a broad shallow sulcus which extends with increasing width to the middle of the ventral margin. Umbonal ridge rather prominent and subangular, especially near the beak; posterodorsal slope gentle, excavated radially to form a broad shallow sulcus. Hinge and internal features not uncovered. Dorsal margin long and straight; anterior margin inclined a little backward above, rounding down regularly into the long ventral margin which is broadly concave centrally; posterior extremity subangular below, with the margin above nearly straight and inclined forward, meeting the hinge at an angle of about 110 degrees.

The lateral surface of the shell is marked by regularly arranged, low, concentric ridges numbering about 3 to the millimeter; they are acentric in cross section with the steepest slope above: they reach the anterodorsal margin, but tend to fade out into mere incremental lines on the posterodorsal slope. The radial ribs are numerous, low, and vary in width on different parts of the surface; on the anterior slope the ribs are of moderate width and form low nodes at the intersections of the concentric ribs; on the side the ribs are very numerous, narrow, and closely packed; the ribs become wider on the umbonal ridge and still wider and flattish on the posterodorsal slope: the interspaces between the ribs are narrow, being little more than impressed The whole surface has a punctate lines. appearance due to the crossing of the radial and concentric ridges.

Dimensions: Length 13.5 mm., height 6 mm., convexity about 2 mm.

The Texas shell is smaller and proportionately more elongated than Gabb's type of N. *eu[aulensis* from Eufaula, Alabama; the radial ribs are flatter and the interspaces narrower, the concentric ribs are sharper and more regular, and the umbonal ridge is a little more prominent and more angular.

Type. -Holotype, U.S.N.M. no. 76324.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, type loc.); ?½ mile north of Cooper (14062).

# Unidentified specimens of NEMODON

Specimens of Nemodon too poorly preserved for specific identification have been found in the Navarro group as follows: In the Nevlandville marl 21/2 miles northeast of Royce City (16157, U.S.N.M. no. 76325): in the Nacatoch sand in the vicinity of Kaufman (761, U.S.N.M. no. 76326); on road 2 miles southwest of Kaufman (7546, U.S.N.M. no. 76327), and on State Highway 22, 21/2 miles west (17368, U.S.N.M. of Corsicana no. 76328); in the Corsicana marl 11/4 miles south by east of Oak Grove (16160, U.S.N.M. no. 76329), 1/2 mile below Martindale (15527, U.S.N.M. no. 76330), 1.3/10 miles north of McQueeney (15521, U.S.N.M. no. 76331), and near Castroville (7665, U.S.N.M. no. 76332); and in the

Kemp clay, 4 miles southeast of Zorn (10877, U.S.N.M. no. 76333), and near Deatsville (764, U.S.N.M. no. 76334).

# Superfamily GLYCYMERACEA

Family GLYCYMERIDAE

# Genus GLYCYMERIS Da Costa

# GLYCYMERIS ROTUNDATA KAUFMANENSIS Stephenson, n.var.

# Pl. 9, figs. 8-12

Shell thick, subcircular in outline, subequilateral, very slightly oblique toward the lower posterior extremity, moderately convex. Beaks prominent, direct, strongly incurved, about 2 mm. apart in the adult, situated near or slightly in advance of the midlength. Hinge plate rugged, arched, truncated above by the lower straight margin of the cardinal area; in the adult there are 7 or 8 centrally located small, short nearly vertical teeth; these are succeeded both anteriorly and posteriorly by 8 or 9 large, strong teeth which become successively more oblique away from the center, pointing inwardly, until at the ends the teeth are nearly horizontal; several of the larger oblique teeth are curved or even subangular in their trend. Cardinal area amphidetic, moderately broad, bounded below by a straight horizontal base, 22 mm. long in the holotype, broadly arched above where it is bounded by a thin carina; ligamental grooves chevron-shaped, sharply impressed, numbering 6 or 7 in the holotype. Adductor scars small, subequal, the posterior one bounded below by a narrow nonprominent, radiating ridge. Pallial line strong, entire, and lying 5 to 6 mm. from the margin. Inner margin strongly crenulated below, the crenulations becoming smaller upward and dving out near the ends of the hinge. Surface marked by fine growth lines, and by 45 to 48 low. broad, flattish, radiating costae separated by narrow, shallow interspaces.

Dimensions of the holotype, an adult right valve: Length 48.5 mm., height 47 mm., convexity, 18.7 mm. Dimensions of the paratype, a left valve, shown in plate 9, figures 11, 12: Length 38.6 mm., height 36.1 mm., convexity 13.7 mm.

This is one of a group of closely related species and varieties of *Glycymeris*, which are common in certain zones in the Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plain. This form is scarcely distinguishable from G. rotundata (Gabb), from Eufaula, Alabama, but appears to be slightly less convex with broader, less obscure and more regularly spaced costae, and probably averages a little higher with respect to the length. Glycymeris lacertosa Wade, from Coon Creek, Tennessee, is also a closely related species but, in a large series, is consistently less convex and more oblique than the Kaufman species. G. hamula (Morton) from Prairie Bluff, Alabama, is a smaller, smoother, and relatively more convex species. G. whiteleyensis Stephenson from Whiteley Creek Landing on Neuse River, North Carolina, is a thinner-shelled, higher species, and has finer and more numerous ligamental grooves.

*Types.*—Holotype, an adult right valve, U.S.N.M. no. 76335; 1 figured paratype, U.S.N.M. no. 76336; 38 selected unfigured paratypes, U.S.N.M. no. 76337.

Distribution in Texas.—Navarro group, Nacatoch sand: Field 3/5 mile west of Kaufman (14103, type loc.); road, 3/5 mile west of Kaufman (7545, 13923, 14098); vicinity of Chatfield (762).

## Unidentified specimens of GLYCYMERIS

Two small, imperfectly preserved specimens from the Neylandville marl, in a road ditch  $2\frac{1}{2}$  miles south of Ben Hur, Limestone County (15543), are questionably referred to *Glycymeris*. U.S.N.M. no. 76339.

A small poorly preserved internal mold from the Nacatoch sand, on the northwardfacing slope of Sulphur Creek valley, in the northwestern corner of Franklin County (12931), probably belongs to the genus *Glycymeris*. U.S.N.M. no. 76338.

## Family NOETIDAE

## Subfamily TRINACRIINAE

## Genus LINTER Stephenson

1937. Linter Stephenson, Washington Acad. Sci. Jour., vol. 27, no. 11, p. 449.
Type species.—Linter acutata Stephenson.
Etymology.—Latin linter, a boat or skiff.

Linter and Breviarca belong to a group of taxodont shells having vertically striated ligamental areas, to which MacNeil<sup>119</sup> has recently applied the family name Noetidae.

This genus is characterized by its long and sharply acute umbonal ridge, its short *Arca*-like hinge, and its broadly excavated triangular cardinal area situated mainly back of the beak; at the forward end of the area under the beak is a small, triangular; amphidetic, multivincular ligamental area, faintly striated at right angles to the hinge line; the rest of the arca is smooth with only incremental lines showing. The hinge is slightly arched and is set with 8 or 10 irregular, short, transverse to slightly oblique teeth, separated by deep sockets.

The genus is represented by 8 specimens from Texas, 7 from the Nacatoch sand, described below under the specific name *Linter acutata*, and 1 from the stratigraphically lower San Miguel formation of Maverick County, described under the name *Linter burrana* Stephenson.

#### LINTER ACUTATA Stephenson

# Pl. 10, figs. 5-7

1937. Linter acutata Stephenson, Washington Acad. Sci. Jour., vol. 27, p. 449, text figs. 1-3.

Shell small, subtrigonal in outline, strongly convex. Beaks prominent, opisthogyrate, slightly separated, situated about 3/10 the length of the shell from the anterior extremity. The umbonal ridge is sharply angular, the median surface meeting the posterodorsal slope at an acute angle, the crest of the ridge slightly overhanging as it approaches the beak. A broad, very shallow radiating depression extends to the posteroventral margin in front of the umbonal ridge. The umbonal ridge stands higher than any other part of the shell, and from it the surface rounds down gently to the anterior and ventral margins. The posterodorsal slope is long, broad, and broadly excavated, the concavity being slightly modified by a broad median swell; this surface meets the cardinal area at a broad, obtuse angle. The cardinal area is triangular and broadly excavated, its lower straight edge is about 2.25 mm. long in the holotype, and its posterior edge meets the posterodorsal

<sup>110</sup>MacNeil, F. Stearns, Washington Acad. Sci. Jour., vol. 27, no. 11, pp. 452-458, 1937.

slope at an obtuse angle; the anterior edge is partly concealed by the incurving of the sharp tip of the beak. Under the beak is a small, shallow, triangular, multivincular ligamental pit, which bears 5 or 6 obscure, transverse striations; the rest of the area is smooth with the exception of fine incremental lines. The hinge plate is short and narrow: as seen on the holotype it is obscure but appears to be set with 10 or more irregular taxodont teeth which centrally are nearly transverse to the hinge line but toward the ends become more or less oblique: the anterior teeth are chevron-shaped. The inner surface is partly exposed posteriorly in one shell and exhibits radial striae which are strongest near the pallial line. The anterodorsal margin is steeply inclined, but curves down below into the regularly rounded anterior margin, which in turn curves into the broadly convex to nearly straight ventral margin; the long, nearly straight, though slightly sinuous, posterodorsal margin meets the ventral margin at a sharp acute angle, forming a pointed extremity; the posterodorsal margin is strongly inclined forward and meets the hinge line at a very wide obtuse angle. The surface is marked with fine, somewhat irregular incremental lines, crossed by very fine, obscure, radiating ridges which are a little stronger and wider apart on the anteroand posterodorsal slopes; the crossing of the two sets of lines tends to form a faint punctate sculpture; these features are too fine to show clearly in the illustration, and vary in strength on different individuals.

Dimensions of the holotype, a right valve: Length 11.3 mm., height 6.8 mm., convexity 3 mm.

Types.—Holotype, a right valve, U.S. N.M. no. 75974; 2 paratypes, U.S.N.M. no. 75975; 1 paratype, U.S.N.M. no. 75976; 4 paratypes, U.S.N.M. no. 75977. Distribution in Texas.—Navarro group, Nacatoch sand: 5 miles south-southwest of Corsicana (7573, type loc.); 2 miles north

Corsicana (7573, type loc.); 2 miles north of Corsicana (9553); 4 miles north of Corsicana (17366).

# Genus BREVIARCA Conrad

- 1872. Breviarea Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 55, pl. 2, figs. 3, 4. (Subgenus of Trigonarea.)
- 1875. Breviarca Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 3. (Subgenus of Trigonarca.)

- 1876. Breviarca Conrad. Meek, Rept. U.S.Geol. and Geog. Survey Terr., vol. 9, p. 91. (Subgenus of Trigonarca.)
- (Subgenus of Trigonarca.) 1884. Breriarca Conrad. Tryon, Struct. and System. Conch., Mollusca, vol. 3, p. 257. (Subgenus of Cucullaea.)
- 1923. Striarca Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 108.
- 1930. Breviarca Conrad. Stewart, Acad. Nat. Sci. Philadelphia Special Pub. No. 3, p. 86. (Designates Trigonarca saffordi (Gabb) Conrad as type species of the genus.)
  1935. Breviarca Conrad. Stephenson, Wash. Acad.
- 1935. Breviarca Conrad. Stephenson, Wash. Acad. Sci. Jour., vol. 25, no. 8, pp. 362–363, Aug. 15, 1935.
- Type species.—Breviarca haddonfieldensis Stephenson (= Trigonarca (Breviarca) saffordi Conrad, not Gabb.)

In 1923 I placed Breviarca in the synonymy under Striarca, the type species of which is S. centenaria (Say), from the Miocene of Virginia. My reason was that the transverse ligamental grooves possessed by both the Cretaceous and Miocene shells, seemed to be a character fundamentally different from the chevron-shaped grooves of Arca, Barbatia, and other groups of the Arcidae, and indicative of a separate line of descent from a pre-Cretaceous common ancestor. It seemed appropriate, therefore, that the forms possessing the transverse grooves should be grouped together under the older name Striarca. It now seems probable from the work of Woodring,120 MacNeil. and other Tertiary paleontologists, that the group possessing this feature will be subdivided into subgroups, each of which will be given generic rank, in which case it is both appropriate and desirable that the Cretaceous subgroup retain the name Breviarca.

*Breviarca*, although variable in form and outline, is in general less quadrate, less elongate, less strongly ornamented, and has a more strongly arched hinge plate than the typical *Striarca centenaria* (Say).

In his original description of *Breviarca*, Conrad named two species as examples, the first *Trigonarca (Breviarca) perovalis* Conrad, from the Upper Cretaceous at Snow Hill, North Carolina, and the second *Trigonarca (Breviarca) saffordi* (Gabb) Conrad, a misidentified species from Cretaceous deposits at Haddonfield, New Jersey. In 1930 Stewart designated the

<sup>&</sup>lt;sup>120</sup>Woodring, W. P., Carnegie Inst. Washington Pub. no. 366, p. 50, 1925.

misidentified species from Haddonfield as the type species of the genus. In 1935 I renamed the latter *Breviarca haddonfield*ensis.

## BREVIARCA PLUMMERI Stephenson, n.sp.

## Pl. 9, figs. 13, 14; pl. 28

Shell large, thick, rather strongly inflated, longer than high. Umbonal ridge prominent, subangular near the beak, becoming more rounded distally. Anterodorsal slope moderately steep, rounding off broadly to the margin except in front of the beak where it is slightly excavated; posterodorsal slope, steep, broadly excavated back of the beak, rounding broadly downward to the extremity; in general the shell rounds down broadly from the beak and umbonal ridge to the ventral and Beaks anterior margins. prominent, broad, incurved, separated by a space of perhaps 1 mm., slightly prosogyrate. Hinge plate broad, arching down strongly at each end, truncated above by the straight, basal edge of the area; teeth numerous, thin, closely spaced, nearly vertical centrally, becoming successively more oblique distally, the end ones being horizontal. Some of the teeth just below the ends of the cardinal area are angulated in their trend, the angulations pointing toward the beak. Cardinal area amphidetic, rather broad centrally, broadly arched on the upper margins, straight on the base, which is 13 mm. long on the holotype. The area, except a narrow border above, is closely covered with ligamental striations which are transverse to the hinge line. Adductor scars unequal, the posterior one the larger. Pallial line simple. Anterior margin regularly rounded, passing below into the very broadly rounded ventral margin; posterior subangulated below. margin nearly straight and inclined forward above, meeting the hinge line at an angle of 115 degrees. The surface exhibits fine, regular inconspicuous growth ridges, with here and there a slight depression, or a slightly stronger ridge, indicating stages of rest and accelerated growth. Very fine radiating striations are present all over the shell; these vary somewhat in strength on different individuals. The crossing of the

radial and concentric markings tends to produce a faint punctate appearance.

Dimensions of the holotype, a left valve: Length 24 mm., height 20 mm., convexity 8 mm.

The species is much larger than Breviarca nolani, is proportionately less inflated, the umbonal region is a little broader, and the umbonal ridge is a little less angular. Both the concentric and radial markings are a little weaker in this species than in *B. nolani*, but otherwise the two species are similarly ornamented. *B. umbonata* Conrad, from the Snow Hill member of the Black Creek formation in North Carolina, is a closely allied species, but is smaller and proportionately more inflated.

Types.—Holotype, a left valve, U.S.N.M. no. 76341; 1 figured paratype, U.S.N.M. no. 76342; 8 selected unfigured paratypes, U.S.N.M. no. 76343; 11 paratypes in large slab, U.S.N.M. no. 76344 (pl. 28). Named in honor of Prof. Frederick B. Plummer, who collected the piece of fossiliferous sandstone in which the specimens included under U.S.N.M. no. 76344 are embedded.

Distribution in Texas.—Navarro group, Nacatoch sand: 1 4/5 miles northeast of Quinlan (16162, 16171, type loc.); 1<sup>1</sup>/<sub>2</sub> miles west of Campbell (12925); vicinity of Kaufman (761, U.S.N.M. no. 21020); vicinity of Kaufman (761, U.S.N.M. no. 20957).

## BREVIARCA NOLANI Stephenson, n.sp.

# Pl. 9, figs. 15, 16

Shell small, moderately thick for the size, subquadrate in outline, longer than high, strongly convex. Beaks prominent, incurved, slightly prosogyrate, separated by about 0.5 mm., situated about 0.45 the length of the shell from the anterior extremity. Umbonal ridge moderately prominent, subangular near the beak, becoming rounded distally. Centrally the shell is broadly and evenly convex, and both the antero- and posterodorsal slopes are steep. Hinge plate moderately broad and heavy, arching down more strongly at the anterior than at the posterior end, and truncated above by the straight lower

edge of the area. Centrally the hinge is set with 9 or 10 small vertical teeth, and these are followed on each of the down arched ends by 7 or 8 stronger and longer teeth which become successively more oblique, pointing inwardly, until the end ones are nearly horizontal. The cardinal area is amphidetic and rather wide and its lower straight edge is about 5.5 mm. long on one of the paratypes. Fine ligamental grooves transverse to the hinge line cover a small central triangular area having its apex under the beak and its base, about 1 mm. long on the upper hinge margin; these are faint and scarcely show in the illustration; they are best seen on one of the paratypes. The rest of the cardinal area is smooth except for fine incremental lines. With the exception of the hinge the interior of the shell is not uncovered for observation. The anterior margin is regularly rounded, meeting the hinge line at a moderately obtuse angle, and passing below into the broadly and regularly rounded ventral The posterior margin is rather margin. sharply rounded below at the extremity, becomes nearly straight above, and meets the hinge line at an angle of 130 degrees. The surface is marked by fairly regular, but not prominent. growth ridges which number 4 or 5 to the millimeter toward the outer margin, and by numerous, faint, radiating ribs which tend to give the surface a fine punctate appearance; although weak the ribs on the holotype show a tendency to alternate in strength; on some shells this tendency to differ in size is particularly strong on the anterodorsal slope, where every other or every third or fourth rib is stronger than the others. There is, however, considerable individual variation in the development of these ribs.

Dimensions of the holotype: Length 6 mm., height 5 mm., convexity 2.5 mm.

This species is closely related to Breviarca webbervillensis Stephenson but is a larger, more robust, and relatively higher shell. Compared with B. plummeri it is much smaller, relatively more inflated, and more pointed posteriorly. The species from the Coon Creek tongue of the Ripley formation in Tennessee, which Wade incorrectly referred to Barbatia saj*fordi* (Gabb), is very close to this one, but is somewhat more elongated.

Types.---Holotype, a left valve, from near Chatfield, U.S.N.M. no. 76345; 2 unfigured paratypes from the same locality, U.S.N.M. no. 76346; 1 unfigured paratype from near Kaufman (U.S.N.M. no. 20957). Named for Philip Nolan who led an invading party into Texas from Louisiana in 1799.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, 17365).

Navarro group, Nacatoch sand: ? 2½ miles north of Corsicana (14114); 3 miles northeast of Corsicana (9545); field south of Chatfield (7569, loc. of holotype and 2 paratypes); vicinity of Chatfield (762); vicinity of Kaufman (761, loc. of 1 paratype); 1 4/5 miles northeast of Quinlan (16162).

# BREVIARCA WEBBERVILLENSIS Stephenson, n.sp.

Pl. 9, figs. 17-19

Shell small, thin, subquadrate in outline, considerably longer than high, moderately convex. Beaks moderately prominent, incurved, slightly prosogyrate, separated by about 0.5 mm., situated about 0.1 the length of the shell from the anterior extremity. Umbonal ridge moderately prominent, subangular near the beak becoming rounded toward the extremity. Centrally the shell is evenly convex, becoming steep on both the anteroand posterodorsal slopes. Hinge plate long, narrow, slightly truncated by the lower edge of the cardinal area, arching down slightly at the ends, set with about 22 teeth which are small and vertical centrally, and become longer and somewhat oblique toward the interior at the ends. Cardinal area amphidetic, about 3.5 mm. long on the base in the holotype, relatively wide, a little wider behind than in front of the beak; the ligamental attachment is confined to a small triangular area under the beak, the sides of which are slightly longer than the base and are slightly concave; on this area the ligamental grooves are transverse to the hinge line; on some of the specimens this area is still covered with a brown, corneous layer which is also strongly marked with transverse grooves;

the remainder of the cardinal area is smooth except for fine longitudinal growth lines. On the interior the pallial line is simple and fairly close to the margin. The adductor scars are relatively large and each is bounded on the lower side by a thin, radial carina which extends well back toward the beak, and the posterior one of The left valve which is the stronger. slightly overlaps the right on the ventral margin, and the edge of the right valve has left a deep groove a fraction of a millimeter within the inner edge of the left valve. The anterior margin is regularly rounded, meeting the hinge line above at an obtuse angle, and passing into the broadly rounded ventral margin below. The posterior margin is sharply rounded below, becomes straight and strongly inclined forward above, and meets the hinge line at an angle of 134 degrees.

The surface is marked by sharply defined, low, concentric ridges, 7 or 8 to the millimeter, and by numerous fine, faint, radiating ribs which show a tendency to alternation in size, although there is irregularity in this respect, 2, 3, or more smaller ribs intervening in places between the larger ones; the ribs toward the upper antero- and posterodorsal slopes are finer than elsewhere on the surface; the ribbing on the left valve appears to be a little more distinct than on the right.

Dimensions of the holotype, a left valve: Length 5.5 mm., height 4 mm., convexity 1.9 mm.

This species is represented by 14 individuals none of which is larger than the holotype. Although some of the shells are broken, others, including the holotype, are almost as perfectly preserved as Recent shells. Compared with *Breviarca nolani* this species is consistently smaller, is proportionately more elongated, has a smaller area of attachment for the ligament, and the concentric ribbing is finer.

*Types.*—Holotype, a left valve, U.S.N. M. no. 76347; 10 unfigured paratypes, U.S.N.M. no. 76348.

Distribution in Texas.—Navarro group, Kemp clay: Webberville (7601, type lot 13910); well 2 miles west of Groesbeck (depth 800 feet) (13124); ?on Brazos River, 2 miles above Milam County line (13776); branch  $6\frac{1}{2}$  miles southwest of Currie (17377).

#### BREVIARCA sp.

Several ferruginous internal molds of a large species of *Breviarca* were found in the Kemp clay 4.5 miles northwest of Lockhart (15528, U.S.N.M. no. 76349; 16151, U.S.N.M. no. 76350). They appear to represent an undescribed species which occurs abundantly in certain layers of the Escondido formation, from Medina County westward to the Rio Grande (pl. 9, figs. 20, 21); this formation is regarded as approximately contemporaneous with the Kemp clay. The internal mold of a young individual, probably of the same species, was found 3.2 miles north-northwest of Fentress (16149, U.S.N.M. no. 76351).

# Family CUCULLAEIDAE

#### Genus IDONEARCA Conrad

## Type species .- Cucullaea capax Conrad.

Conrad's genus is based on perfectly preserved shells from the Owl Creek formation on Owl Creek near Ripley, Tippah County, Mississippi, which he originally described under the name *Cucullaea capax.*<sup>121</sup> *C. tippana* Conrad from the same locality is merely a young stage of *C. capax*. Several authors have subsequently put this species in the synonomy of *Idonearca vulgaris* (Morton).<sup>122</sup>

Pilsbry<sup>123</sup> has recently called attention to the name *Cyphoxis* Rafinesque,<sup>124</sup> the description of which he concludes "applies in every respect to the casts of *Cucullaea* of the subgenus *Idonearca* Conrad, found abundantly in the Cretaceous marls of New Jersey." Rafinesque named four species which, however, were never defined, leaving the genus without species. Invoking Opinion No. 46 of the International Commission that a genus proposed without species contains all the species of the world that would come under the original description, and that the first species published in connection with the genus

<sup>&</sup>lt;sup>121</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 54, 1872.

<sup>&</sup>lt;sup>122</sup>Morton, S. C., Amer. Jour. Sci., 1st ser., vol. 17, p. 285, and vol. 18, pl. 3, fig. 21, 1830.

<sup>&</sup>lt;sup>123</sup>Pilsbry, H. A., The Nautilus, vol. 42, no. 4, pp. 113-114, 1929. See also Siewart, Kalph, Acad. Nat. Sci. Philadelphia Special Pub. No. 3, p. 75, 1930.

<sup>&</sup>lt;sup>124</sup>R.finesque, C. S., Prodrome de 70 nouveaux Genres, Etats-Unis d'Amérique: Jonr. de Phys., de Chimie, d'Hist. Nat., vol. 88, June, 1819.

# becomes the type, Pilsbry designated *Cucullaea vulgaris* Morton as the type of *Cyphoxis*.

The cotypes of Cucullaea vulgaris are 16 internal molds preserved in the collection of the Academy of Natural Sciences of Philadelphia. The original drawing is so poor that the figured specimen can not be identified among the cotypes. Since the external features are necessary in the identification of the species of this group the name C. vulgaris at the best can be reasonably applied only to the 16 types, which means the virtual abandonment of the name. It does not seem possible to demonstrate the specific identity of Cucullaea capax Conrad and C. vulgaris, and Conrad's species must therefore be recognized as valid.

Pilsbry's Doctor assumption that Rafinesque picked up the molds on which he based his genus Cyphoxis, in the marl pits of New Jersey, may be correct and he was perhaps legally justified in designating Cucullaea vulgaris as the type species of Cyphoxis. However, Rafinesque did not state where he obtained his material and there is reasonable doubt, and probably always will be, as to its having been obtained in New Jersey. The original description of Cyphoxis is brief and incomplete and, were it not for the mention of a groove on the posterior slope, might apply equally well to the internal mold of any one of many genera. A groove of this sort is not peculiar to the internal mold of Idonearca, but is present on the molds of other arcid genera, as for example, Trigonarca Conrad, which is recorded from the Upper Cretaceous of New Jersey and other Coastal Plain States. There is also a question as to whether the original Cyphoxis was an Idonearca at all. In my opinion the fact that Cucullaea vulgaris is based on imperfect material inadequate for specific description, and from an unknown locality (somewhere in the marl of New Jersey), makes it unsatisfactory and wholly inappropriate as the type species of a genus. Although the Commission's Opinion No. 46 may serve the ends of justice in particular cases, it appears that in other cases it may have the effect of putting a premium on careless methods of introducing new generic names.

On the basis of reasonable doubt as to the source and true nature of the material on which *Cyphoxis* was based, I prefer to continue the use of *Idonearca* Conrad.

# IDONEARCA POWERSI Stephenson, n.sp.

# Pl. 10, figs. 1, 2

Shell subquadrate in outline, large and strongly convex. Shell wall rather thick. The beaks rise prominently above the hinge, are slightly prosogyrate, approach within 6 mm. of each other in the holotype, and are situated 0.45 the length of the shell from the anterior extremity. The umbonal portion of the shell is broad, plump, and evenly rounded. A somewhat subdued rounded umbonal ridge extends to the lower posterior extremity. The anterodorsal slope rounds down steeply, becoming somewhat excavated, and bends up slightly again toward the hinge. The posterodorsal slope is broad, steep, and broadly excavated. The hinge is not uncovered. The cardinal area in the adult is marked by about four strongly impressed, chevron-shaped ligamental grooves, and the straight base of the area is about 55 mm. long in the holo-Anterior margin evenly rounded; type. ventral margin broadly and evenly rounded; posterior extremity low, and sharply rounded; posterodorsal margin inclined forward, slightly arched, meeting the hinge line at an angle of about 125 degrees. The surface is marked by fine to moderately coarse incremental lines, and in part by fine, closely spaced, radiating ridges, which are narrower than the interspaces; these ridges are faint on the anterior part of the shell, nearly wanting centrally, more strongly marked in a band attaining a width of 4 or 5 centimeters on the umbonal ridge, and becoming faint again on the posterodorsal slope; where best developed the ribs are closely but irregularly spaced, and are of irregular prominence: from the beak toward the margin weak radiating ridges appear between the stronger ones and grow somewhat stronger ventrally.

As is true of other species of this genus, the fine radiating ridges are somewhat stronger on the left than on the right valve. The tip of each beak exhibits a small, short, radiating sulcus which is faint on the right valve and stronger on the left. The posterodorsal slope of one of the right valves exhibits a narrow groove which extends in a broad curve from the beak to a point on the margin somewhat above the posterior extremity; this line is an outward reflection of a prominent radiating buttress on the interior of each valve, which passes out along the lower margin of the posterior adductor scar; this groove is as a rule either absent or only faintly reflected on left valves.

Dimensions of the slightly defective holotype: Length 93 + mm., height 84 mm., thickness 77.5 mm.

Morton,<sup>125</sup> in 1834, described *Cucullaea* antrosa from the "ferruginous sand" of New Jersey. No locality is given for the type specimen and it might have come from any one of the marine Upper Cretaceous formations of that State. An internal mold of a complete individual marked "type,"<sup>126</sup> in the Academy of Natural Sciences of Philadelphia, is probably the type specimen described by Morton, though his figure is poor and is only about 3/5 as large as the so-called type.

The Texas species undoubtedly belongs to the same subgroup or section as Idonearca antrosa (Morton), but it appears to attain a much larger size and has a much more pronounced angularity in the umbonal ridge. But even though the Texas and New Jersey specimens were of closely similar form, the fact that Morton's type is only a distorted internal mold from an unknown locality, would justify any author in restricting his name to the type specimen. Other forms that belong in the same group occur in the Ripley formation of the eastern Gulf region, and in the Peedee formation of the Carolinas, but these are more like the typical I. antrosa than are the Texas specimens.

Types.—Holotype, U.S.N.M. no. 76352; 2 unfigured paratypes, U.S.N.M. no. 76353. Named in honor of the late Dr. Sidney Powers.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); in the northwest corner of Franklin County (12931).

Outside distribution. --- Arkansas: A form of Idonearca which appears to be indentical with I. powersi, occurs in the Saratoga chalk which, in Clark County, Arkansas, underlies the Nacatoch sand.

# IDONEARCA KINGSENSIS Stephenson, n.sp.

# Pl. 10, figs. 3, 4

Shell subquadrate in outline, moderately large, strongly convex. Shell thick. Beaks prominent, prosogyrate, approaching within 5 or 6 mm. of each other, situated about 0.42 the length of the shell from the anterior extremity. The umbonal portion of the shell is of moderate width and rather plump. A moderately well defined, though rounded, umbonal ridge extends to the lower posterior extremity, and just in front of the ridge is a broad, faint, radiating depression extending to the ventral margin. Both the antero- and posterodorsal slopes are quite steep; the former is modified by a broad, shallow, radiating depression below the anterior end of the area; the latter is slightly excavated but is modified by a low, radial, The hinge is not uncovcentral swell. ered in the available material. The base of the cardinal area is 44 mm. long in the holotype; the cardinal area of adults is ornamented with 6 to 8 chevron-shaped grooves which exhibit the curious irregularities shown in the figures. Anterior margin slightly concave above, becoming evenly rounded below; ventral margin broadly rounded anteriorly, straightening out and becoming slightly concave posteriorly; posterior margin subangular below, becoming moderately convex and inclining forward at the midheight, and becoming slightly concave as it approaches the hinge line. The angle of the upper posterior margin with the hinge line is about 119 degrees. The surface is rather coarsely marked with irregularly spaced concentric ridges representing growth and resting stages. Both valves are ornamented with obscure irregular, fine, radiating lines,

<sup>&</sup>lt;sup>125</sup>Morton, S. G., Synops's of the organic remains of the Cretaceous group of the United States, p. 65, pl. 13, fig. 6, Philadelphia, 1834.

<sup>&</sup>lt;sup>139</sup>The right side of the mold is figured by Stephenson in North Carolina Geol. and Econ. Survey, vol. 5, "The Cretaceous formations of North Carolina," pl. 12, fig. 5, 1923.

which are just a little stronger on the left than on the right valve. The posterodorsal slope of the right valve exhibits the narrow, faint, radiating channel, arched in its trend, which is present on most species of the genus; back of this channel is a broad, shallow, radiating depression, and a corresponding though less pronounced depression is present on the left valve.

Dimensions of the holotype, a right valve: Length 64.5 mm., height 64.3 mm., convexity 30 mm.

This species is not very close to any of the described species of the Coastal Plain. It is not so large as *I. powersi*, is narrower in the umbonal region, and has a much coarser development of incremental lines.

A species from the Owl Creek formation of northern Mississippi, described by Conrad<sup>127</sup> under the two specific names, *Cucullaea capax* (valid species), and *C. tippana*, is somewhat like this Texas species, but is smaller and much more compressed in the umbonal region, and much more oblique and pointed toward the lower posterior extremity. *I. capax* is also present in Texas in the Corsicana marl. The Owl Creek species is sometimes referred to *C. vulgaris* Morton, which is based on an inadequate internal mold from New Jersey.

A species from the lower Ripley (Coon Creek tongue) of Tennessee, which Wade<sup>128</sup> incorrectly referred to *C. vulgaris*, is more like the Texas species, but is relatively longer, is not so plump in the anterior umbonal region, and rounds down less steeply toward the front. Imlay has renamed this species *Cucullaea wadei* (Bull. Geol. Soc. Amer., vol. 48, p. 1817, 1937), designating a shell figured by Wade as holotype.

*Types.*—Holotype, U.S.N.M. no. 76354; 4 unfigured paratypes, U.S.N.M. no. 20958; 3 unfigured paratypes, U.S.N.M. no. 76355.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); ?3 miles north of town of Sulphur Bluff (5322).

#### IDONEARCA CAPAX Conrad

Pl. 11, figs. 1-4; pl. 12, fig. 3

- 1858. Cucullaea capax Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 328, pl. 35, fig. 2.
- 1858. Cucullaea tippana Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 328, pl. 35, fig. 1.
- 1872. Idonearca capax Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 24. p. 54, pl. 2, fig. 2.
- 1876. Idonearca alabamensis Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 315, 1876.
- 1916. Cucullaea vulgaris Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 529, pl. 20, figs. 8, 9; pl. 21, figs. 1, 2. (The Mississippi shells only.)

poorly preserved lots of Several Cucullaeas from localities in the Corsicana marl appear to belong to Idonearca capax (Conrad) which was originally described the Owl Creek formation of from Mississippi. The specimens average smaller than those from Mississippi, but this may be due to local environmental conditions affecting growth: a few of the specimens, however, are large, one being larger than any in the Mississippi collections. The description here given is based on material from Owl Creek, near Ripley, Mississippi, the type locality of the species, one nearly perfect adult left valve of which is figured.

Shell thick, subquadrate in outline in the young, becoming obliquely elongated posteriorly in the adult, moderately large, strongly convex, markedly narrow in the umbonal region. Beaks prominent. prosogyrate, about 5 mm. apart in the adult, situated about 0.38 the length of the shell from the anterior extremity. The umbonal ridge is subangular and prominent, being more inflated than any other part of the shell. In front of the umbonal ridge a broad shallow depression extends radially to the lower posterior margin, but this is a variable feature and is absent occasional specimens. on The high median part of the shell rounds down steeply toward the front meeting the margin at a right angle. The posterodorsal slope is broad and steep, and meets the median surface at the umbonal ridge in a right or an obtuse angle.

<sup>&</sup>lt;sup>127</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 328, pl. 35, figs. 1, 2, 1858.

<sup>&</sup>lt;sup>125</sup>Wade, Bruce, U. S. Geol, Survey Prof, Paper 137, p. 43, pl. 9, figs. 3, 4, 1926.

The hinge is normal for the genus and the teeth are strongly developed, but individuals show considerable variation in detail, particularly as to the fineness of the dentition. In the figured left valve the central and anterior distal teeth are unusually fine. The sides of the teeth are ornamented with finely and irregularly developed transverse corrugations. The inner surface is somewhat roughened by fine, irregular, radiating corrugations in a band bordering the inner side of the simple pallial line, and rough irregular, radiating corrugations are present on the part of the inner surface which lies under the hinge and cardinal area. A strong radiating buttress extends from the umbonal region out along the lower margin of the posterior adductor scar, and forms a platform on the upper side of which the adductor muscle was attached. The adductor scars are relatively small and the anterior one is situated high in the shell. The cardinal area is broad. subtriangular, about 35 mm, long on the base of the figured left valve, and is ornamented with 7 or 8 somewhat irregularly spaced chevron-shaped grooves. The anterior margin meets the hinge line almost at a right angle, and rounds down broadly into the ventral margin which is nearly straight, but strongly inclined posteriorly in the adult; the posterior extremity is sharply rounded, and the posterior margin is slightly convex below, becoming nearly straight above, and meeting the hinge line at an angle of about 120 degrees. The outer surface is rather coarsely marked with irregularly spaced growth ridges, and is faintly marked with irregular, fine, radiating ribs which become noticeably stronger on, and for about a centimeter on either side of, the umbonal The radiating ribs are a little ridge. stronger on the surface of the young stage and become very obscure or are wanting toward the margins of the adults. crossing of the ribs and incremental lines produces a fine pitting particularly on the surface of the younger stages. The posterodorsal slope exhibits two broad, shallow radiating depressions, the upper one of which is the broader.

Dimensions of the figured topotype from Owl Creek, a left valve: Length 53 mm., height 53 mm., convexity 31 mm.

This species is distinguished by its compression in the direction of the length in the umbonal region, by its short hinge line, and by its strong obliquity and elongation in the direction of the umbonal ridge. The shell described by Conrad as *Cucullaea tippana* is a young stage of *Idonearca capax*, as shown by numerous young and old shells from the type locality. The latter name is selected because it appears first in the text, and because it pertains to an adult shell.

The form described by Wade<sup>129</sup> as *Cucullaea vulgaris* Morton, and later named *C. wadei* by Imlay, is a larger, more elongated, and less oblique species, than *I. capax*.

Several authors have referred Conrad's Idonearca capax to Morton's older species, Cucullaea vulgaris, which is based on an internal mold from the "marl formation" or "arenaceous deposits" of New Jersey. Morton<sup>130</sup> first figured an internal mold which is presumably one of 16 specimens bearing Morton's original label, in the collection of the Academy of Natural Sciences of Philadelphia, and later he figured the rear end view of a "perfect shell,"131 and a side view of an internal mold. The present whereabouts of the so-called perfect shell is not known. In the case of a species based on an internal mold from an unknown locality it seems a reasonable procedure to restrict the name to the type material alone. This seems particularly necessary in this case since the so-called "marl formation" or "arenaceous deposits" are now known to be in part Eocene, and indeed Weller<sup>132</sup> restricted the name C. vulgaris to specimens from the Hornerstown marl, the basal one of the Eocene formations. The specimens which Weller, in the same work (pl. 31,

<sup>&</sup>lt;sup>120</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 43, pl. 9, figs. 3, 4, 1826.

<sup>&</sup>lt;sup>130</sup>Morton, S. G., Amer. Jour. Sci., 1st ser., vol. 17, p. 285; vol. 18, pl. 3, fig. 21, 1830.

<sup>&</sup>lt;sup>23</sup>Morton, S. G., Synops's of the organic remains of the Cretaceous group of the United States, p. 64, pl. 3, fig. 8; pl. 13, fig. 5, 1834.

<sup>&</sup>lt;sup>132</sup>Weller, Stuart, New Jersey Gool, Survey, Paleontology, vol. 4, pp. 397-399, pl. 30, figs. 5, 6, 1907.

figs. 5-10; pl. 32, figs. 1, 2) referred to *Cucullaea tippana*, obviously do not belong to *Idonearca capax*.

Idonearca alabamensis Gabb (1876) from Prairie Bluff, Alabama, appears to be an *I. capax* Conrad about one-third grown. The type is in the Academy of Natural Sciences of Philadelphia.

Types.—The types of Cucullaea capax Conrad and C. tippana Conrad are in the collection of the Academy of Natural Sciences of Philadelphia. They are from the Owl Creek formation on Owl Creek, 2½ miles northeast of Ripley, Tippah County, Mississippi. Topotype, U.S.N.M. no. 76356. Plesiotype from Texas, U.S.N.M. no. 76357.

Distribution in Texas. - Navarro group, Corsicana marl: 3 7/10 miles southwest of Campbell (15547); <sup>1</sup>/<sub>2</sub> mile below Martindale (7621; 15526, 1 specimen figured); 3 miles northwest of Lockhart (Tex. Bu. 1174); 1 3/10 miles north of McQueeney (7637, 15524); 2<sup>1</sup>/<sub>2</sub> miles west of McQueeney (15523); 1 3/10 miles southeast of Marion (13389); near Castroville (7665); well on G. A. Harper Survey, Medina County, at depth of 1015 feet (13844).

Outside distribution.---Mississippi: Owl Creek formation in northern Mississippi and Prairie Bluff chalk in cast-central Mississippi.

Alabama: Prairie Bluff chalk.

# IDONEARCA DEATSVILLENSIS Stephenson, n.sp.

# Pl. 11, figs. 5-7

Shell large, thick, subquadrate in outline in the young, becoming noticeably elongated in the direction of the umbonal ridge in the adult, strongly convex, moderately broad in the umbonal region. Beaks moderately prominent, prosogyrate, 10 or 12 mm. apart in large shells, situated 0.4 the length of the shell from the anterior extremity. The umbonal ridge is well developed where the median surface meets the steep posterodorsal surface roughly at an angle of 125 degrees. Most specimens exhibit a broad, very shallow radial depression in front of the umbonal ridge; this extends to the posteroventral margin and is of variable strength in different individuals. The shell is plump at the midheight in front of the midlength and rounds down rather steeply to the anterior margin. The hinge is normal for the genus and the dentition is vigorous. The internal features are not exposed. The cardinal area is subtriangular with a relatively long straight base (53 mm. in the holotype) and with slightly arched sides; it bears 6 or 7 chevron-shaped grooves in large adults. The anterior margin meets the hinge line at an angle of about 106 degrees in the holotype, but this angle varies in different individuals from 105 to 120 degrees. The anterior margin is only slightly convex down to the midheight, below which it rounds regularly into the nearly straight, to slightly inclined ventral margin; the lower posterior extremity of the shell is subangular, above which the posterior margin is first broadly convex, becoming broadly concave above, and meeting the hinge line at angles varying from 100 to 115 degrees. The surface is somewhat corroded in most specimens, but is marked by fine growth lines, by undulations indicating resting stages, and by very fine, faint, irregularly spaced radiating ridges which, by intersection with the growth ridges, produce a finely punctate surface.

Dimensions of the holotype, a large right valve: Length 74 mm., height 72 mm., convexity 35 mm.

This species appears to be closely related to *Idonearca capax* (Conrad) but is less oblique and therefore more quadrate, less strongly compressed in the direction of the length, has a longer hinge line, and is not so steep on the antero- and posterodorsal slopes. It differs from *I. kingsensis* chiefly in the greater length of its hinge line and area, and in the greater angularity of its umbonal ridge.

Types.- Holotype, U.S.N.M. no. 76358; 7 selected paratypes, U.S.N.M. no. 76359.

Distribution in Texas.—Navarro group, Corsicana marl: ? 1/2 mile below Martindale (15526); ? 1 3/10 miles north of McQueeney (15524).

Navarro group, Kemp clay: Near Deatsville (764, loc. of 7 unfigured paratypes); 2¼ miles north by west of Deatsville (16146, loc. of holotype); Buckman Survey, 4 miles south of Manor (Texas Bu. 2399); 2 2/5 miles southeast of Manor (18196); 2 miles east of Manor (Texas Bu. 2398);  $3\frac{1}{4}$  miles east by north of Manor (13861); 5 miles west by north of Elgin (14162);  $3\frac{1}{2}$  miles east of Manor (15534);  $1\frac{1}{2}$  miles northwest of Texas Hill (15533).

*Range.*—Questionably from the Corsicana marl, upward into the Kemp clay.

## IDONEARCA MURRAYI Stephenson, n.sp.

# Pl. 12, figs. 1, 2

Shell large, thick, subquadrate in outline, becoming elongated in the direction of the umbonal ridge in the adult, strongly convex, rather narrow in the umbonal region. Beaks moderately prominent, prosogyrate, about 12 mm. apart in the adult, situated at about the midlength of the area. Umbonal ridge prominent, sub-angular; from this ridge the surface rounds rather gradually down toward the ventral and anterior margins, and more steeply to the anterodorsal margin; senility is indicated by a sharp bending in of the surface and by coarse growth lines, near the ventral margin. The posterodorsal slope is high and steep. A broad, very shallow excavation extends radially from below the beak to the anterior margin just below the end of the area. The hinge and interior are not uncovered. The subtriangular area has a relatively short, straight base, with slightly arched margins above, and is marked with 6 or 7 chevronshaped ligamental grooves. The anterior margin is nearly straight above, meeting the hinge line at an angle of about 125 degrees, and becomes rather sharply rounded below; the ventral margin is nearly straight centrally, rounding up sharply at each end; the posterior extremity is very sharply rounded below: the posterodorsal margin is rounded below, long and nearly straight above, and meets the hinge line at an angle of about 120 degrees. The surface is marked by fairly vigorous growth lines, and by fine, obscure radial lines which are most distinct on and near the umbonal ridge.

Dimensions of the holotype: Length 62 mm., height 57 mm., thickness about 54 mm.

Compared with *Idonearca capax*, its nearest allied species, this species is more elongated, and is not so conspicuously compressed in the direction of the length in the umbonal region; the umbonal ridge is less angular, and the shell lacks the broad radiating sulcus just in front of this ridge; the radial sculpture is much less distinct.

Type.--Holotype, U.S.N.M. no. 76360. Named for the Hon. Pendleton Murray, Governor of Texas, 1863-1865.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

## IDONEARCA sp.

A small internal mold of a right valve, which appears to be that of *Idonearca*, was found in the Nacatoch sand, 3 miles northeast of Corsicana (9560). The mold is subrhomboidal in outline, somewhat more elongated than most species of *Idonearca*, and moderately convex. It may be a *Nemodon* though it seems rather short for that genus. Length 13.5 mm., height 3.5 mm., convexity 2.5? mm. U.S.N.M. no. 76361.

# IDONEARCA sp.

A small internal mold of an *Idonearca* found in the base of the Corsicana marl near the old Freeze well of the Morgan Oil Company, 2 3/5 miles north by east of Malta, Bowie County, Texas (12934), is too poorly preserved for specific identification (U.S.N.M. no 76362). A very similar internal mold was obtained from the base of the same formation in a road ditch 1 4/5 miles north, 20 degrees west of Tona siding, in Hunt County (15515). U.S.N.M. no. 76363.

# IDONEARCA? sp.

An internal mold, questionably referred to *Idonearca*, was obtained in the Corsicana marl in a westward-facing bluff of Guadalupe River valley, 1 3/10 miles north of McQueeney, Guadalupe County (15524). This mold is too high and too compressed and its umbonal ridge is too broadly rounded for *I. capax* Conrad, which occurs abundantly at the same locality. U.S.N.M. no. 76364.

In the same formation in a pit of the Corsicana Brick Company, 2 miles south of Corsicana, Navarro County (16167), a tiny internal mold of a taxodont shell was found which is questionably referred to *Idonearca*. It is subcircular, depressed convex, and has rather strong concentric growth lines impressed on the mold; the teeth, though short, appear to be parallel to the hinge line; there is no evidence of radiating sculpture. U.S.N.M. no. 76365.

Two poorly preserved crushed right valves of *Idonearca* were found in the Corsicana marl in a core sample at a depth of 1045 feet in Redus well No. 1, G. A. Harper 92-acre Survey, Henderson-Holden gas field, Medina County (13844). U.S. N.M. no. 76366.

#### Family LIMOPSIDAE

# Genus LIMOPSIS Sasso

# LIMOPSIS MEEKI Wade

## Pl. 10, fig. 8

1926. Limopsis meeki Wade, U.S.Geol. Survey Prof. Paper 137, p. 45, pl. 10, figs. 4, 4a, 5.

Shell small, depressed convex, broadly subovate to subcircular in outline, fullest in outline in the posteroventral direction, flattening and broadening a little toward the margin on the posterodorsal slope. Greatest inflation above the midheight at the midlength. Dorsal margin nearly straight, about 4 to 5 millimeters long in adults, rounding down at each end; anterior and anteroventral margins broadly rounded; posteroventral margin a little more strongly rounded; posterior margin broadly rounded. Hinge narrow, not clearly uncovered; apparently with 6 or more direct to strongly oblique teeth on each side of the small triangular resilifer. Other internal features not uncovered. Surface ornamented with regularly spaced concentric lines of medium sharpness, numbering 4 to the millimeter; the interspaces are densely covered with exceedingly fine concentric, microscopic lines. Only a very faint trace of radiating sculpture can be detected.

Dimensions of the figured specimen, a left valve: Length 5.7 mm., height 6 mm., convexity about 2.5 mm.

The types from Coon Creek, Tennessee, are nearly perfect shells and they exhibit faint radiating lines most clearly seen on the posterodorsal slope; the practical absence of such lines on the Texas shells is probably due to their imperfect preservation. *Types.*—Holotype and 1 paratype, U.S. N.M. no. 32726. One plesiotype and 1 unfigured example from Texas, U.S.N.M. no. 76367.

Distribution in Texas.—Navarro group, Nacatoch sand:  $2\frac{1}{2}$  miles west by south of Corsicana (17368); 5 miles northeast of McClanahan (17371, 1 specimen figured).

*Outside distribution.*—Tennessee: Coon Creek tongue of Ripley formation.

Range.—Lower part of Exogyra costata zone in the Gulf region.

# Superfamily PTERIACEA

#### Family PEDALIONIDAE

#### Genus GERVILLIOPSIS Whitfield

- 1885. Gerrilliopsis Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 73 (Geol. Survey New Jersey, Palcontology, vol. 1, p. 73, 1886).
- 1887. Dalliconcha White, Acad. Nat. Sci. Philadelphia Proc., vol. 39, p. 34, pl. 2, figs. 4, 5. Type: Dalliconcha invaginata White.

Type species .- Gervillia ensiformis Conrad.

Whitfield, although he saw only New Jersey material, cited *Gervillia ensiformis* Conrad from the Ripley formation on Owl Creek, 2½ miles northeast of Ripley, Tippah County, Mississippi, as the type of the genus. Conrad's species is, however, well figured, so that Whitfield must have been familiar with its essential generic characters.

White's type species, *Dalliconcha invaginata*, came from the *Gervilliopsis* bed (Denton subgroup) of the Denison formation, upper part of the Comanche series, north of Fort Worth, Texas.

## GERVILLIOPSIS ENSIFORMIS EXTENSA Stephenson, n.var.

#### Pl. 21, fig. 10

Shell moderately thick, very long, slightly convex, becoming nearly flat posteriorly, composed of layers which scale off readily. Beaks terminal, nearly flat. An upward protruding wing or keel extends from the beak backward for about 18 mm., rising at the posterior extremity about 3 mm. higher than the dorsal margin behind it; on the interior of this wing is the opisthodetic cardinal area which is not exposed in either of the two available specimens. The hinge plate and other internal features are not exposed; a break near the rear end of the holotype shows that the shell is considerably thickened in a band 2 to 3 mm. wide, paralleling the dorsal margin. The dorsal margin is long and broadly concave, but the downward curvature appears to be slightly exaggerated by mechanical distortion; the anterior end is bluntly terminated by a truncation about 8 mm. long in the holotype; the ventral margin is very broadly convex: the shell near the posterior extremity is only about 6 mm. high and is terminated by a bluntly rounded margin. The surface is smooth with the exception of very fine growth lines and gentle undulations marking successive growth stages.

Dimensions of the holotype, a right valve: Length 80 mm., height 19.5 mm., thickness 5.4 mm.

This shell is very much like the typical *Gervilliopsis ensiformis* (Conrad) from the Ripley formation, Tippah County, Mississippi, but appears to be proportionately longer, more slender and thinner-shelled.

*Types.*—Holotype, a right valve, U.S.N. M. no 20990; 1 paratype, a smaller left valve, U.S.N.M. no. 76368.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.): 5 miles northeast of McClanahan (17371).

## Genus GERVILLIA Defrance

#### GERVILLIA BRYANI Stephenson, n.sp.

# Pl. 10, fig. 10

Shell strongly oblique, greatly elongated, inequivalve, left valve moderately convex, right valve nearly flat and apparently very much shorter than the left valve. Beaks small, nonprominent, slightly incurved, situated about 2.5 mm. back of the anterior extremity. Anterior wing short, small, curved sharply outward in the left valve to form a small byssal notch. Posterior wing long, rising high above the body. In the holotype the posterior wing is broadly excavated and along its lower edge rounds broadly up into the main part of the shell. Below the wing on the main shell a broad, shallow depression extends from the beak to the posterior extremity, broadening distally. The latter feature is variable in different individuals and is more pronounced on the holotype than on the paratype. Hinge and internal features not exposed. The anteroventral margin is long and very broadly convex; the posterior margin is subtruncated nearly vertically, subangular below, rounding more broadly into the long, broadly concave posterodorsal margin above. The surface is smooth except for fine growth lines, and numerous, but somewhat irregular, gentle growth undulations on the back of the shell parallel to the posterior subtruncation, and similar gentle undulations on the posterior wing.

Dimensions of the holotype, a left valve: Length 28 mm., height about 17 mm., convexity about 4.5 mm. Dimensions of the paratype: Length of left valve 30 mm., height 19 mm., thickness 5 mm.; length of right valve 24 mm.

This species is closely related to *Ger*villia wellsi, from which it differs in its more slender form and the greater convexity of the left valve. A specimen from near Chatfield, Navarro County, is broader and apparently not so elongated as the types, and is questionably referred to this species.

Types.—Holotype, U.S.N.M. no. 76370; 1 unfigured paratype, U.S.N.M. no. 76369. Named in honor of Mr. Frank Bryan, geologist, of Dallas, Texas.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, loc. of holotype); field 3/5 mile west of Kaufman (14103, loc. of paratype); road 3/5 mile west of Kaufman (7545); ?vicinity of Chatfield (762).

# GERVILLIA WELLSI Stephenson, n.sp.

## Pl. 10, fig. 9

Shell oblique, elongated, left valve moderately convex. flattened toward the beak. Beak small, nonprominent, situated about 3 mm. back of the anterior extremity. Anterior wing small, short, curved slightly in the left valve to form a very narrow byssal notch. Posterior wing long (14 mm.), flat, rising to a prominent keel posteriorly, separated from the body of the shell below by a broad shallow radiating sulcus. Below this sulcus on the main body a broad, flattish to slightly concave area extends radially from the beak to the posterior extremity. The hinge is not well exposed on any specimen, but on one 4 or 5 of the characteristic ligamental pits of the cardinal area appear along the margin. The hinge is long and straight. The other internal features are not revealed. The anteroventral margin extends from the anterior end of the hinge downward and backward in a long, broad, slightly bulging curve; the posterior extremity is subtruncated nearly vertically, sharply rounded below, rounding more broadly above into the posterodorsal margin which is first nearly straight, but inclined, turning up more steeply at the posterior end of the rear wing. The surface is smooth with the exception of fine growth lines and some gentle growth undulations.

Dimensions of the holotype, a left valve: Length 31 mm., height 21 mm., convexity about 3 mm.

The only nearly related species is *Ger*villia bryani which is more slender, not so high, and somewhat more inflated. Only left valves are present in the collection, which includes 9 imperfectly preserved specimens, with some thin shell material adhering to the internal molds.

*Types.*—Holotype, U.S.N.M. no. 76371; 8 unfigured paratypes. 1 very small, U.S. N.M. no. 76372. Named in honor of Dr. John W. Wells.

Distribution in Texas.---Navarro group, Kemp clay: Near McQueeney (7632).

# Genus INOCERAMUS J. Sowerby

The authorship of the name *Inoceramus* was discussed by me in 1923.133 Additional data on the history of the name were given by Cox in 1930.134 He contends that the name Inoceramus cuvieri J. Sowerby was first published validly in a work by William Smith in 1816,135 and that the specimen (Linncan Soc. Cat. no. 1444) to which it was applied, though reported from the Lower Chalk, actually came from the Upper Chalk at Heytesbury, Wilts., and that it is specifically identical with Inoceramus involutus J. de Sowerby (1828), which is therefore invalid. The name *Inoceramus cuvieri* appears in Smith's paper merely as a part of the explanation of the plate illustrating

Lower Chalk fossils; there is no text description of the species, and J. Sowerby's name does not appear in connection with the published name; there is nothing whatever to indicate that Sowerby had even seen the specimen (fig. 1) illustrated by The question may be fairly Smith. raised, therefore, whether Smith's publication constitutes a valid introduction of the name as of J. Sowerby. It would seem that if this use of I. cuvieri is to be accepted as valid the specific name must be attributed to Smith and not to Sowerby. The question of its validity hinges on whether or not the figure given by Smith is accepted as an adequate designation. If this designation be rejected as inadequate, then the first acceptable designation of the species would be that of Sowerby,136 published in 1822, which is based on a different specimen.

Some two dozen specific names have been used for the representatives of this genus in the Atlantic and Gulf Coastal Plain, but most of them can not be accepted without more critical study than has yet been given to them. Because of poor preservation, mechanical deformation, and individual variation in the members of the group, their classification is difficult, and most of the attempts to separate them into species have been unsatisfactory.

One of the commonest names applied to members of the group is *Inoceramus barabini* Morton.<sup>137</sup> The two types of this species, which may represent separate species, are recorded as having come from the "older Cretaceous strata of Greene County, Alabama": this may mean either the Tombigbee sand member of the Eutaw formation, or the lower part of the Selma chalk. The species was originally inadequately described and poorly figured, and its locality and stratigraphic position are not accurately known. Meek<sup>138</sup> refigured the type specimens, and his figures are doubtless more accurate than Morton's.

<sup>&</sup>lt;sup>133</sup>Stephenson, L. W., North Carolina Geol, and Econ. Survey, vol. 5, p. 127, 1923.

<sup>&</sup>lt;sup>134</sup>Cox, L. R., Ann, and Mag. Nat. Hist., ser, 10, vol. 6, pp. 291-292, 1930.

<sup>&</sup>lt;sup>185</sup>Smith, William, Strata identified by organized fossils, London, p. 10, pl. illustrating fossils from the Lower Chalk, fig. 1, 1816.

<sup>&</sup>lt;sup>310</sup>Sowerby, James, Linnaean Soc. London Trans., vol. 13. p. 455, 1822.

<sup>&</sup>lt;sup>137</sup>Morton, S. G., Synops's of the Organic remains of the Cretaceous group of the United States, p. 62, pl. 13, fig. 11; pl. 17, fig. 3, 1834.

<sup>&</sup>lt;sup>138</sup>Meek, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 49, figs. 1-4, 1876.
Unfortunately the types have disappeared and presumably are lost, but neither specimen appears to have been sufficiently complete to serve as the basis for a species. Inoceramus proximus Toumey139 is an other name that is frequently applied to specimens from the Atlantic and Gulf Coastal Plain and the Western Interior. Tuomey's type material of this and two other species is recorded as having come from Columbus, Mississippi. The species was inadequately described, was not figured, and the type material is lost. Meek<sup>140</sup> attempted to give the name good standing, but he did not see Tuomey's types, and based his identification of western material on specimens from Eufaula, Alabama, which he believed to be typical. His conclusion can scarcely be regarded as satisfactory, since the horizon exposed at Eufaula is stratigraphically much higher that than at Columbus. Inasmuch as no reviewer has seen Tuomey's types, and the source of his material is not well enough known to permit the collection of new material confidently therefrom, it seems useless to try to perpetuate a name based on material so inadequately described.

Part of the material described on following pages has been questionably referred to *Inoceramus vanuxemi* Meek and Hayden, and the rest, which probably represents at least 5 species, is described without specific names.

This group of shells in our American Cretaceous is in great need of a thorough monographic study.

I have not been able to devote the time necessary to a critical consideration of the classification of the Inocerami proposed by Heinz in 1932,<sup>141</sup> but the splitting of so compact and simple a group of organisms as the Inocerami into 2 families, 24 subfamilies, 63 genera, and 29 subgenera, scems on the face of it an incredible procedure, and one calculated to add to the already serious difficulties attendant upon the classification of the

group. The poor state of preservation of many of the fossils would seem to preclude the possibility of accurately placing them in the classification. A subdivision of the group into several of its more striking variations could be made to advantage, and some attempt at this has already been made, as for example, the subgenus Actinoceramus of Meek and the subgenus Volviceranus of Stoliczka. But in the extreme to which Heinz has gone systematics in paleontology would seem to have arrived at a stage of reductio ad absurdum. A further criticism of Heinz's classification relates to the total inadequacy of the designations of the new species on which many of his subgroups are based. Not only are his text descriptions inadequate, but the new species are not illustrated, leaving the reader at a total disadvantage in his attempt to judge the validity of the subgroups. In fact in the absence of these designations many of the proposed names must be treated as nomina nuda.

## **INOCERAMUS VANUXEMI Meek and Hayden?**

### Pl. 13, figs. 1-4

- 1861. Inoceramus vanuxemi Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc. (1860), p. 180.
- 1876. Inoceramus ranuxemi Meek and Hayden. Meek, Rept. U.S.Geol. Survey Terr., vol. 9, p. 57, pl. 14, figs. 2, a, b.
  1880. Inoceramus vanuxemi Meek and Hayden.
- 1880. Inoceramus vanuxemi Meck and Hayden. Whitfield, Rept. Geol. Black Hills of Dakota, p. 396, pl. 7, figs. 8, 9; pl. 8, figs. 4, 5.
- 1885. Inoceranus vanuxemi Meek and Hayden. Whiteaves, Contr. Canadian Paleontology, vol. 1, p. 175.
- 1903. Inoceranus vanuxemi Meck and Hayden. Johnson, School of Mines Quart., vol. 24, no. 2, p. 189, pl. 3, fig. 19. (Also, Contributions, Geol. Dept., Columbia University, vol. 10, no. 90, p. 117, pl. 3, fig. 19.)
- 1917. Inoceranus vanuxemi Meek and Hayden. Dowling, Canada Dept. Mines, Geol. Survey, Mem. 93, p. 27, pl. 22, fig. 2.

The Texas shells referred to this species are longer than high, not strongly convex, flattening posteriorly. Beaks prosogyrate, only moderately prominent, rising but slightly above the dorsal margin, incurved, situated well forward. The shells exhibit considerable variation in outline and form, but in general they are proportionately rather high and rather compressed

<sup>&</sup>lt;sup>320</sup>Tuomey, M., Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 171, 1854.

<sup>140</sup> Meck, F. B., op. cit., p. 53.

<sup>&</sup>lt;sup>111</sup>Heinz, Rudolf, Aus der neuen Systematik der Inoceramen: Beitrage zur Kenntnis der Inoceramen XIV: Mitteilungen aus dem Mineralogisch-Geologischen Staatsinstitut in Hamburg, Heft 13, pp. 1-26, 1932.

laterally. Some specimens are elongated obliquely backward and downward in the median and later stages of growth and consequently appear much higher posteriorly than anteriorly. In general the anterior margin of the shell is regularly rounded, but there is a tendency in some shells to bulge rather strongly forward, a little above the midheight and many individuals exhibit a noticeable subtruncation on the anterodorsal margin; in large shells the lower part of the anterior margin may become elongated and subtruncated: the ventral margin ranges from broadly to rather sharply rounded; the posterior margin ranges from regularly rounded to subtruncated. Surface marked by narrow, sharp concentric ridges spaced 3 to 7 mm. apart centrally, smoothing out and becoming obscure toward the margin in the larger specimens. On specimens with the shell preserved it is seen that the concentric ridges are not parallel to the growth lines which cross the ridges obliquely, and the ridges do not therefore indicate successive stages of more and less vigorous growth. Some of the specimens referred to this species (pl. 13, fig. 3) exhibit fine, radiating lines on the central and anterior parts of the shell, but this feature, though needing explanation, does not seem to be a specific character in the genus Inoceramus.

The Texas specimens referred to this species are in general poorly preserved, but exhibit considerable variation in form, outline and sculpture; they all agree in the nonprominence of the beak, the relative flatness of the umbonal region and of the shell in general, and in the numerous sharp-crested, and fairly uniformly spaced, concentric ribs. The shells appear to be enough like the type of *Inoceranus* vanuxemi Meek and Hayden, from the Pierre shale of the Western Interior, to justify referring them tentatively to that species.

The specimen described by Bruce Wade under the name *I. proximus* Tuomey,<sup>142</sup> may belong to this species, and the species is probably represented in the undescribed material of this genus from the Nacatoch sand of Arkansas and from the Ripley formation of Mississippi.

*Type.* -Holotype, U.S.N.M. no. 483, from White River above the Bad Lands, in the upper part of formation No. 4 (=- upper part of Pierre shale). Four plesiotypes from Texas, U.S.N.M. nos. 76373, 76374 (2 specimens), 76375.

Distribution in Texas.—Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (4064, 7509);  $2\frac{1}{2}$  miles northeast of Royce City (16157);  $1\frac{1}{2}$  to 2 miles northwest of Corbet (14119, 1 specimen figured);  $2\frac{1}{2}$  miles south of Ben Hur (15543).

Navarro group, Nacatoch sand: ?5 miles northeast of McClanahan (17371); vicinity of Corsicana (763); north edge of Corsicana (518, 2 figured specimens); 21/2 miles north of Corsicana (14114); 3 miles northeast of Corsicana (9545); 3 miles north of Corsicana (9549); Watkins' place, 4 miles north of Corsicana (9558); vicinity of Chatfield (762, 1 figured specimen); field south of Chatfield (7569): <sup>1</sup>/<sub>2</sub> mile east of Chatfield (7570); ?from 34 mile east of Chatfield (7571); 3/5 to 4/5 mile northeast of Chatfield (14117); vicinity of Kaufman (761); road 2 miles southwest of Kaufman (7546); 3 miles north of town of Sulphur Bluff (5322): ?41/2 miles east by north of Rosali (14061).

*Outside distribution.*- Western Interior: Pierre shale.

Range.- Neylandville marl and Nacatoch sand of Navarro group.

# INOCERAMUS sp.a

# Pl. 12, fig. 4

This form is represented by poorly preserved internal molds. It is longer than high, rather strongly convex, with a prominent, incurved, strongly prosogyrate beak, and with fairly pronounced, rather numerous, irregular concentric ridges which bend strongly forward as they approach the hinge line. Specimens are recorded from the Neylandville marl at the following localities: 1/2 mile north of Cooper (4064: 14062, 1 figured specimen,

<sup>&</sup>lt;sup>112</sup>Wade, Brace, U. S. Geol, Survey Prof. Paper 137, p. 49, pl. 12, fig. 2, 1926.

U.S.N.M. no. 76376);  $2\frac{1}{2}$  miles northeast of Royce City (16157);  $2\frac{1}{2}$  miles north of Corbet (16170); and  $2\frac{1}{2}$  miles south of Ben Hur (15543).

### INOCERAMUS sp.b

# Pl. 12, fig. 5

A few poorly preserved internal molds from the Nacatoch sand pertain to a somewhat clongated, moderately convex species with a nonprominent beak and with coarse concentric ridges separated by wide, deep interspaces. They have been recorded from the following localities: Vicinity of Corsicana (763); 2 miles north of Corsicana (9555, figured, U.S.N.M. no. 76377); and vicinity of Kaufman (761).

#### INOCERAMUS sp.c

### Pl. 12, fig. 6

A form of the genus represented by small individuals is elongated, moderately convex, has an incurved, nonprominent, only slightly prosogyrate beak, and is ornamented with numerous, rather strong concentric ridges, separated by much wider interspaces. Compared with *I. vanuxemi* Meek and Hayden, this form is relatively longer and more strongly convex. It has been collected from the following localities: From the Nacatoch sand in the vicinity of Corsicana (763), at north edge of Corsicana (518), and west of K a u f m a n (14098, figured, U.S.N.M. no. 76378); ?from the Corsicana marl near Castroville (7796).

### INOCERAMUS sp.d

## Pl. 14, figs. 1, 2

Among the collections from the Navarro group are about 12 specimens of this genus which, though variable, agree in possessing a rather strong elongation parallel to the hinge, strong convexity, a moderately prominent, prosogyrate beak situated near the anterior extremity, and a relatively smooth surface, characterized, however, by concentric undulations varying greatly in strength and spacing. They have been collected as follows: From the Neylandville marl:  $2\frac{1}{2}$  miles south of Ben Hur (15543); from the Nacatoch sand north edge of Corsicana (518, figured, U.S.N.M. no. 76379), 2½ miles north of Corsicana (14114), Watkins' place 4 miles north of Corsicana (9558), vicinity of Chatfield (762, figured, U.S.N.M. no. 76380), and vicinity of Kaufman (761).

### INOCERAMUS sp.e

## Pl. 13, fig. 5; pl. 14, fig. 3

Specimens from several localities in the Nacatoch sand possess characters that seem to separate them from the other recognized forms. They are more elongated than any of the others, are relatively flattish, have a small nonprominent beak situated well forward, and exhibit relatively fine concentric sculpture characterized by irregularity of spacing and strength, with a tendency to smoothness on parts of most specimens. The large figured specimen has the following dimensions: Length 112+ mm., height 87 mm., convexity about 22 mm. The localities are as follows: 5 miles south-southwest of Corsicana (7573); 3 3/10 miles westsouthwest of Corsicana (16163);  $4\frac{1}{2}$ miles east by north of Rosali (14061, U.S.N.M. no. 76381, 2 specimens figured).

### INOCERAMUS sp.f

### Pl. 14, fig. 4

Shells of *Inoceramus* resembling the one figured have been found in the Nacatoch sand at three localities. They are characterized by a moderately prominent, rounded umbonal ridge, and a tendency to elongation in the posteroventral direction, thus producing a high, squarish, and flattish posterior; the concentric ornamentation is relatively fine and not very prominent. The localities are: Vicinity of Corsicana (763); 3 1/5 miles north of Corsicana (16168, 1 figured specimen, U.S.N.M. no. 76383); vicinity of Chatfield (762).

## Family PTERIIDAE

### Genus PTERIA Scopoli

Shells having the outward appearance of *Pteria* are fairly common in the Upper Cretaceous of the Coastal Plain. These shells have been generally referred to *Pteria* (or *Avicula*), but some of them are now known to possess a multivincular ligament in the younger stages, whereas the true *Pteria*, which is based on a Recent species, has an alivincular ligament. This fact throws doubt on the correctness of the assignment. The ligamental area is not clearly exposed on any of the specimens from the Navarro group.

## PTERIA? LINGUAEFORMIS (Evans and Shumard)?

#### Pl. 12, figs. 7, 8

- 1854. Avicula linguaeformis Evans and Shumard, Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 163.
- 1859. Avicula linguaeformis Evans and Shumard. Meek, Northwest Terr., Rept. Prog. Assiniboine and Saskatchewan exploring expedition (H.Y.Hind), p. 183, pl. 1, fig. 6.
- 1864. Pteria linguiformis (Evans and Shumard). Meek, Smithsonian Misc. Coll. No. 177, p. 9.
- 1876. Pteria linguiformis (Evans and Shumard). Meek. Rept. U.S.Geol. Survey Terr., vol. 9, p. 32, pl. 16, figs. 1, a,b,c,d.
- ?1896. Pteria linguiformis (Evans and Shumard). Whiteaves, Trans. Roy. Soc. Canada, ser. 2, vol. 1, sect. 4, p. 106.
- 1899. Aricula linguaeformis Evans and Shumard. Stanton, U.S.Geol. Survey Mon., vol. 32, pt. 2, p. 637.
- ?1908. Pteria linguiformis (Evans and Shumard). Shimer and Blodgett, Am. Jour. Sci., 4th ser., vol. 25, p. 62.
- 1917. Pteria linguiformis (Evans and Shumard). Dowling, Canada Dept. Mines, Geol. Survey, Mem. 93, pp. 27, 45, pl. 21, figs. 5, 5b.
- 1920. Pteria linguaeformis (Evans and Shumard). Stanton, U.S.Geol. Survey Prof. Paper 128, p. 24, pl. 3, fig. 1.

The synonymy given above is tentative because the classification of this group is in about the same state of confusion and uncertainty as that of Inoceramus. As shown by the individual variation manifested among great numbers of the shells occurring together in the same matrix at certain places in the upper part of the Pierre shale of the Western Interior, the group is an exceedingly variable one, and is in need of critical monographic treatment. This individual variation and the simplicity of the shell render the group separable into species with difficulty; in our present state of knowledge the group is of little value in close correlation.

The description here given is based on the Texas material. Shell subtrigonal, strongly oblique, moderately convex, inequivalve, the left valve more strongly convex than the right. Beaks small, projecting slightly above the hinge line, situated about 0.3 the length of the shell from the anterior extremity. The hinge is straight and 13 + mm. long on the figured right valve (pl. 12, fig. 7); the hinge features are not exposed. Faint radial ribbing may be seen on some of the internal molds. On the right valve the anterior wing is somewhat convex and is separated from the main part of the shell by a sulcus which extends from just front of the beak downward and in slightly forward to the anterior margin where it produces a shallow notch. From the high central part of the shell the surface slopes rather gently backwards flattening out toward the posterior wing and the posterior margin. The anterior margin is nearly straight except for the sulcal notch, and slopes strongly downward and backward rounding into the ventral margin; the posterior extremity is rather sharply rounded; the posterior margin is convex and, in well preserved specimens, rounds sharply backward at the end of the pronounced posterior wing. The surface is smooth except for incremental lines; one specimen on which the shell is partly preserved shows fine concentric threads at the edges of growth laminae, spaced about 0.5 mm. apart.

Dimensions of the right valve shown in pl. 12, fig. 7: Length 17 + mm., height 11.6 mm., convexity 3 mm. Dimensions of the small left valve shown in pl. 12, fig. 8: Length 9.4 mm., height 7.5 mm., convexity 1.5 mm.

This species is similar to *Pteria petrosa* (Conrad), the type of which, now lost, came from Upper Cretaceous beds on the Chesapeake & Delaware Canal, Delaware, but the Delaware species, as figured, appears to be more inflated, and more oblique downward, than the Texas species. The Texas species is a little more inflated, and has not so long and flat an anterior wing as the specimen from the Ripley formation (Coon Creek tongue), Coon

Creek, Tennessee, figured by Wade<sup>143</sup> under the name P. petrosa (Conrad); Wade's P. percompressa from the same locality is more inflated, more elongated, and has a longer, flatter anterior wing, which is more sharply separated from the main part of the shell.

Pteria linguaeformis (Evans and Shumard), as it has been identified from the Pierre and Fox Hills groups, is variable in form, and may subsequently be separated into species and varieties.

Type .--- The species was originally described from the Pierre formation on Sage Creek, South Dakota, but the whereabouts of the type material is not known, and it is probably lost. Two plesiotypes from Texas, U.S.N.M. no. 20966.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Kaufman (761, figured); road 3/5 mile west of Kaufman (7545, 14098); road 2 miles southwest of Kaufman (7546); and vicinity of Chatfield (762).

Outside distribution .--- Western Interior: Pierre shale.

### Unidentified specimens of PTERIA?

In the collection from the low exposure of the Kemp clay on Colorado River at Webberville, Navarro County (7601), is an incompletely preserved right valve of rather large thick - shelled Pteria?, a which is only slightly convex and has a small, low beak which does not rise above the hinge line. The rather large, flattish anterior wing, which is partly broken away, is separated from the main shell by a flat, shallow, but distinct channel; the posterior wing is nearly all broken away. The poorly preserved cardinal area exhibits an ill defined ridge extending obliquely backward and downward, and ending in a broad bulge along the inner margin of the area; the rest of the area, as preserved, is smooth except for fine sharp growth lines. Below the inner end of the ridge on the inner surface of the shell is a group of numerous, small irregular, muscle scars. In the same collection is a small, thin-shelled left valve,

poorly preserved, which is more inflated than the large right valve, and exhibits a small anterior wing, and a much larger posterior wing. U.S.N.M. no. 76384.

### Superfamily OSTRACEA

# Family OSTREIDAE

# Genus OSTREA Linné

## **OSTREA OWENANA Shumard**

Pl. 15, figs. 1, 2; pl. 16, figs. 1-3

- 1861. Ostrea owenana Shumard, Boston Soc, Nat,
- 1884. Ostrea owenana Shumard, Dobri 507, Full
  1884. Ostrea owenana Shumard. White, U. S. Geol. Survey 4th Ann. Rept., p. 298.
  1906. Ostrea subspatulata Forbes. Veatch, U.S. Geol. Survey Prof. Paper 46, p. 27, pl.
- 11, figs. 3, 3a. (Figures only.)
   1924. Ostrea owenana Shumard. Deussen, U.S. Geol. Survey Prof. Paper 126, pl. 11, figs. 3, 3a. (Figures only.)
- 1929. Ostrea owenana Shumard. Dane, Arkansas Geol. Survey Bull. 1, pl. 24 (op. p. 136), figs. 1, 2. (Figures only.)

Shell subovate in outline, inequivalve, elongated in the direction of the height, broadest below, narrowing upward toward the hinge. Shell moderately thick in the umbonal region, becoming thin ventrally. Beaks small, flattish, slightly incurved, centrally situated. Ventral portion of shell strongly curved to left and slightly bent toward the rear. Hinge longer than broad; a broad shallow ligamental depression extends inward from the beak, becoming broader away from the beak, and in the right valve ending in a strongly convex margin which is almost a half-circle; this depression is much deeper on the left than on the right valve; the cardinal area on either side of the ligamental depression is slightly concave; the whole area is crossed by sinuous growth lines, convex inward on the ligamental depression, and convex outward on either side of this depression; the area is also marked by numerous fine, irregular lines transverse to the growth lines. Interior smooth: adductor scar large, elongated, curving upward posteriorly, situated below the midheight near the posterior margin; a small, deeply impressed pedal muscle scar is present slightly back of the midlength, 6 to 12 mm. below the inner hinge margin. Anterior and posterior margins nearly straight to slightly convex above,

<sup>&</sup>lt;sup>113</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 51, pl. 13, fig. 7, 1926.

diverging somewhat downward away from the hinge extremities, rounding broadly below into the rather sharply rounded Surface marked by ventral margin. strongly developed growth undulations and lamellae.

Approximate dimensions of the neotype: Length 77 mm., height (estimated) 95 mm., thickness of shell in the umbonal region 24 mm.

Ostrea owenana is a characteristic species of the Nacatoch sand of the Navarro group in Texas, and of the upper part of the Nacatoch sand in Arkansas. The species is a close analogue of Ostrea subspatulata Forbes from the Peedee formation of North Carolina and the Ripley formation of the eastern Gulf region, and has been referred to that species by some authors. It is. however, consistently less convex, and the shell is correspondingly thinner, as seen in a large suite of specimens. Both species are narrowly restricted in their vertical range, but subspatulata ranges a little lower in the Chattahoochee region than does owenana in the western Gulf region; both species are valuable index fossils.

Types.—Shumard's types were obtained at Chatfield (=Chatfield Point), Navarro County, Texas. They are probably lost, but the original description is good, and many specimens confidently referred to the species have been collected along the outcrop of the Nacatoch sand between Chatfield and Corsicana. The selected neotype, a right valve shown in plate 16, figures 1--3 (U.S.N.M. no. 76386), is from near Corsicana, Navarro County. The plesiotype, U.S.N.M. no. 76387, is from a road exposure 3 7/10 miles east of Greenville, Hunt County.

Distribution in Texas.---Navarro group, Nacatoch sand: Vicinity of Chatfield (762); road  $7\frac{1}{2}$  to  $8\frac{1}{2}$  miles north by east of Corsicana (7567, 9544, 9559, 14115, 14116); Watkins' place 4 miles north of Corsicana (9558); vicinity of Corsicana (763, neotype, figured); 3 7/10 miles east of Greenville (12926; 15548, 1 specimen figured).

Outside distribution.---Arkansas: Upper part of Nacatoch sand in Hempstead and Nevada counties.

### **OSTREA PANDA Morton**

Pl. 15, figs. 3-6

- 1830. Ostrea cristagalli Schlotheim?. Morton, Am. Jour. Sci., vol. 18, p. 250, pl. 3, fig. 22. (Figured but not described.)
- 1833. Ostrea panda Morton, Am. Jour. Sci., 1st ser., vol. 23, p. 293. 1834. Ostrea panda Morton. Synopsis of the
- organic remains of the Cretaceous group of the United States, p. 51, pl. 3, fig. 6 (not pl. 19, fig. 10).
- 1861. Ostrea panda Morton. Gabb, Acad.Nat. Sci. Philadelphia Proc., vol. 13, p. 328.
  1869. Ostrea panda Morton. Coquand, Mon. Genre Ostrea Terrain Crétacé, p. 57, pl. 30, fig. 8 (not fig. 9).
- ?1884. Ostrea panda Morton. White, U.S.Geol. Survey 4th Ann. Rept., pp. 298, 311.
- Considered to be Eocene. ?1885. Ostrea panda Morton. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 30. (Geol. Survey New Jersey. Paleontology, vol. 1, p. 30, 1886.) Considered to be Eocene.
- 1907. Ostrea panda Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 437, pl. 42, fig. 10.
- 1926. Ostrea panda Morton. Stephenson, Geol. Survey, Alabama Special Rept. No. 14, p. 250, pl. 92, fig. 6. (Figure only.)
- 1929. Ostrea panda Morton. Dane, Arkansas Geol. Survey Bull. 1, pl. 27 (op. p. 150), fig. 3. (Figure only.)

This species varies greatly in form and surface sculpture, but in general is roughly subcircular, flattish to only moderately convex, and the right valve, except in extremely nontypical specimens, exhibits irregular costae which vary greatly in coarseness on different individuals in any large suite of specimens. The species is rather small, rarely exceeding 60 mm. in its greatest dimension, and the thin to moderately thick shell is tough and as a rule well preserved. The shell is generally attached to other shells or to foreign objects over most of the surface of the left valve, the habit of the species in this respect being similar to that of Ostrea congesta Conrad, O. plumosa Morton, and some other species. The shape of the shell depends, therefore, to a considerable extent on the shape of the object of attachment. The hinge is that of a typical oyster, but is small and varies greatly in its proportions in different individuals, depending upon its position of attachment, and its condition of crowding with respect to other nearby shells; the trend of the ligamental groove may be

curved either forward or backward, or may be bent either to the right or to the left. The adductor scar is relatively large and is situated somewhat above the midheight. Irregular corrugations, generally fine, are present on the dorsal margin of most well preserved shells.

Ostrea panda is very much like some of the shells from the zone of Belemnitella mucronata of the Upper Cretaceous of England, which Woods<sup>144</sup> referred to Ostrea semiplana Sowerby, particularly the shells figured on page 384, and on plate 57, figures 6a, b, and 7a, b, of the work cited. Most of the other shells figured by him under the same name are very unlike O. panda, and probably belong to other species.

Type.---The specimen figured by Morton on plate 3, figure 6, of his Synopsis must be considered the holotype, but unfortunately this shell is lost. It came from St. Georges, Delaware, and must have come from either the Marshalltown formation (Matawan group), or from the Mount Laurel sand (Monmouth group), of the Upper Cretaceous series. Both White and Whitfield seem to have considered this species to be a synonym of O. mortoni, a Tertiary species. The specimen figured on Morton's plate 19, figure 10, is the type of the species O. mortoni later described by Gabb.<sup>145</sup> It is in the Academy of Natural Sciences at Philadelphia and, although marked as coming from South Carolina, Dr. C. Wythe Cooke states orally that in his opinion this is an error, and that the specimen probably came from the Oligocene (Red Bluff clay) of Ala-It is undoubtedly a different bama. species from O. panda of the Cretaceous. One plesiotype, U.S.N.M. no. 76388; 3 plesiotypes, U.S.N.M. no. 76389.

Distribution in Texas.--Taylor marl: Guadalupe River, 4 miles below New Braunfels, Guadalupe County (771); a small arroyo, 2<sup>1</sup>/<sub>4</sub> miles south of the courthouse at San Marcos, Hays County, 1/3 mile east of the San Marcos-Staples Store road (7617); bluff on right side of San Marcos River,  $2\frac{3}{4}$  miles southeast of the courthouse at San Marcos (7619).

Upson clay: Sauz Creek, 1½ miles north of the old Burr ranch house, 3 miles northwest of Paloma, Maverick County (8256).

Annona chalk: Youngs Creek, <sup>1</sup>/<sub>4</sub> mile north of the Texas & Pacific Railroad, 4 miles cast of Clarksville, Red River County (13086).

Navarro group, Neylandville marl: 3/5 mile northeast of Royce City (13835, 1 specimen figured); 1½ miles east of Gastonia (7549, 3 specimens figured); 1 mile cast of Gastonia (7550).

Outside distribution. — Arkansas: Occurs in the Ozan formation, in the basal part of the Annona chalk, and in the Marlbrook, all within the Exogyra ponderosa zone, and of Taylor age.

Mississippi: Tombigbee sand member of Eutaw formation; Selma chalk (lower part and *Exogyra cancellata* zone).

Central and west-central Alabama: Selma chalk (lower part); Ripley formation (*Exogyra cancellata* zone).

New Jersey: Marshalltown formation.

Range.—In Texas the species ranges from the Taylor marl and beds of Taylor age, upward into the Neylandville marl of the Navarro group. The species is found throughout the length of the Atlantic and Gulf Coastal Plain, ranging through the *Exogyra ponderosa* zone, and the *E. costata* zone.

## OSTREA CONGESTA Conrad

# Pl. 13, figs. 6, 7

- 1843. Ostrea congesta Conrad, Rept.Hydrog. Basin Upper Missouri River, I. Iin error for J.] N. Nicollet, App.C., p. 169. (A brief footnote description.)
- Ostrea congesta Conrad. Hall and Meek, Mem.Am.Acad. Arts and Sci., Boston, new ser., vol. 5, p. 405. (Listed only.)
   Ostrea congesta Conrad. Hall, U.S. Pacific
- 1856. Ostrea congesta Conrad. Hall. U.S. Pacific R.R. Explorations: U.S. 33d Congress, 2d sess., Senate Ex.Doc. 78 and House Ex. Doc. 91, vol. 3, pt. 4, p. 100, pl. 1, fig. 11.
- 1856. Ostrea congesta Conrad. Meek and Hayden, Acad.Nat.Sci. Philadelphia Proc., vol. 8, p. 286. (Listed only.)
- Proc., vol. 8, p. 286. (Listed only.) 1869. Ostrea congesta Conrad. Coquand, Mon. Genre Ostrea Terrain Crétacé, p. 49, pl. 17, fig. 5.

<sup>&</sup>lt;sup>144</sup>Woods, Henry, The Cretaceous Lamellibranchia of England: Paleontographical Soc., Mon., vol. 2, pt. 9, pp. 879-387, 1913.

<sup>&</sup>lt;sup>115</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc. (1861), vol. 13, p. 329, 1862.

- 1876. Ostrea congesta Conrad. Meek, Rept. U.S. Geol. Survey Terr., vol. 9, p. 13, pl. 9, figs. 1a-f.
- 1879. Ostrea congesta Conrad. White, U.S.Geol. Survey Terr., 11th Ann.Rept., pp. 197, 198, 233. (Listed and briefly discussed.)
- 1884. Ostrea congesta Conrad. White, U.S.Geol. Survey 4th Ann.Rept., p. 294, pl. 39, figs. 11-13.
- 1885. Ostrea congesta Conrad. Whiteaves, Geol. and Nat. Hist. Survey Canada, Contr. Canadian Paleontology, vol. 1, pt. 1, pp. 78, 83.
- 1889. Ostrea congesta Conrad. Whiteaves, Geol. and Nat. Hist. Survey Canada, Contr. Canadian Paleontology, vol. 1, pt. 2, p. 186.
- 1893. Ostrea congesta Conrad. Stanton, U.S. Geol. Survey Bull. 106, p. 55, pl. 2, figs. 2-4.
- 1896. Ostrea congesta Conrad. Gilbert, U.S. Gcol. Survey 17th Ann. Rept., pt. 2, p. 566, pl. 61. (Figure only.)
- 1898. Ostrea congesta Conrad. Logan, Kansas Univ. Geol. Survey, vol. 4, p. 444, pl. 99, figs. 10, 11, 13.
- 1899. Ostrea congesta Conrad. Logan, Kansas Univ. Quart., vol. 8, p. 90, pl. 20, figs. 1, 2, 6.
- 1903. Ostrea congesta Conrad. Johnson, School of Mines Quart., vol. 24, no. 2, p. 186. Also in Columbia Univ. Contr. Geol. Dept., vol. 10, no. 90, p. 114.
  1905. Ostrea congesta Conrad. Darton, U.S.Geol.
- 1905. Ostrea congesta Conrad. Darton, U.S.Geol. Survey Prof. Paper 32, pl. 24, fig. A. Also in Prof. Paper 52, pl. 13, fig. A, 1906, and in Prof. Paper 65, pl. 12, fig. A., 1909.
- ?1907. Ostrea congesta Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 435, pl. 43, fig. 16.
- 1908. Ostrea congesta Conrad. Condra, U.S.Geol. Survey Water-Supply Paper 215, pl. 6, A. (Same as figured by Darton.)

The Neylandville marl of the Navarro group has yielded specimens of a small, irregular oyster, from two localities near Cooper, Delta County, which appear to belong to this species. They consist of colonies of small, irregular oysters, no individual of which exceeds 15 mm. in greatest dimension. They are attached to the fragments of the shells of Inoceramus With the exception of several very sp. small, young individuals which have both valves preserved, the shells are left valves. The individuals are in closely crowded groups and, in consequence of the interference to each other's growth, are exceedingly irregular in size and shape. Each left valve is attached over a broad surface at the edge of which the shell bends sharply upward in a wall-like ridge; this

ridge is double wherever two shells touch, and may be very sinuous in its trend, due to the crowding and the resulting competition for space. As shown by specimens from the Colorado group of the Western Interior, the right valve is typically flat to broadly concave and is depressed between the upturned margins of the left valve; it is essentially smooth with the exception of somewhat irregular growth lines. The hinge is small and very irregular, due to the crowding, but in general is triangular. The adductor scars are proportionately large and lie at, or a little above, the midheight. The line of contact between the two valves is marked on the inner surface of the left valve by fine crenulations which extend downward for varying distances from the ends of the hinge, in some specimens continuing entirely around the line of contact. This species belongs to a group of oysters in which the left valve is attached over a large part of its surface to a foreign hard object, usually the shell of Inoceramus. Ostrea plumosa is another notable longranging species of the group in the Upper Cretaceous series.

Types.—Conrad's type material, which was not figured, was obtained by J. N. Nicollett "from the Cretaceous marls on the Missouri," which marls were later named the Niobrara limestone; the whereabouts of this material is unknown. Conrad's original description of the species, given in a footnote, is as follows: "Elongated; upper valve flat; lower valve ventricose, irregular; the umbo truncated by a mark of adhesion; resembles a little *Gryphaea vomer* of Morton." Two plesiotypes from Texas, U.S.N.M. no. 76390.

The material figured by Hall in 1856 was brought by Jules Marcou from 3 miles north of Galisteo, New Mexico.

The specimens figured by Meek in 1876 were obtained from the Niobrara limestone "near the mouth of L'Eau Qui Court" (Niobrara River), near Niobrara, Nebraska; they are in the U.S. National Museum (cat. no. 238).

Distribution in Texas.—Austin chalk (upper part): 9/10 mile southwest of

Melissa, Collin County (12875); Dallas-Mesquite road,  $2\frac{1}{2}$  miles west by south of Arnold, Dallas County (7544); near Sterrett, Ellis County (3655); "White Cliff" on Seco Creek, 61/2 miles above the G. H. & S. A. R.R. bridge, Medina County (7704).

Chalk in Palestine salt dome, Anderson County: At a negro cabin east of the salt works (12943).

Ector tongue of Austin chalk (of lower Austin age): Branch west of public road, 3 miles south of Ravenna, Fannin County (10550).

Bonham clay (of Austin age): Ravenna road, 21/2 miles north by west of Bonham, Fannin County (10549); Randolph road,  $5\frac{1}{4}$  miles southwest of Bonham (9693); Arthurs City road, 31/2 miles north of Paris, Lamar County (7502); near Hopewell, 6 miles northwest of Paris (9707); 1 1/5 miles west of Globe, Lamar County (13074); Emberson road, 5 2/5 miles northwest of Paris (13076); Garretts Bluff road, 4/5 mile north of Emberson (13075); 4 miles north of Faught, Lamar County (5313); Detroit road, 1 4/5 miles south of Woodland, Red River County (13563).

Blossom sand (upper part, Austin age): In the bed of a branch in the southwestern part of Paris, Lamar County (7508; 13078); 21/4 miles east by south of Paris (9703); Lone Elm church, 7 miles northwest of Honey Grove, Fannin County (9699).

Gober tongue of Austin chalk: 1 mile west of High, Lamar County (4060).

Navarro group, Neylandville marl: 1/2 mile north of Cooper (4064; 7509, 2 specimens figured).

Outside distribution.-Western Interior: The species is of common occurrence in the Niobrara limestone of the Western Interior, and is known to range both into the Benton shale below and into the Pierre shale and beds of Pierre age above.

New Jersey: Weller questionably identified the species from the Cliffwood clay (Magothy formation), the lowest formation in the Upper Cretaceous series of new Jersey.

Range .--- In the Gulf region the species is most common in the Austin chalk, and in nonchalky formations of Austin age, but ovsters that can not be distinguished from it range from the Austin upward into the lower part of the Navarro group.

# OSTREA TECTICOSTA Gabb

### Pl. 14, figs. 5, 6

- 1860. Ostrea tecticosta Gabb, Acad.Nat.Sci. Philadelphia Jour., vol. 4, 2d ser., p. 403, pl. 68, figs. 47, 48, 1856-1860.
- 1869. Ostrea tecticosta Gabb. Coquand, Mon. Genre Ostrea Terrain Crétacé, p. 50, pl. 17, figs. 10, 11.
- 1876. Ostrea pusilia Gabb, Acad.Nat.Sci. Phila-delphia Proc., vol. 28, p. 321.
  1884. Ostrea tecticostata White, U.S.Geol. Survey 4th Ann. Rept., p. 301, pl. 50, figs. 3, 5.
- 1885. Ostrea tecticosta Gabb. Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 33, pl. 3, figs. 1, (Geol. Survey New Jersey, Paleontol-ogy, vol. 1, p. 33, pl. 3, figs. 1, 2, 1886.)
   1905. Ostrea tecticosta Gabb. Johnson, Acad.Nat.
- Sci. Philadelphia Proc., vol. 57, p. 10.
- 1907. Ostrea tecticosta Gabb. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 443, pl. 43, figs. 17-19.
- 1916. Ostrea tecticosta Gabb, Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 560, pl. 24, figs. 2-4.
- 1923. Ostrea tecticosta Gabb. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 143, pl. 38, figs. 1-9.
- 1926. Ostrea tecticosta Gabb. Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 250, pl. 92, fig. 5. (Figure only.)
- 1926. Ostrea tecticosta Gabb. Wade, U.S.Geol. Survey Prof. Paper 137, p. 54, pl. 14, figs. 4, 5.

Shell irregular in outline but in general roughly triangular to subovate, inequivalve, generally more or less pointed in the umbonal portion, and becoming broader below. Beaks situated centrally, that of the left valve being prominent and generally pointed, and that of the right valve pointed to blunt or squarish. The left valve is compressed to moderately ventricose above, becoming flattened below; the right valve is compressed to moderately ventricose and is inclosed between the overlapping margins of the left valve. Hinge on left valve triangular, elongated in the direction of the long dimension of the shell, traversed by numerous fine growth lines; ligamental groove long, narrow, and moderately impressed. Hinge on right valve shorter and ligamental groove less deeply im-Inner margins of left valve pressed.

crenulated or wavy, the crenulations corresponding to the terminations of the surface costae and intervening depressions. Crenulations faintly present on the inner margins of some right valves, and absent on others. Adductor scar large, situated at about the midheight, and near the posterior margin. The anterior and posterior margins diverge somewhat from the ends of the hinge, and curve downward into the rather sharply rounded ventral margin. The surface of the left valve is marked by fine concentric growth lines some of which rise into more prominent lamellae, and by radiating, round-crested costae, which differ markedly in coarseness on different individuals. The scar of attachment varies greatly in size on the left valves of different individuals. The surface of the right valve presents fine growth lines and stronger growth lamellae at intervals of 1 to 5 mm.; rarely there are faintly developed radiating costae.

Dimensions of the left valve shown in figure 5: Length 17 mm., height 30 mm., convexity 8 mm. Dimensions of the right valve shown in figure 6: Length 16 mm., height 17 mm., convexity 5 mm.

This species is not likely to be confused with any other Cretaceous oyster. It bears some resemblance to Ostrea saltillensis Böse and is about the same size, but the sculpture of Böse's species is very much finer.

Types.—Gabb's types, including 2 left and 2 right valves from Tennessee and 1 left valve from New Jersey, are in the collection of the Academy of Natural Sciences of Philadelphia. He figured a left and a right valve from Tennessee. Both the Tennessee and the New Jersey material lack accurate locality descriptions. One plesiotype from Texas, U.S.N.M. No. 76391; 1 plesiotype from Texas, U.S.N.M. no. 76392,

Distribution in Texas .--- Navarro group, Neylandville marl: 1 mile east of Gastonia (7550, 1 specimen figured);  $1\frac{1}{2}$ miles east of Gastonia (7549).

Navarro group, Corsicana marl: 11/4 miles south by east of Oak Grove  $(16160); \frac{1}{2}$  mile below Martindale (15527); 2 miles east of Marion (Tex. Bu. 2395); 21/2 miles west of McQueeney

(15523); arroyo, 2/5 mile south by west of St. Mary's University, Bexar County (Tex. Bu. 744); 6 miles east of Castroville (16156; Tex. Bu. 3282); Castroville road, 1 1/5 miles west of Leon Creek (Tex. Bu. 746).

Navarro group, Kemp clay: Branch 61/2 miles southwest of Currie (14139, 1 specimen figured); near Deatsville (14125); 4 miles southcast of Zorn (10877).

*Outside* distribution.—Arkansas: The species has been recorded from several localities in the Nacatoch sand, and from one locality in the Marlbrook marl, of Arkansas.

Mississippi: Selma chalk (Exogyra costata zone) and Ripley formation.

Central and west-central Alabama: Tombigbee sand, Selma chalk (Exogyra costata zone), and Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Cusseta sand, Ripley formation, and Providence sand.

Carolinas: Common in the Peedee formation and questionably identified from the Snow Hill member of the Black Creek formation.

Maryland: Monmouth formation.

New Jersey: Wenonah sand of Matawan group.

Range.---In Texas the species is recorded from all four formations of the Navarro group. Elsewhere in the Coastal Plain the species occurs rarely in the Exogyra ponderosa zone and is fairly common in the E. costata zone.

### OSTREA PLUMOSA Morton

### Pl. 16, figs. 4-6

- 1833. Ostrea plumosa Morton, Am. Jour. Sci., 1st ser., vol. 23, p. 293.
- 1834. Ostrea plumosa Morton, Synopsis of the organic remains of the Cretaceous group
- of the United States, p. 51, pl. 3, fig. 9, 1858. Ostrea denticulifera Conrad. Acad. Nat. Sci. Philadelphia Jour., vol. 3, p. 330, pl. 34, figs. 1, 8.
- 1869. Ostrea plumosa Morton. Coquand, Mon. Genre Ostrea Terrain Crétacé, p. 61, pl. 32, fig. 9.
- 1869. Ostrea denticulifera Conrad. Coquand, Mon. Genre Ostrea Terrain Crétacé, p. 50, pl. 17, figs. 8, 9. 1876. Ostrea plumosa Morton. Gabb, Acad. Nat.
- Sci. Philadelphia Proc., vol. 28, p. 320.

- 1884. Ostrea plumosa Morton. White, U.S.Geol. Survey 4th Ann. Rept., p. 299, pl. 37, figs. 5, 6.
- 1884. Ostrea denticulifera Conrad. White, U.S. Geol. Survey 4th Ann. Rept., p. 295.
- 1885. Ostrea plumosa Morton. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 30, pl. 3, figs. 12, 13. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 30, pl. 3, figs. 12, 13.)
- ?1885. Anomia argentaria Morton, Whitfield, U. S.Geol, Survey Mon., vol. 9, p. 42, pl. 4, fig. 9 (not figs. 10, 11). (Geol, Survey New Jersey, Palcontology, vol. 1, p. 42, pl. 4, fig. 9, 1886.)
- 1893. Ostrea plumosa Morton. Cragin, Geol. Survey Texas, 4th Ann. Rep., p. 206.
- 1900. Ostrea plumosa Morton. Harris, Geol. Survey Louisiana, Rept. for 1899, p. 293, pl. 49, fig. 4.
- 1905. Ostrea plumosa Morton. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 10.
- 1907. Ostrea plumosa Morton. Weller, Geol, Survey New Jersey, Paleontology, vol. 4, p. 439, pl. 42, figs. 16–18.
- 1907. Ostrea crenulimarginata Gabb. Weller, Geol. Survey New Jersey, Paleontology, vol. 4. p. 441, pl. 42, figs. 12, 13.
  1907. Ostrea denticulifera Conrad. Weller, Geol.
- 1907. Ostrea denticulifera Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 436, pl. 43, figs. 1, 2.
- 1916. Ostrea plamosa Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 556.
- 1923. Ostrea plumosa Morton. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 147, pl. 38, figs. 14–17; pl. 39, figs. 11–15.
- 1926. Ostrea plumosa Morton. Stephenson, Geol. Survey Alabama Special Rept., No. 14, p. 250, pl. 92, fig. 3. (Figure only.)
- 1926. Ostrea plumosa Morton. Wade, U.S.Geol, Survey Prof. Paper 137, p. 53, pl. 14, figs. 1-3, 7.
- 1929. Ostrea plumosa Morton. Dane, Arkansas Geol. Survey Bull. 1, pl. 27 (op. p. 150), figs. 4–6. (Figures only.)

Morton described this species as follows: "Ovate-triangular, thin; lower valve convex, crenated near the hinge; dorsum marked with delicate striae, radiating in fasciculi from the beak to the margin. Length, about an inch and a half."

Only two specimens have been recorded from the Navarro group, but the species has been collected from a larger number of localities in the Upper Cretaceous series of the Atlantic and Gulf Coastal Plain than has any other species of oyster. In the following description the variations of the species, as shown by the numerous collections, are taken into consideration.

Shell variable in form and outline, being subtriangular, subovate, and subcircular

in different individuals. Shell wall thin to moderately thick. Left valve generally attached over the greater part of its surface to some hard object, often the shell of Inoceramus, the nature of this attachment and the crowding of adjacent individuals determining to large extent the form and outline of individual shells. The margin of the left valve turns sharply upward in a wall-like projection from the outer edge of the area of attachment; right valve compressed to moderately ventricose. In typical specimens the midline of the shell from the beak to the ventral margin is curved toward the rear, but this feature is extremely variable in different individuals. Hinge variable in shape, but in general triangular, and more or less bent downward toward the object of attachment; ligamental pit more deeply impressed on the left than on the right valve. On typical specimens the inner anterior and posterior margins are crenulated to different distances from the hinge. Inner surface of shell smooth; adductor scar large, situated a little above the midheight and toward the posterior margin. Outer surface marked by fine concentric growth lines and, on typical specimens, by fine, radiating, unequal, bifurcating costae whose plumose arrangement suggested the name plumosa. These costae are best seen on a thin brownish film-like outer layer which is easily destroyed and on many specimens this layer has been entirely removed by corrosion or corrasion.

Approximate dimensions of the right valve shown in plate 16, figures 5, 6: Length 31 mm., height 46 mm. The maximum measured height of the species is 55 mm.

The life habit of the species is like that of Ostrea congesta Conrad. It grew attached over a large part of the surface of the left valve to a hard object, usually the shell of *Inoceramus*. A cluster of young individuals attached to a fragment of *Inoceramus* shell might readily be mistaken for Ostrea congesta, but in the adult stage, such as that shown in plate 16, figure 4, the area of attachment is larger and in general more elongated.

In Texas the species has been recorded from several localities in the Austin chalk, and becomes common in the overlying Taylor marl and beds of Taylor age, much more common indeed than in the Navarro group. One locality in the upper part of the Pecan Gap tongue of the Annona chalk, at which the shells occur in vast numbers, is on a small branch of Bear Creek, about 4/5 mile cast of Lavon, Collin County. A large collection from this place shows the great individual variation in form, outline, thickness, and ornamentation.

A species closely related to O. plumosa, and which may be its ancestral form, occurs in the basal beds of the Eagle Ford clay, notably in an abandoned brick pit, 4/5 mile east of South Bosque (14120). This form differs from the typical O. plumosa in the weaker development of costae, in the finer but more persistent development of crenulations along the line of contact between the two valves, and in the more robust development of the hinge. In habit outline and general form the two are identical.

Ostrea plumosa Morton is closely allied to oysters in the Upper Cretaceous of England, figured by Henry Woods,<sup>116</sup> under the name O. incurva Nilsson. Nilsson's<sup>147</sup> types came from the Upper Chalk of Sweden, and he described them under the three names O. incurva, O. curvirostris, and O. acutirostris. Hennig<sup>118</sup> in 1879 probably correctly regarded Nilsson's three species as variations of one species, and selected the name O. incurva.

As judged from the original figures, the identity of the English and Swedish shells is doubtful, the latter having a heavier type of hinge and apparently lacking radial markings. Furthermore, Woods has included under his O. incurva forms ranging in age from the lower Cenomanian (zone of Schloenbachia varians) to upper Senonian (zone of Belemnitella mucronata), a range which the published figures scarcely justify and which may perhaps be a priori doubted; for unless evidence is strong the chances are against the species having so long a range. Of the specimens figured by Woods those represented by figures 12 to 16, Plate 59, from the zone of *Belemnitella mucronata* (upper Senonian) agree most closely with the American species. Figure 14 represents the type of *O. triangularis* Woodward,<sup>149</sup> which Woods regards as a synonym of *O. incurva*.

Type.—Collection of the Academy of Natural Sciences of Philadelphia, from the "Blue marl of Arneytown, New Jersey." This is probably the Navesink marl. Two plesiotypes from Texas, U.S.N.M. no. 76393.

Distribution in Texas.—Austin chalk: Public road, 2 miles west of Sherman, Grayson County (7516); Prairie Creek, 1½ miles southeast of Arnold, Dallas County (7540); gullics a mile south of Arnold, Dallas County (7542).

Chalk in salt domes: Brooks salt dome, Smith County, at location No. 37 at north end of the saline prairie (11092), at location No. 38 (11093), in road near the southeast edge of the dome (12947), and in an old quarry on the north edge of the dome west of Copperas Creek (12918). Palestine salt dome, Anderson County, in road, 1/5 mile northeast of the salt works (12944).

Bonham clay: Randolph road, 6 miles southwest of Bonham, Fannin County (10557); Direct road, 1 1/5 miles west of Globe, Lamar County (13074).

Blossom sand:  $2\frac{1}{4}$  miles east by south of Paris (9703); 1 1/8 miles south-southwest of the public square, Paris (7508).

Brownstown marl: Atlas road, 4 miles south of Paris, Lamar County (4056); at roadside 4 miles south of Paris (4059).

Gober tongue of Austin chalk: Public road, 4 miles west of Bailey, Fannin County (7527); Arledge Ridge Church, 5 miles south of Bonham, Fannin County (7729); old rock quarry, 3½ miles south of Honey Grove, Fannin County (7534); 1 mile west of High, Lamar County (4060).

Taylor marl: North Sulphur Creek,  $\frac{1}{2}$ mile south of Gober, Fannin County (9566); Colorado River, 1 mile east of Delvalle, Travis County (7606); Colorado River, 1 mile north-northeast of Delvalle (12892); questionably at Hornsby Bend, Colorado River, 7 miles east of Austin,

<sup>&</sup>lt;sup>146</sup>Woods, Henry, Paleontographical Soc., vol. 2, pt. 9, pp. 388-391, pl. 58, figs. 10-13; pl. 59, figs. 1-15, 1913.

<sup>&</sup>lt;sup>147</sup>Nilsson, S., Petrificata Succana, Formationis Cretacea, pars prior. Vertebrata et Mollusca, pp. 30, 31, tab. 6, fig. 5A. B, 1827.

<sup>&</sup>lt;sup>148</sup>Hennig, A., Rev. Lamell br. i Nilsson's "Petrif, Suecana Form, Cret,", p. 11, pl. 1, figs. 15, 17, 21-23, 25-28, 1897.

<sup>&</sup>lt;sup>149</sup>Woodward, Samuel, An outline of the geology of Norfolk, Norwich, p. 48, pl. 6, figs. 6, 7, 1833.

Travis County (7600); a small arroyo,  $2\frac{14}{4}$  miles south of the courthouse at San Marcos, Hays County (7617); San Marcos River, below the mouth of Blanco River, Hays County (7618); San Marcos River,  $2\frac{3}{4}$  miles southeast of San Marcos, Hays County (7619); gully south of Clear Springs road, 4 miles southeast of New Braunfels. in Guadalupe County (7626, 7627); Palestine salt dome, at the salt works at northeast end of the lake, Anderson County (10045).

Pecan Gap chalk: 2 miles north by east of Enloe, Delta County (4061); railroad cut 1/2 mile cast of Pecan Gap, Delta County (9714); near Cotton Belt R.R., 3 miles cast by south of Wolfe City, Hunt County (9712); 5 miles south of Wolfe City, Hunt County (9565); branch of Bear Creek. 4/5 mile east of Lavon, Collin County (14090, 2 specimens figured); branch at crossing of Otto road, 2 7/10 miles southeast of Mart, McLennan County (12913); 200 yards south of Branson Brick Company's plant, 9/10 mile south by west of Marlin, Falls County (12915): Marlin-Cedar Springs road, 5 miles cast of Lott, Falls County (12917).

Wolfe City sand: Cuts of Santa Fe R.R., 1 to 2 miles east by north of Wolfe City, Hunt County (9562, 9709, 9710).

Annona chalk: Branch 2<sup>1</sup>/<sub>4</sub> miles northwest of Annona. Red River County (14077); branch 3 miles southwest of Clarksville, Red River County (14058); Youngs Creek, 4 miles east of Clarksville (13085, 13086).

San Miguel formation: Questionably from Uvalde road, 14 miles northeast of Eagle Pass, Maverick County (8251); northward-facing slope of Agua de Fuera Creek. 5 miles southeast of Spofford, Kinney County (8262).

Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (14062); 2 7/10 miles northwest of Cooledge (16169).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

Navarro group, Escondido formation (Upper part): 15 miles southeast of Eagle Pass. Maverick County (10854); Cuevas Creek, 3½ miles cast of Indio ranch headquarters (8236); Cuevas Creek, 17¾ miles southeast of Eagle Pass (8241, 8242); bluff on Rio Grande, 4 miles west of Windmill ranch, Maverick County (8239). Outside distribution.—Arkansas: Tokio formation, Brownstown marl, Ozan formation (common), Annona chalk, Marlbrook marl, and Nacatoch sand.

Tennessee: Selma chalk and Ripley formation (Coon Creek tongue).

Mississippi: Tombigbee sand member of Eutaw formation, Selma chalk, Ripley formation, Owl Creek formation, and Prairie Bluff chalk.

Central and west-central Alabama: Tombigbee sand member of Eutaw formation, Selma chalk, and Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama–Georgia): Blufftown formation and Ripley formation.

Carolinas: Snow Hill marl member of Black Creek formation, and Peedee formation.

Maryland: Monmouth formation.

New Jersey: Marshalltown formation, Wenonah sand, and Red Bank sand.

Western Interior: Oysters which appear to be correctly referred to this species have been found at several localitis in Colorado, Wyoming, and Utah, in beds which are stated by T. W. Stanton and J. B. Reeside, Jr., to be of middle Pierre age. Stanton<sup>150</sup> in 1897 reported the species from an Upper Cretaceous horizon near Harpers, Wyoming, which is of Pierre age.

Range.—In Texas the species ranges from the upper part of the Austin chalk upward into the Nacatoch sand and Escondido formations of the Navarro group. Geographically the species ranges throughout the Atlantic and Gulf Coastal Plain in beds corresponding in age to those in Texas.

# **OSTREA FALCATA Morton**

## Pl. 14, figs. 7, 8

- 1827. Ostrea falcata Morton. Acad. Nat. Sci. Philadelphia Jour., vol. 6, 1st ser., p. 50, pl. 1, fig. 2.
- 1830. Ostrea falcata Morton, Am. Jour. Sci., 1st ser., vol. 17, p. 284, vol. 18, pl. 3, figs. 19, 20.
- 1834. Ostrea falcata Morton, Synopsis of the organic remains of the Cretaceous Group of the United States, p. 50, pl. 3, fig. 5 (not pl. 9, figs. 6, 7).

<sup>150</sup>Stanton, T. W., Stratigraphy and paleontology of the Laramie and related formations in Wyonning: Bull. Geol. Soc. Amer., vol. 8, pp. 138, 139, 1897.

- 1860. Ostrea falcata Morton. Owen, Geol. Survey Arkansas 2d Rept. Geol. Recon. Arkansas, pl. 7, fig. 5.
- 1868. Ostrea larra Lamarck, Cook, Geol. Survey New Jersey (Geology of New Jersey), p. 375, text figure.
- 1869. Ostrea ungulata Coquand. Mon. Genre Ostrea Terrain Crétacé, p. 58, pl. 31, fig. 12.
- 1870. Ostrea larva Lamarck. Credner, Zeitsch. Deutsch. Geol. Ges., Band 22, p. 226.
- Ostrea larra Lamarek, Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 320.
   1884. Ostrea (Alectryonia) larra Lamarek, White
- 1884. Ostrea (Alectryonia) larva Lamarck, White (in part), U.S. Geol, Survey 4th Ann. Rept., p. 296, fig. 8.
- 1885. Ostrea larva Lamarck. Whitfield (in part), U.S.Geol. Survey Mon., vol. 9, p. 34, pl. 3, figs. 5 -7. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 34, pl. 3, figs. 5 -7, 1886.)
- ?1889. Ostrea larva Lamarck, Hill, Geol. Survey Texas, Bull. No. 4, p. 6.
- 1889. Ostrea larva Lamarck. Hill and Vaughan, U.S.Geol. Survey 18th Ann. Rept., pl. 44, fig. 2c (not figs. 2a, 2b).
- 1899. Ostrea larva Lamarck, Harris, Geology of Louisiana for 1899, p. 293, pl. 49, fig. 3.
- 1905. Ostrea falcata Morton. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 11.
- 1907. Ostrea falcata Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 444, pl. 43, figs. 3-6.
- 1911. Ostrea falcata Morton. Miller, Maryland Geol. Survey, Prince Georges County, p. 96, pl. 5, fig. 6. (Figure only.)
- 1916. Ostrea larva subsp. falcata Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 552, pl. 22, fig. 4.
- 1923. Ostrea falcata Morton. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 154, pl. 39, figs. 1 10.
- 1926. Ostrea falcata Morton, Stephenson, Geol, Survey Alabama Special Rept. No. 14, p. 250, pl. 92, fig. 4. (Figure only.)
  1926. Ostrea falcata Morton, Wade, U.S. Geol.
- 1926. Ostrea falcata Morton. Wade, U.S. Geol. Survey Prof. Paper 137, p. 55, pl. 14, figs. 9–13.
- 1929. Ostrea falcata Morton. Dane, Arkansas Geol. Survey Bull. 1, pl. 25 (op. p. 138), figs. 3, 4. (Figures only.)

This species is represented in the Navarro group by a few imperfectly preserved specimens from four localities, two examples of which are shown in plate 14, figures 7, 8.

Shell long, relatively narrow, and strongly curved backward and upward. Left valve slightly ventricose, right valve compressed or only slightly ventricose. Beaks small, situated midway of the hinge, slightly prominent on left valve, compressed on right valve. Scar of attachment on left valve generally small.

The antero- and posterodorsal portions of the shell are provided with wing-like extensions which vary greatly in prominence on different individuals. Hinge small and variable in shape, but in general triangular and crossed by fine growth lines. Ligamental pit narrow and distinctly impressed on left valve, and shallow and more obscure on right valve. Adductor scar of moderate size and situated 5 to 10 mm. below the hinge, near the posterior Surface marked by fine conmargin. centric growth lines and by 5 to 10 or more round-crested, rugose, radiating costae which flare out into prominent plications along the ventral margin of the shell; the costae and intervening depressions alternate in position on the two valves which, when closed, fit together in a zigzag margin.

Dimensions of the shell shown in pl. 14, fig. 7: Length 39 + mm., height 33 mm., convexity 5 mm. Although the shells do not as a rule exceed 40 or 45 mm. in length, specimens from the Selma chalk in the eastern Gulf region are known to attain a length as great as 54 mm. and a height of 45 mm.

This species belongs to a group of variable, plicated oysters, one of which, a European form, Lamarck designated Ostrea larva. Many authors have referred all the representatives of the group to Ostrea larva, but, as certain authors have shown, it is possible to subdivide them into several fairly well defined species. In 1829 Morton<sup>151</sup> named one of these Ostrea falcata. In 1834 he described<sup>152</sup> two varieties for which he proposed the names Ostrea falcata var. nasuta (his fig. 6) and Ostrea falcata var. mesenterica (his fig. 7). In 1907 Weller<sup>153</sup> raised the two varieties to the rank of species.

Lamrack's original description of Ostrea larva is not accompanied by a figure, but he refers to a figure published by Knorr<sup>154</sup>

<sup>154</sup>Morton, S. G., Acad. Nat. Sci. Philadelphia Jour., vol. 6, pt. 1, p. 50, pl. 1, fig. 2, 1829.

<sup>153</sup>Weller, Stuart, Geol, Survey New Jersey, Paleontology, vol. 4, pp. 444-448, pl. 43, figs. 3-14, 1907.

<sup>154</sup>Knorr, Georg Wolfgang, Sammlung von Merckw, der Natur and Alterthümern des Erdhod, welche petrif, Körper enthält, Atlas, th. 2, pl. II (DVII), fig. 6, Nürnberg, 1768.

<sup>&</sup>lt;sup>152</sup>Morton, S. G., Synopsis of the organic remains of the Cretaceous group of the United States, p. 50, pl. 9, figs. 6, 7, 1834.

which corresponds more closely to Morton's variety Ostrea falcata var. mesenterica, than to other American representatives of the group. Morton's original figure of Ostrea falcata differs markedly from Knorr's figure and is, in my opinion, a distinct species.

Type.—Collection of the Academy of Natural Sciences of Philadelphia (Morton's coll. no. 244). From the Chesapeake and Delaware Canal near St. Georges(?). The nearly complete specimen, with both valves attached, labeled "type" corresponds approximately with Morton's original figure, which is a drawing. There is a discrepancy, however, in the label, which indicates new Jersey instead of St. Georges, Delaware, as the source of the specimen. The specimen later figured in Morton's Synopsis appears to be a different one. One plesiotype from Texas, U.S.N.M. no. 76394; 1 plesiotype from Texas, U.S.N.M. no. 76395.

Distribution in Texas.—Taylor marl: Questionably in Taylor marl (upper) in Burlington road 2 3/10 miles west-southwest of Rosebud. Falls County (14135); bluff on Colorado River, 1 mile northnortheast of Delvalle, Travis County (12892); a small arroyo, 2½ miles south of San Marcos, Hays County (7617); San Marcos River, below mouth of Blanco River, Hays County (7618).

Questionably in the Annona chalk: Creek near the railroad 4 miles east of Clarksville, Red River County (5437).

Questionably from Anacacho limestone, about  $1\frac{1}{24}$  miles west of Fratt station, Bexar County (7652).

Upson clay: Bluff and gullies in westward-facing slope of Sauz Creek, 1½ miles north of the old Burr ranch house, 3 miles northwest of Paloma, Maverick County (8256); Agua de Fuera Creek, ¼ to 3% mile below the Galveston, Harrisburg and San Antonio Railroad bridge near Spofford, Kinney County (8259).

Navarro group, Neylandville marl:  $7\frac{1}{1}$  miles northeast of Cooper (14084, 2 specimens figured);  $\frac{1}{2}$  mile north of Cooper (7509, 1 specimen figured).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761). Navarro group, Kemp clay: West of Zuehl (7085).

Outside distribution.--Arkansas: Ozan formation, Annona chalk, Marlbrook marl, and Nacatoch sand.

Louisiana: Questionably in the Saratoga chalk at Rayburn salt dome.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Selma chalk, Coffee sand, Ripley formation, Owl Creek formation, and Prairie Bluff chalk.

Central and west-central Alabama: Selma chalk (*Exogyra cancellata* zone) and Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Ripley formation.

The Carolinas: Peedee formation.

Maryland: Monmouth formation.

Delaware: Crosswicks clay, Marshalltown formation, and Mount Laurel sand.

New Jersey: Marshalltown formation and Navesink marl.

Range.—The range of the species in Texas is through the Taylor marl and beds of Taylor age, and through the Navarro group. Geographically the species ranges throughout the Atlantic and Gulf Coastal Plain, where it may be found in marine beds at almost any stratigraphic position within the zones of Exogyra ponderosa and E. costata.

## **OSTREA MESENTERICA Morton?**

Pl. 16, figs. 7-9

- 1834. Ostrea falcata Morton, var.B (the name mesenterica suggested), Synopsis of the organic remains of the Cretaceous group of the United States, p. 51, pl. 9, fig. 7.
- 1869. Ostrea ungulata Schlotheim, Coquand, Monog. Genre Ostrea Terrain Crétacé, p. 58, pl. 31, fig. 10 (only).
- 1884. Ostrea (Alectryonia) larva Lamarck. White, U.S.Geol. Survey 4th Ann. Rept., p. 296, pl. 42, figs. 6, 7 (not figs. 2-5, 8, 9).
- 1907. Ostrea mesenterica Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 446, pl. 43, figs. 9-14.

In the general form, size, width, and curvature of the shell, and also in the magnitude of its individual variations, this species is like *O. falcata* Morton, and it therefore seems unnecessary to give a detailed description of these similar characters. Morton treated the species as variety B of O. *falcata*, with the suggestion that if found to be a separate species it be called O. mesenterica. The two species differ markedly, however, in surface ornamentation. In O. mesenterica the surface along a central, longitudinal band is smooth, broadly arched, and is completely wanting in radiating costae, but the margins are strongly plicated or folded, as in O. *Jalcata*, and as in that species these folds vary greatly in number and coarseness on different individuals. The left valves are moderately convex and the right valves vary from slightly concave to slightly convex.

In a suite of specimens from the Kemp clay, near McQueeney, Guadalupe County, which includes 10 left and 19 right valves, the shells are smooth with the exception of several of the larger specimens, which show incipient marginal plications, and the two largest left valves exhibit several large, coarse plications. Were it not for these two specimens one would feel justified in treating this lot as belonging to a separate species.

Type.—The whereabouts of Morton's original figured specimen is not known. Morton says: "My specimens were chiefly obtained in the arenaceous marls near Shrewsbury, New Jersey." Shrewsbury is located on the Tinton sand member of the Red Bank sand, in Monmouth County. One plesiotype from Texas, U.S.N.M. no. 76396; 1 plesiotype from Texas, U.S.N.M. no. 76397.

Distribution in Texas. Austin chalk?: ?bed of Elm Creek, at west end of Anacacho Mountain,  $\frac{1}{2}$  mile southeast of the Galveston, Harrisburg & San Antonio Railroad bridge, Kinney County (8270).

Taylor marl (lower part): ?Walnut Creek, 1½ miles below the Sprinkle road crossing, Travis County (7583).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

Navarro group, Corsicana marl: Onion Creek, 2½ miles west of old Garfield (7605, 1 specimen figured); ?13 (10 miles south-southeast of Marion (13389); 2 miles east of Marion (Tex, Bu. 2395). Navarro group, Kemp clay: Near Mc-Queeney (7631, 1 specimen figured); 10 miles northeast of Corsicana (9556).

Outside distribution. - Arkansas: Questionably in the Brownstown marl and questionaby in the Nacatoch sand.

Mississippi: Upper part of Selma chalk (*Exogyra costata* zone) and Prairie Bluff chalk.

Central and west-central Alabama: Selma chalk (*Exogyra cancellata* zone) and Prairie Bluff chalk.

New Jersey: Navesink marl and Red Bank sand.

Range.—In Texas the species ranges questionably from the upper part of the Austin chalk upward through the Taylor marl and the Navarro group. Although in the Coastal Plain outside of Texas the known occurrences of the species are mainly in the *Exogyra costata* zone, it will probably be found also ranging through the *E. ponderosa* zone.

### OSTREA sp.

A small, smooth, very irregular oyster, found in the Kemp clav at Black Bluff on Brazos River, Falls County (13776), is specifically indeterminate. U.S.N.M. no. 76398.

# Genus GRYPHAEA Lamarck, sensu lato

The name *Gryphaea* is here used in its broad sense to include all the gryphaeoid oysters of both Jurassic and Cretaceous According to Arkell<sup>155</sup> and other age. authors, the species of ostreid shells which have been called Gryphaea do not form a monophyletic group and should therefore be reclassified into lesser groups according to their origin, each of which should be treated as of full generic rank within the family. If this be done the gryphaeoid shells of the Navarro group of Texas would seem to fit into the genus Pycnodonte Fischer de Waldheim,<sup>156</sup> the genotype of which is Pycnodonte radiata Fischer de Waldheim (reported to be a synonym of Ostrea vesicularis Lamarck), from the Crimean region, south Russia. It is not

<sup>&</sup>lt;sup>155</sup>Arkell, W. J., Cotteswold Naturalists Field Club Proc., vol. 25, pt. 1, pp. 21-68, 1933.

<sup>&</sup>lt;sup>156</sup>Fischer de Waldheim, Bull. See. Impér. Natur. Moscou, Tome 8, pp. 118-120, Tab. 1, 1835.

clear from the original figures that *Pycnodonte radiata* is in fact a synonym of *Ostrea vesicularis* Lamarck, but the two species appear to be at least congeneric. Some authors have treated *Pycnodonte* as a subgenus of *Gryphaea*.

## **GRYPHAEA MUTABILIS Morton**

Pl. 17, figs. 1-6

- 1828. Gryphaea mutabilis Morton, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 6, p. 81, pl. 4, fig. 3.
- 1830. Gryphaea mutabilis Morton, Am. Jour. Sci., 1st ser., vol. 17, p. 283.
- 1834. Gryphaea mutabilis Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 53, pl. 4, fig. 3.
- 1868. Pycnodonta vesicularis (Lamarck). Cook, Geol. Survey New Jersey (Geology of New Jersey), p. 374, the larger text figure.
- 1885. Gryphaea vesicularis Lamarck. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 36. pl. 3, fig. 16 (not fig. 15); pl. 4, fig. 3 (not figs. 1, 2); pl. 4, figs. 1–3.
- 1885. Gryphaea resicularis var. mutabilis Morton. Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 38, pl. 3, fig. 16.
- 1900. Gryphaea vesicularis Lamarck. Harris, Geology of Louisiana for 1899, p. 292, pl. 49, fig. 2; pl. 50, figs. 1, 2.
- 1902. Gryphaea vesicularis Lamarck. Taff, U.S. Geol. Survey 22d Ann. Rept., pt. 3, pl. 51, figs. 1, 1a; pl. 52, figs. 1, 1a. (Figures only.)
- 1905. Gryphaea mutabilis Morton. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 11.
- 1906. Gryphaea vesicularis Lamarck. Veatch, U. S.Geol. Survey Prof. Paper 46, pl. 10, figs. 2, 2a (not figs. 1, 1a). (Figures only.)
- 1906. Gryphaea vesicularis Lamarck. Böse, Bol. Inst. Geol. de Mexico No. 24, p. 49, pl. 4, fig. 1 (questionably figs. 2, 3); pl. 7, fig. 2; pl. 9, fig. 4; pl. 11, fig. 6.
- 1907. Gryphaea mutabilis Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 452, pl. 46, fig. 1.
- 1916. Gryphaea (Pycnodonte) resicularis Lamarck (Races A, B, D, E). Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 572, pl. 28, figs. 1, 2; pl. 29, figs. 1-3; pl. 30, figs. 1, 2; pl. 31, figs. 1-3; pl. 32, figs. 1-3; pl. 33, figs. 1-3.
- 1923. Gryphaea vesicularis Lamarck. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 161, pl. 42, figs. 1 5; pl. 43, fig. 6 (not figs. 1-5); pl. 44, figs. 1, 2.
- 1926. Gryphaea vesicularis Lamarck. Wade, U. S. Geol. Survey Prof. Paper 137, p. 58, pl. 17, figs. 1,2; pl. 18, figs. 1, 2; pl. 19, figs. 1, 2.

1929. Gryphaca vesicularis Lamarck. Dane, Arkansas Geol. Survey Bull. 1, pl. 18 (op. p. 94); pl. 23 (op. p. 134). (Figures only.)

Shell large, massive, and extremely variable in outline and form; in general subcircular to broadly subelliptical in outline; may become very thick in the senile stage, attaining 60 mm. or more in extreme Left valve ranging from comcases. pressed, almost flat, to strongly convex, the convexity depending to a considerable extent upon the stage of growth; that is, the older the more convex. On most left valves a radiating sulcation extends from the vicinity of the beak backward and downward to the posteroventral margin, and this tends to produce a posterodorsal auriculation; this sulcation varies greatly in strength, being practically absent in some shells, becoming pronounced in others, and in extreme cases the shell back of the sulcation forms a rugged, prominent, radiating ridge; on occasional shells there is a similar sulcation extending from the beak to the anteroventral margin, which tends to produce a corresponding anterodorsal auriculation. Right valve flat to strongly concave and overlapped by the margins of the left valve. The posterior auriculation of the left valve, if present, is reflected in the right valve, which bends in to fill the notch produced by the auriculation. Beaks as a rule relatively small and nonprominent, located centrally or a little in advance of the center, that of the left valve curving over to the right and overhanging the right beak slightly. The hinge line is typically long, nearly straight, and edentulus; the ligamental area is triangular, the basal or inner border longer than the sides; ligamental groove broad and strongly impressed on left valve, less strongly so on right valve, occupying a third or more of the ligamental area. Inner surface smooth and more or less irregular on different individuals. Adductor muscle scar large, deeply impressed, situated above the midheight and a little back of the midlength. A small pedal muscle scar is situated on the inner surface just below the inner end of the ligamental groove of each valve. Surface of left valve marked by incremental lines and by rather coarse growth undulations and imbricating lamellae. Surface of right

valve similarly marked, the growth lamellae becoming coarse and strong toward the outer borders of adults; right valve further marked by a dozen or more radiating very narrow lines or shallow channels of unequal spacing and strength.

Dimensions of the left valve of the type in the Academy of Natural Sciences of Philadelphia: Length 107 mm., height 99 mm., thickness 42 mm. Dimensions of a large shell from Texas: Length 150 mm., height 139 mm., thickness about 65 mm. An unusually large right valve is 158 mm. long and 135 mm. high.

The genus Gryphaea forms a conspicuous element in the faunas of the Upper Cretaceous series of the Atlantic and Gulf Coastal Plain. The shells are numerous in many beds and some of the shells attain large size. They exhibit extreme individual variation and many of them can be assigned to definite species only with great difficulty; because many of the American shells bear a general resemblance to the variable species, Gryphaea vesicularis Lamarck, of the European Upper Cretaceous, there has been a tendency among American authors to refer them to Lamarck's species. One species, Gryphaea aucella Roemer, which is sometimes thus included, is not only clearly distinct, but is, with a few questionable exceptions, confined in its range to the Austin chalk, and beds of Austin age.

The type of Gryphaea vesicularis Lamarck is a young shell from the Upper Chalk of Meudon, France (Campanian). As figured it appears to be more convex than the shells of G. mutabilis at the same stage of growth. Woods157 in his monographic treatment of the English Ostreidae included in Lamarck's species a large variety of forms ranging in age from Aptian (Lower Cretaceous) to the uppermost Upper Cretaceous. None of them seem to attain the length of hinge line, nor the massiveness of the adults of G. mutabilis. In lieu of a representative suite of specimens from Meudon for comparison with the American shells, it does not seem possible to refer the latter confidently to Lamarck's species.

Most of the American shells which have been included by authors under G. vesicularis may be fairly satisfactorily divided into two groups, one composed of relatively small, short, strongly and smoothly convex shells, examples of which Say<sup>158</sup> as early as 1820 described without figures under the name Ostrea convexa, and the other of larger, broader, flat to strongly convex shells of a type which Morton<sup>159</sup> named Gryphaea mutabilis. Morton also figured a shell which he considered to be typical of Conrad's Ostrea convexa (pl. 4, figs. 1, 2) but referred it to Gryphaea instead of Ostrea. With the exception of the small shells described in this paper under the name G. belli, the representatives of the genus Gryphaea in the Navarro group of Texas seem to fall into Morton's group, G. mutabilis.

Although Morton had both valves of the type specimen of *Gryphaea mutabilis*, he figured only the right valve; the left valve is moderately convex and has a fairly strong posterodorsal auriculation. Considering the known individual variation among the shells of this group from single localities, the reference of the Texas shells to this species seems justified.

In Texas shells of *Gryphaea* from several localities in the Austin chalk, questionably referred to this species, are thinner and flatter than the more typical shells found in the Taylor marl and in the Navarro group.

Type.--Academy of Natural Sciences of Philadelphia. From near St. Georges, Delaware. One plesiotype from Texas, U.S.N.M. no. 76399; 2 plesiotypes from Texas, U.S.N.M. no. 76400; 1 plesiotype from Texas, U.S.N.M. no. 76401.

Distribution in Texas.—Questionably in the Austin chalk: On Colorado River, 1 mile below Congress Avenue bridge, Austin, Travis County (7607); on Cibolo Creek, near Bracken, in Bexar County (7662); a mile north of Dillard's ranch, 5 miles north of Sabinal, Uvalde County (1877); Tequesquite Creek, ½ mile below the old Eagle Pass-Del Rio road, Maverick County (8229, 10856).

<sup>&</sup>lt;sup>157</sup>Woods, Henry, Paleontographical Society, vol. 2, pt. 9, pp. 360-366, 1913.

<sup>&</sup>lt;sup>158</sup>Say, Thomas, Amer. Jour. Sci. and Arts, vol. 2, p. 42, 1820.

<sup>&</sup>lt;sup>150</sup>Morton, S. G., Acad. Nat. Sci. Philadelphia Jour., vol. 6, p. 81, pl. 4, fig. 3, 1828.

Taylor marl: Colorado River, a mile east of Delvalle, Travis County (7606); same river, a mile north-northeast of Delvalle (12892); a small arroyo, 2<sup>1</sup>/<sub>4</sub> miles south of the courthouse at San Marcos, 1/3 mile east of Staples store road, Hays County (7617); San Marcos River, just below the mouth of Blanco River, Hays County (7618).

Pecan Gap chalk member of Taylor marl: North of Enloe, Delta County (4063).

Anacacho limestone: ?Anacacho Mountain, southward-facing slope of Fry Pan valley, 5 miles southwest of Cline, Kinney County (7719).

Navarro group, Neylandville marl: 1/2 mile north of Cooper (4064, 7509); ?2 4/5 miles northeast of Royce City (13833); 1 mile east of Gastonia (7550); 1/2 to 2 miles northwest of Corbet (14119); 21/2 miles north of Corbet (16170); 1 mile west of Pettibone station (14132); 1 7/10 miles south of Burlington (14133).

Navarro group, Nacatoch sand: 8 miles north of New Boston (12935, 1 specimen figured).

Navarro group, Corsicana marl: 2 miles south of Oak Grove (12932, 1 specimen figured); 2 3/5 miles north by east of Malta (5432); 1 mile southeast of Moore's store, Travis County (Hill coll. 46); Onion Creek at crossing below Moore's ford, Travis County (Hill coll. 48); 1 3/10 miles south-southeast of Marion (13389); near Highway 90, 11/2 miles west of Woman Hollow Creek, Bexar County (16490); Redwood store, Guadalupe County (7643); near Camp Travis Hospital northeast of San Antonio (Tex. Bu. 39); Guadalupe River, 1 3/10 miles north of McQueeney (7637); arroyo, 2/5 mile south by west of St. Mary's University, Bexar County (16354; Tex. Bu. 744); well 7/20 mile south by west of St. Mary's University, Bexar County (16353); Častroville road, 1 1/5 miles west of Leon Creek (15522; Tex. Bu. 746); fuller's earth pit 14 miles west of San Antonio (15520; Tex. Bu. 743); 14 miles west by south of San Antonio (Tex. Bu. 742); 6 miles east of Castroville (15502; Tex. Bu. 756, 3282); near Castroville (7665, 7796); 4 or 5 miles northwest of Castroville (10627, 2 specimens figured; Tex. Bu. 747); 2 miles south of Cliff (10870); 3 miles west of Cliff (16494).

Navarro group, Kemp clay: Vicinity of Webberville, Travis County (Hill coll. 8; 4 miles northwest of Lockhart (Tex. Bu. 1170); west of Zuehl (7085).

Outside distribution.—Arkansas: Ozan formation, Marlbrook marl, Saratoga chalk, and Nacatoch sand.

Louisiana: Saratoga chalk in Rayburns Salt Dome.

Tennessee: Selma chalk (sandy equivalents in *Exogyra ponderosa* and *E. cancellata* zones) and Coon Creck tongue of Ripley formation.

Mississippi: Selma chalk, Coffee sand, Ripley formation and Prairie Bluff chalk.

Central and west-central Alabama: Selma chalk (*Exogyra cancellata* zone and upper part) and Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Ripley formation.

Carolinas: Peedee formation.

Maryland: Monmouth formation.

Delaware: Marshalltown formation.

New Jersey: Marshalltown formation.

Range.—The species ranges throughout the Atlantic and Gulf Coastal Plain and is common in both the *Exogyra ponderosa* and *E. costata* zones.

### GRYPHAEA BELLI Stephenson, n.sp.

## Pl. 18, figs. 1-4

Shell small, variable in form, in general subtrigonal and elongated posteriorly, but varying greatly in outline, strongly inequivalve. Left valve strongly convex, subhemiglobose anteriorly, flattening out posteriorly, steep on the dorsal slopes. Right valve flattish to concave, especially toward the ventral margin. Beak of left valve prominent, strongly incurved. Hinge of left valve small, trigonal, crossed by growth lines, with a moderately deep, trigonal ligamental pit; hinge of right valve similar to that of the left. Inner margins of shell more or less rugose both in front and back of the beaks where the edges of the two valves are in close proximity to each other. Adductor scar small, situated high in the shell. Surface of left valve smooth with the exception of fine growth lines, and irregular growth undulations which are weakly developed or absent on some individuals. Surface of right valve typically smooth with the exception of narrow, weak, rather widely spaced radiating grooves which are strongest toward the ventral margin.

Dimensions of the holotype, a mediumsized left valve: Length 23.7 mm., height 22 mm., convexity about 11 mm.; a large left valve in the same lot is 33.5 mm. long and 27 mm. high.

Like other species of the Ostreidae the individuals of this species exhibit considerable variation in form due to the shapes of the objects of attachment, and to the conditions of crowding. The species is remarkably like Gryphaea aucella Roemer in form, outline and size, but differs from that species in the smoother outer surface of its right valve and the presence thereon of widely spaced, radiating grooves. The shells are most common in the Corsicana marl, but are not confined thereto.

Two small shells from the Peedee formation of North Carolina, figured by me in 1923.160 under the name Gryphaea vesicularis Lamarck, may belong to this species. I have found small shells of Gryphaea, which appear to be this species, in the Prairie Bluff tongue of the Selma chalk, near Gastonburg, Wilcox County, Alabama.

Types.-Holotype, U.S.N.M. no. 76402; 3 figured paratypes, U.S.N.M. no. 76403. Named for the Hon. P. Hansborough Bell, Governor of Texas, 1849 to1853.

Distribution in Texas.---Navarro group, Corsicana marl:  $1\frac{1}{4}$  miles south by east of Oak Grove (13568, 16160); about 5 miles east by north of Greenville (12924, loc. of holotype); 1 4/5 miles N. 20° W. of Tona siding (15545); 3 7/10 miles southwest of Campbell (15547, 17384);  $2\frac{1}{2}$  miles west of McQueeney (15523, loc. of 3 paratypes); 1/2 mile below Martindale (15527).

Navarro group, Kemp clay: 10 miles northeast of Corsicana (9556); 3 miles northwest of Lockhart (Tex. Bu. 1174).

Outside distribution.-Alabama: Prairie Bluff chalk.

North Carolina: Peedee formation (upper part).

Range.-In Texas the species is fairly common in the Corsicana marl and is present rarely in the Kemp clay. Shells apparently of this species occur in the Prairie Bluff chalk in Alabama and in the Peedee formation in North Carolina.

# Genus GRYPHAEOSTREA Conrad

## **GRYPHAEOSTREA VOMER** (Morton)

Pl. 18, figs. 5-9

- 1828. Gryphaea vomer Morton, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 6, p. 83. (Not pl. 5, figs. 1, 2, 3; Morton later stated that these illustrations were introduced by misake.)
- 1834. Gryphaea vomer Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 54, pl. 9, fig. 5.
- 1861. Exogyra lateralis Nilsson. Gabb, Synopsis of the Mollusca of the Cretaceous formation, p. 123 (179).
- 1864. Exogyra lateralis Nilsson. Meek, Check list of the invertebrate fossils of North America; Cretaceous and Jurassic: Smithsonian Misc. Coll., vol. 7, Art. 8, p. 6.
- 1865. Ostrea (Gryphaeostrea) subeversa Conrad, Am. Jour. Conch., vol. 1, p. 15. (Name and locality only.)
- 1868. Gryphaeostrea lateralis (Nilsson). Conrad, in Cook's Geology of New Jersey, p. 724.
- 1876. Ostrea (Gryphaeostrea) vomer (Morton). Meek, Rept. U.S.Geol. Survey Terr., vol. 9, p. 11. (Quotes diagnosis of Gryphaeostrea furnished by Conrad).
- 1884. Ostrea vomer Morton. White, U.S.Geol. Survey 4th Ann. Rept., p. 302, pl. 48, figs. 8-10.
- 1885. Gryphaeostrea vomer (Morton). Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 195, pl. 26, figs. 11, 12. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 195, pl. 26, figs. 11, 12, 1886.)
- 1898. Ostrea (Gryphaeostrea) subeversa Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 681. (In part.)
  1901. Ostrea (Gryphaeostrea) vomer (Morton). Clark and Martin, Maryland Geol. Sur-(Morton).
- vey, Eocene, p. 193, figs. 4, 4a, 5. (Probably not figs. 1-4.)
- 1905. Ostrea (Gryphaeostrea) vomer (Morton). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 11.
- 1907. Gryphaeostrea romer (Morton). Weller, Gcol. Survey New Jersey, Paleontology, vol. 4, p. 455, pl. 44, figs. 7-11. (Probably not fig. 6.)
- 1916. Gryphaea (Gryphaeostrea) vomer Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 579, pl. 25, figs. 1 - 4.
- 1926. Gryphaeostrea vomer (Morton). Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 250, pl. 92, figs. 7, 8. (Figures only.)
- 1935. Gryphaeostrea vomer (Morton). Gardner, Univ. Texas Bull. 3301, p. 135.

<sup>100</sup>Stephenson, L. W., North Carolina Geol, and Econ. Survey, vol. 5, p. 163, pl. 43, figs. 1-3, 1923.

Shell of moderate size and of exceedingly variable shape, roughly subovate, clongate in outline, strongly inequivalve. Cretaceous shells as a rule do not exceed a length of 35 mm., nor a height of 50 mm. Eocene shells are known to attain a height or 65 mm. or more. The left valve varies from moderately to strongly convex, and from broadly rounded to narrow, and sharp ridged centrally in the direction of the height; on many shells this central ridge is sinuous, bending a little forward as it approaches the beak, then curving around rearward until the beak itself is pointed backward, or even twisted into an exogyrate form. Typically this valve exhibits antero- and posterodorsal wing-like projections, which vary greatly in strength of development on different individuals; these are as a rule thin and fragile and arc rarely well preserved. The hinge is small, triangular and generally overhung by the lower margin of the twisted beak; it bends to the right somewhat overhanging the hinge of the right valve. The adductor scar is of moderate size and is situated at or a little above the midheight and toward the rear. The right valve, which is strikingly unlike the left, varies in different individuals from slightly convex to strongly concave; it is smaller than the left valve, whose margins overlap it, and it varies in outline and shape to conform to that of the left valve. Surface marked with 5 to 12 or more conspicuous, sharp, upturned, concentric lamellae, which are spaced from less than 1 to 8 mm. apart. The flat beak bends a little toward the rear on most specimens. The hinge is small, triangular, longer on base than on sides, and bends over markedly to the right. The adductor scar is of moderate size, and is situated at or a little above the midheight and toward the rear.

This species was originally described by S. G. Morton from the "arcnaceous strata at [New] Egypt, New Jersey." This town is located on the outcrop of the Vincentown sand of the Rancocas group, which was then correlated with the Cretaceous, but which is now known to be Eocenc. A careful comparison of shells from New Egypt with numerous shells from the Cretaceous, which are usually referred to Morton's Eocene species, fails to reveal any essential difference between them, and apparently this is one of the rare cases in which a species maintained its specific identity from Upper Cretaceous well into Eccene time.

Gryphaeostrea vomer is a close analogue of Gryphaeostrea canaliculata (Sowerby) of the European Upper Cretaceous, which, according to Henry Woods,<sup>161</sup> has a recorded range from the Lower Greensand (Aptian) of the Lower Cretaceous, upward to the zone of Ostrea lunata (upper Maestrichtian) of the uppermost Upper Cretaceous.

Types.—Academy of Natural Sciences of Philadelphia. From the upper marl beds near [New] Egypt, New Jersey, which are now known to be of Eocene age. Three plesiotypes from Texas, U.S.N.M. no. 76404; 1 plesiotype from Texas, U.S. N.M. no. 76405.

Distribution in Texas.—Gober tongue of Austin chalk: Cut of Texas Midland Railroad, a mile northeast of Atlas, Lamar County (5316).

Taylor marl: San Marcos River, 23/4 miles southeast of San Marcos, Hays County (7619); ravine between the Clear Springs road and Guadalupe River, 4 miles southeast of New Braunfels, in Guadalupe County (7627).

Pecan Gap member of Taylor marl: Branch at crossing of Marlin road, 2 7/10 miles southeast of Mart, McLennan County (12913); Big Creek at crossing of secondary road, 3 1/5 miles south of Mart, McLennan County (13854).

Upper Cretaceous chalk: Old quarry on north edge of Brooks Salt Dome, west of Copperas Creek, Smith County (12948).

Navarro group, Neylandville marl:  $4\frac{1}{2}$  miles southwest of Cooper (7512).

Navarro group, Corsicana marl: 2 3/5 miles north by east of Malta (5310, specimen figured; 12933); 2 miles south of Oak Grove (12932); south by east of Oak Grove (13568, loc. of 3 plesiotypes; 16160); 1½ miles north of the town of Sulphur Bluff (5321); 1 4/5 miles N. 20° W. of Tona siding (15545); 3 7/10 miles southwest of Campbell (15547); ½ mile below Martindale (7621, 15527); 2½ miles west of McQueency (15523); 1 3/10 miles north of McQueency (15524); 1½

<sup>161</sup>Woods, Henry, Paleontographical Society, vol. 2, pt. 9, pp. 375-379, pl. 56, figs. 2-16, 1913. miles south-southeast of Marion (13389); near Highway 90, 1½ miles west of Woman Hollow Creek, Bexar County (16490); near Castroville (7665).

Navarro group, Kemp clay: 2 miles northwest of Deatsville (14128); near Deatsville (14125); 3 miles northwest of Lockhart (Tex. Bu. 1174).

Outside distribution.—Arkansas: Ozan formation, Annona chalk, Marlbrook marl, Arkadelphia clay.

Mississippi: Tombigbee sand, Selma chalk (lower part and *Exogyra cancellata* zone), Coffee sand, Ripley formation, Owl Creek formation, and Prairie Bluff chalk.

Central and west-central Alabama: Selma chalk (lower part and *Exogyra* cancellata zone) and Prairie Bluff chalk.

Maryland: Monmouth formation; Naujemoy and Aquia formations of the Eccene.

Delaware: Marshalltown formation of the Upper Cretaceous.

New Jersey: Upper Cretaceous: Marshalltown formation, Navesink marl, and Red Bank sand. Eocene: Hornerstown marl, and Vincentown sand.

Range.—In Texas the species ranges through the Taylor marl and the Navarro group. In the Atlantic and Gulf Coastal Plain it ranges through the zones of *Exogyra ponderosa* and *E. costata* (Upper Cretaceous), and well up into the overlying Eocene.

#### Genus EXOGYRA Say

#### **EXOGYRA CANCELLATA Stephenson**

### Pl. 18, figs. 10, 11

- 1914. Exogyra costata var. cancellata Stephenson, U.S.Geol. Survey Prof. Paper 81, p. 53, pl. 20, figs. 2–4: pl. 21, figs. 1, 2.
- 1916. Exogyra costata var. cancellata Stephenson. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 566, pl. 27, fig. 3.
- 1923. Exogyra cancellata Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 182, pl. 50, figs. 5, 6; pl. 51, figs. 1, 2.
- 1926. Exogyra cancellata Stephenson. Wade, U. S.Geol. Survey Prof. Paper 137, p. 58, pl. 16, figs. 1-3.
- 1926. Exogyra cancellata Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 242, pl. 87, fig. 3. (Figure only.)
- 242, pl. 87, fig. 3. (Figure only.) 1929. Exogyra cancellata Stephenson. Dane, Arkansas Geol. Survey Bull. 1, pl. 18,

(op. p. 94), fig. 2; pl. 20 (op. p. 108), fig. 1. (Figures only.)

1933. Exogyra cancellata Stephenson, Bull. Amer. Assoc. Petro. Geol., vol. 17, pp. 1351-1361.

Shell medium to large, inequivalve, thick in the adult, subcircular to broadly subovate in outline. Left valve much larger than right valve, strongly convex, umbonal region twisted into a low spiral, beak more or less deformed by scar of attachment, which varies greatly in size. On many specimens a broad flattened or slightly depressed band extends from the beak to the posteroventral margin in a curve corresponding to the spiral twist of the shell (pl. 18, fig. 10), but this feature varies greatly in strength on different individuals, and is wanting on some; it is barely discernible on the shell shown in plate 18, figure 11. Surface ornamented with more or less distinct, low, bifurcating, nodular costae; the nodes are produced by regularly spaced concentric depressions which cross the costae transversely and give to the surface its characteristic cancellated appearance; on parts of some specimens the nodes are more prominently connected concentrically than they are radially, thus producing distinct concentric ridges. In nontypical specimens the costae are weakly developed or absent, except near the beak, and there is a corresponding strong development of concentric growth lamellae; on adults the costae become faint and disappear distally, leaving the shell ornamented only with overlapping lamellac. On some shells sharp-edged lamellae are strongly developed over most of the shell, and where they cross the costae are upfolded into spine-like projections, giving to the shell a rough, shaggy appearance (pl. 18, fig. 10). The hinge and internal characters are normal for the genus. Right valve operculiform, flattened to strongly concave, overlapped by the projecting margin of the left valve. Beak small, depressed, with a nearly flat-spiral twist or coil. In the vicinity of the beak is a smooth area, which varies in size on different individuals: away from this smooth area the surface becomes broken with sharp-edged, concentric lamellae, separated by deep

narrow channels. Costae either absent or very faintly developed.

Typical shells of this species are restricted in Texas to the Neylandville marl. In Williamson and Travis counties, the upper part of the Taylor marl contains a varietal form of *Exogyra ponderosa* Roemer, which exhibits an incipient development of cancellated sculpture, and this variety is probably the ancestral form of the typical *E. cancellata*. Similar shells occur in the upper part of the Marlbrook marl of Arkansas, where, however, among the varietal forms are mingled specimens which are fairly typical of *E. cancellata*, and might reasonably be referred to that species.

The Exogyra cancellata zone is traceable, with certain interruptions due to the overlap of younger formations, from the western Gulf region, through the eastern Gulf region and the Atlantic Coastal Plain, to New Jersey where the zone is coextensive with the Mount Laurel sand, which forms the lowermost unit of the Monmouth group.

Types.—United States National Museum: Lectotype, selected from cotypes, U.S.N.M. no. 31235; from the Selma chalk, a mile east of Cedar Bluff, Clay County, Mississippi. Remaining cotypes, U.S.N.M. nos. 31236–31239; from the Selma chalk, Mississippi and Tennessee. One plesiotype from Texas, U.S.N.M. no. 76406; 1 plesiotype from Texas, U.S.N.M. no. 76407.

Distribution in Texas.--Navarro group, Neylandville marl: 71/4 miles northeast of Cooper (14084, 1 specimen figured); 1/10 miles northeast of Cooper 7 (14083);  $\frac{1}{2}$  mile north of Cooper (5318, 7509): 2/5 mile north of Cooper (14063);  $\frac{1}{2}$  mile north of Cooper (4064, 1 specimen figured); 2 miles southwest of Cooper (7511);  $4\frac{1}{2}$  miles southwest of Cooper (7512); 6 2/5 miles northeast of Greenville (11089, 17383); 5 3/10 miles northeast of Greenville (14088); 4 3/10 miles northeast of Greenville (14087);  $3\frac{1}{2}$  miles northeast of Greenville (16158); near fair ground, Greenville (9717); field south of fair grounds, Greenville (13836); 2 1/5 miles northeast of Royce City (13833);  $2\frac{1}{2}$  miles northeast of Royce

City (13834, 16157);  $2\frac{1}{2}$  miles southeast of Chisholm (13831); 5 miles northwest of Terrell (14104); 3 9/10 miles west of Terrell (17379): 4 3/5 miles west of Terrell (13851); 3 7/10 miles west of Kaufman (13852, 14101); 4 2/5 miles west of Kaufman (13856);  $1\frac{1}{2}$  miles east of Gastonia (7549); 1 mile east of Gastonia (7550); 3 miles northeast of Drane (16164):  $2\frac{1}{2}$  miles north of Corbet (16170): 3 4/5 miles southeast of Drane (13855);  $1\frac{1}{2}$  to 2 miles northwest of Corbet (14119); 5 miles northeast of McClanahan (13849); 21/2 miles south of Ben Hur (15543); 1 mile west-northwest of Ben Arnold (15541); 1 mile west of Pettibone station (14132, 15540); 3/4 mile west of Pettibone station (15539).

Outside distribution. Arkansas: Upper part of Marlbrook marl and Saratoga chalk.

Illinois: One shell of *Exogyra can*cellata waş found, probably not in place, in an excavation for a bridge pier, Ohio River, near Cairo.

Tennessee: Selma chalk (lower part of *Exogyra cancellata* zone) and Coon Creek tongue of Ripley formation (upper part of *E. cancellata* zone).

Mississippi: Selma chalk (Exogyra cancellata zone).

Central and west-central Alabama: Selma chalk (*Exogyra cancellata* zone) and Ripley formation (*E. cancellata* zone).

East-central Alabama and Chattahoochee region (Alabama-Georgia): Lower part of Ripley formation.

North Carolina: Lower part of Peedee formation.

Maryland: Lower part of Monmouth formation.

Delaware: Mount Laurel sand.

New Jersey: Mount Laurel sand (lower part of Monmouth group).

Mexico: Three typical specimens of this variety, brought from Mexico in 1906 by Dr. T. W. Stanton as souvenirs of a dinner of the International Congress of Geologists held at San Luis Potosi, were collected from Upper Cretaceous beds exposed near Ciudad del Maiz, State of San Luis Potosi (4064); one specimen collected from the Cardenas beds near Cardenas, San Luis Potosi, by Dr. Bruce Wade.

Range.---In Texas typical shells are found only in the Neylandville marl, the lowest formation of the Navarro group. In general in the Atlantic and Gulf Coastal Plain the species is restricted to the lower part of the Exogyra costata zone, but fairly typical shells may occur in the upper part of the E. ponderosa zone, as in the upper part of the Marlbrook marl of Arkansas.

#### **EXOGYRA COSTATA Say**

Pl. 19, figs. 1, 2; pl. 20, figs. 1, 2; pl. 21, fig. 2

- 1820. Exogyra costata Say, Am. Jour. Sci., 1st ser., vol. 2, p. 43.
- 1828. Exogyra costata Say. Morton, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 6, p. 85, pl. 6, figs. 1-4.
- 1830. Exogyra costata Say. Morton, Am. Jour. Sci., 1st ser., vol. 17, p. 284.
  ?1833. Ostrea torosa Morton, Am. Jour. Sci., 1st
- ser., vol. 24, p. 130, pl. 10, fig. 1. 1834. Exogyra costata (Say). Morton, Synopsis
- of the organic remains of the Cretaccous group of the United States, p. 55, pl. 6, figs. 1-4.
- ?1834. Ostrea torosa Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 52, pl. 10, fig. 1.
- ?1849. Exogyra costata Say. Roemer, Texas. Bonn, p. 396.
- ?1852. Exogyra costata Say. Roemer, Kreide-
- bildungen von Texas, Bonn, p. 72.
  1857. Exogyra costata Say. Conrad, U.S. and Mexico Boundary Survey Rept., vol. 1, pt. 2, p. 154, pl. 9, figs. 2a-b; pl. 10, fig. 1.
- 1858. Exogyra interrupta Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 330, pl. 34, fig. 15. p. 330, pl. 34, fig. 15.
- 1858. Exogyra costata Say. Emmons, North Carolina Geol. Survey Rept., p. 278, text fig. A.
- 1860. Exogyra costata Say. Owen, Geol. Survey Arkansas 2d Ann. Rept., Geol. Reconnaissance Arkansas, pl. 8, fig. 4.
- 1868. Exogyra costata Say. Cook, Geol. Survey New Jersey (Geology of New Jersey), p. 374, text fig.
- 1869. Exogyra torosa Morton. Coquand, Mon. 1809. Exogyra torosa morion. Coquand, Mori. Genre Ostrea Terrain Crétacé, p. 38, pl. 14, figs. 1–4; pl. 15, figs. 1, 2. (In part.)
  1876. Exogyra costata Say. Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 323.
- 1884. Exogyra costata Say. White, U.S.Geol. Survey 4th Ann. Rept., p. 304, pl. 56, figs. 1, 2; pl. 57, figs. 1, 2. (See also p. 301.)
- 1885. Exogyra costata Say. Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 39, pl. 6, figs. 1, 2, (Geol. Survey New Jersey, Paleontology, vol. 1, p. 39, pl. 6, figs. 1, 2, 1886.)

- 1896. Exogyra costata Say, Bull. Am. Paleon-tology, vol. 1, p. 291 (No. 5, p. 21). (A reprint of Say's paper published in Am. Jour. Sci. in 1820.)
- ?1900. Exogyra costata Say. Harris, Geology of Louisiana, Rept. for 1899, p. 292, pl. 49, fig. 1.
- 1901. Exogyra costata Sav. Hill, U.S.Geol, Survey 21st Ann. Rept., pt. 7, pl. 47, figs. 1, la. (Figures only.)
- 1902. Exogyra costata Say. Hill and Vaughan, U.S.Geol. Survey Geol. Atlas, Austin Folio (no. 76), illustration sheet, fig. 52. (Figure only.)
- 1906. Exogyra costata Say. Böse, Bol. Inst. Geol. de Mexico, no. 24, p. 51, pl. 6, fig. 3;
- pl. 7, fig. 1; pl. 8, figs. 2, 3; pl. 9, fig. 3, 1906. Exogyra costata Say. Veatch, U.S.Geol. Survey Prof. Paper 46, pl. 11, figs. 2, 2a. (Figures only.)
- 1907. Exogyra costata Say. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 456, pl. 47, fig. 1.
- 1911. Exogyra costata Say. Miller, Maryland Geol. Survey, Prince Georges County, p. 96, pl. 5, fig. 8. (Figure only.)
- 1913. Exogyra costata Say. Böse, Bol. Inst. Geol. de Mexico, no. 30, p. 51. 1914. Exogyra costata Say. Stephenson, U.S.
- Geol. Survey Prof. Paper 81, p. 50, pl. 16, figs. 3, 4; pl. 18; pl. 19, figs. 3, 4; pl. 20, fig. 1.
- 1916. Exogyra costata Say. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 564, pl. 25, fig. 5; pl. 26; pl. 27, figs. 1, 2.
- 1923. Exogyra costata Say. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 173, pl. 47, figs. 2-5; pl. 48.
- 1924. Exogyra costata Say. Jourdy, Annales Paléontologie, vol. 13, p. 81, pl. 1, fig. 2.
  1924. Exogyra costata Say. Deussen, U.S.Geol. Survey Prof. Paper 126, pl. 12, fig. 1. Figure only.)
- 1926. Exogyra costata Say. Stephenson, Geol. Survey Alabama Special Rept. No. 14, pp. 242, 248, pl. 87, fig. 4; pl. 91, fig. 1. (Figures only.)
- 1926. Exogyra costata Say. Wade, U.S.Geol. Survey Prof. Paper 137, p. 56, pl. 15, figs. 1, 2.
- 1928. Exogyra costata Say. Adkins, Univ. Texas Bull. 2838, p. 116, pl. 37, fig. 2.
- 1929. Exogyra costata Say. Reeside, U.S.Geol. Survey Prof. Paper 154, p. 271, pl. 69, figs. 5 8.
- 1929. Exogyra costata Say. Dane, Arkansas Geol. Survey Bull. 1, pl. 20 (op. p. 108), fig. 2; pl. 26 (op. p. 140), figs. 1, 2. (Figures only.)

Shell markedly inequivalve, thick to massive, occasional overgrown specimens becoming ponderous; variable in form, but in general subcircular to subovate in outline. Left valve much larger than the right, strongly convex, spirally incoiled to 11/2 to 2 volutions. The beak is, as a

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rule, more or less deformed by the scar of attachment, which varies in size on different individuals from very small to a maximum measured length of 88 mm. On most shells there is a perceptible umbonal ridge extending from the beak in a curve around to the postero-ventral margin, but some shells are so regularly rounded that they seem to lack this ridge. The surface is ornamented with regularly arranged, prominent, radiating, entire or bifurcating costae which in medium-sized specimens extend from the beak to the margin in curves conforming to the twist of the shell. The costae are separated by channels which are as a rule narrower than the costae. In nontypical specimens the costae are weakly developed, and toward the margins of the older and larger shells the costae become weak and disappear. The costae vary in cross section from semicircular to squarish, and in width from 2 to 8 mm.; the concentric growth features are such as to roughen the costae with rounded nodes and more or less prominent lamellae. Right valve operculiform, flatly spiral, varying from broadly convex to rather strongly concave, the valve inclosed within the projecting margin of the left valve; in some shells the portion in front of the beak is pronouncedly convex, and the portion back of the beak more or less concave. Beak small and flatly depressed. Surface ornamented with numerous, concentric, sharp-edged lamellae; on the anterior and ventral parts of the surface these lamellae stand up as sharp-edged ridges separated by deep channels, but centrally and toward the rear the lamellae flatten out giving to this portion of the shell a smooth Costae wanting on most appearance. shells but faintly developed on some and becoming fairly distinct on the upper posterior third of occasional individuals. The hinge and internal characters are normal for the genus.

Dimensions of the medium-sized specimen shown in plate 19, figure 2: Length 92 mm., height 95 mm., thickness 54 mm. Senile shells become elongated in the direction of the height. The largest shell in the collection from Texas, found near Lewis Ferry on Red River, Bowie County (12935), is about 118 mm. long and 150 mm. high. One of the largest specimens ever collected, found in the Selma chalk in Kemper County, Mississippi, is 200 mm. high.<sup>162</sup>

Like most other members of the oyster family, this species exhibits considerable variation in form and in the strength and coarseness of its ornamentation. In Mississippi the species is represented in the lower part of the Exogyra costata zone  $(=Exogyra \ cancellata \ zone), chiefly$ by shells ornamented with strong, rather broad, coarse costae; in the Neylandville marl (*Exogyra cancellata* zone) in Texas a few well preserved shells of medium size and with costae of medium width have been found (pl. 21, fig. 2), and also a few small, imperfectly preserved, nontypical and fragmentary specimens; on these latter the costae are either narrow or of medium width. Specimens from the Nacatoch sand exhibit costae varying on different individuals from medium width to very narrow. Most of the numerous specimens from the Corsicana marl have narrow costae, but on some shells the costae are of medium width; one individual from the marl has broad, coarse costae over part of its surface. All the shells of this species from the Kemp clay have narrow costae, and in general these shells are narrower and more elongated in the direction of the height than shells from the lower formations (pl. 19, fig. 1), though here, as in lower formations, the shells vary greatly in form.

The shells of this genus from the O at a to or group of India, which Stoliczka<sup>163</sup> referred to *E. costata*, occur at a much lower geologic horizon (Cenomanian) than does the American species, and it certainly is a distinct species; the published figures do not justify considering them the same.

Types.—Say described this species without figuring it, and his type material has apparently been lost. He cites it as having come from the "ancient alluvial deposit of

<sup>&</sup>lt;sup>102</sup>Stephenson, L. W., U. S. Geol. Survey Prof. Paper 81, p. 51, pl. 18,

<sup>&</sup>lt;sup>103</sup>Stoliczka, F., Geol. Survey India Mem., Palacontologia Indica, Cretaceous faunas of Southern India, vol. 3, p. 461, pl. 40, figs. 1-3; pl. 41, fig. 1, 1871.

New Jersey." The species was first figured by Morton in 1828, who states that the figured specimen was lent to him by Samuel R. Wetherill, of Burlington, New Jersey. Apparently this specimen was not preserved in any Museum, and it is probably lost. Although so far as known no author after Say saw the type material, the species has been accepted by all authors as a valid one, and costate shells such as those figured in this volume have been referred to it without question. Plesiotypes from Texas, U.S.N.M. nos. 76408, 76409, 76410, 76411.

Distribution in Texas.—Navarro group, Neylandville marl: Specimens with costae of medium width from 3½ miles northeast of Greenville (16158, 1 specimen figured); 3 9/10 miles west of Terrell (17379); nontypical, fragmentary specimens from 5 miles northwest of Terrell (14104), and 1 mile east of Gastonia (7550).

Navarro group, Nacatoch sand: 8 miles north of New Boston (12935); vicinity of Kaufman (761); Watkins' place 3 miles north of Corsicana (9552).

Navarro group, Corsicana marl: 2 3/5 miles north by east of Malta (5310, 5432; 12933, 1 specimen figured; 12934,16159); 11/1 miles south by east of Oak Grove (13568, 16160); 2 miles south of Oak Grove (12932);  $\frac{1}{2}$  mile north of the town of Sulphur Bluff (5321); about 3 miles south-southwest of Campbell (12927); 3 7/10 miles southwest of Campbell (15547): dam on Cedar Creek, 10 miles south-southeast of Greenville (Tex. Bu. 739);  $1\frac{1}{4}$  miles northeast of Quinlan (12928); 14/5 miles N. 20°W. of Tona siding (15545); near Terrell (15544); west edge of Kaufman (7548); 4 miles south by west of Kaufman (14100); 7 7/10 miles west of Cameron (14131, 15538); <sup>1</sup>/<sub>1</sub> mile west of Kimbro (14129); Carlson farm, Kimbro Survey, Travis County (Tex. Bu. 3033); bluff on Cottonwood Creek west of Kimbro (Tex. Bu. 2320);  $3\frac{1}{4}$  miles east by north of Manor (14127); 4 miles south of Manor (Tex. Bu. 2399): Onion Creek, 21/2 miles west of old Garfield (7605, 1 specimen figured; 12920, 14156, 15531; Tex. Bu. (625); public road  $2\frac{1}{2}$  miles west of old

Garfield (7604); 1 mile southeast of Moore's store, Travis County (Hill coll. 46); near Moore and Berry's store, Travis County (16148); west end of Simpson's Hill on road leading up from Onion Creek ford, Travis County (Hill coll. 47);  $\frac{1}{2}$  mile below Martindale (7621);  $1\frac{1}{2}$ miles southeast of Redwood store, Guadalupe County (7622); 1 3/10 miles north of McQueenev (7637); 1 3/10 miles south-southcast of Marion (13389);  $2\frac{1}{2}$ miles west of McQueeney (15523); 2 miles east of Marion (Tex. Bu. 2395): near Highway 90, 11/2 miles west of Woman Hollow Creek, Bexar County (16490); Salado Creek upstream from Highway 90, Bexar County (16671); Salado Creek below Hedwig road, Bexar County (16492, 16669); near Camp Travis Hospital northeast of San Antonio (Tex. Bu. 39); well 7/20 mile south by west of St. Mary's University, Bexar County (16353): arroyo, 2/5 mile south by west of St. Mary's University, Bexar County (16354, Tex. Bu. 744); 1 mile south of B.M. 746 on Culebra road, Bexar County (16352); fuller's earth pit 14 miles west of San Antonio (15520, Tex. Bu. 743); Castroville road, 11/5 miles west of Leon Creek, Bexar County (15522, Tex. Bu. 746); 14 miles west by south of San Antonio (Tex. Bu. 43, 742): 6 miles east of Castroville (15502, 16156, Tex. Bu. 3282); near Castroville (7665, 7796); 4 or 5 miles north by west of Castroville (10627, Tex. Bu. 747); 2 miles south of Cliff (10870, 1 specimen figured; 17450): at depth of 1045 feet in well on G. A. Harper Survey, Medina County (13844).

Navarro group, Kemp clay: 12 miles southeast of Greenville (11247); 10 miles northeast of Corsicana (9556); 6½ miles southwest of Currie (14138); branch, 6½ miles southwest of Currie (14139); 5 miles east of Cooledge (14136); San Gabriel River, 2/5 mile above San Gabriel (14130); 5 miles west by north of Elgin (14162); 3¼ miles north of Manor (13861); 4 miles south of Manor (Tex. Bu. 2399); 2 miles northwest of Deatsville (14128, 1 specimen figured); vicinity of Webberville (Hill coll. 8); near Deatsville (764, 14125); Littig (765); 4 3.5 miles west of Lytton Springs (15529); 4 miles southeast of Zorn (10877); near McQueeney (7633); 4/5 mile north of Zuchl (16489); west of Zuchl (7085): Leon Creek valley, 1 mile above the Southern Pacific Railroad bridge, Bexar County (15519).

Navarro group, Escondido formation: Uvalde road about 11 miles northeast of Eagle Pass (1885); old Batesville road, 5 miles northeast of Chimeneas ranch house, 6 miles southwest of Burke ranch (10284); bed of a small branch east of the Chimeneas ranch house, 18 miles east of Eagle Pass (8246); Uvalde road,  $6\frac{1}{2}$ miles northeast of Eagle Pass (8258); about 4 miles east of Eagle Pass (609); about 600 yards east of Eagle Pass (608).

Outside distribution.—Arkansas: Saratoga chalk, Nacatoch sand, and Arkadelphia marl.

Tennessee: Coon Crcek tongue of Ripley formation.

Mississippi: Selma chalk (*Exogyra cancellata* zone and upper part), Ripley formation, Owl Creek formation, and Prairie Bluff chalk.

Central and west-central Alabama: Selma chalk (*Exogyra cancellata* zone and upper part), Ripley formation and Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Ripley formation and Providence sand.

The Carolinas: Peedee formation.

Maryland: Monmouth formation.

Delaware: Mount Laurel sand.

New Jersey: Mount Laurel sand, Navesink marl, and Red Bank sand.

Mexico: The species is known to occur in the continuation of the beds of the lower part of the Escondido formation southward in the State of Coahuila, Mexico. Böse<sup>164</sup> has recorded the species from the Senonian of Coahuila, but he did not distinguish between the varietal form of the species, *Exogyra costata* var. *spinifera*, which occurs in the San Miguel formation and in the southward extension of the San Miguel in Coahuila. It is probably the varietal form which occurs in his so-called lower Senonian, which includes the San Miguel beds. Bösc<sup>105</sup> has also recorded the species from Upper Cretaceous beds near Cardenas, State of San Luis Potosi, Mexico.

Colorado: Reeside<sup>166</sup> has described and figured a few small imperfectly preserved specimens of *Exogyra* from either the Rocky Ridge or the Larimer sandstone member of the Pierre shale of Upper Campanian age in northeastern Colorado, which appear to be fairly good representatives of *Exogyra costata* Say, though they are not strictly typical of the species.

Range.—The species is considered to be virtually restricted in its range to the Exogyra costata zone, which in Texas includes all of the Navarro group. Specimens which approach rather closely to the more typical costate forms are occasionally found in the Exogyra ponderosa zone, but these exceptional specimens are all smaller and exhibit differences in form and other characters from those of the higher zone; most of them exhibit the spinose characters in greater or less degree, which distinguish E. costata spinifera from the typical E. costata; they may well be the progenitors of E. costata Say.

## EXOGYRA COSTATA SPINIFERA Stephenson, n. name

## Pl. 21, fig. 1

- 1914. Exogyra costata Say. Stephenson, U.S.Geol. Survey Prof. Paper 81, pl. 17, fig. 2; pl. 19, figs. 1, 2. (In part.)
- 1923. Exogyra costata var. spinosa Stephenson, North Carolina Geol. and Econ. Survey, vol. 5. pt. 1. p. 179. pl. 49, figs. 1-6: pl. 50, figs. 1-4. (Preoccupied.) Not E. spinosa Matheron.

As the name *spinosa*, which was originally proposed for this variety, is preoccupied for a species of *Exogyra* in beds of Cenomanian age in France,<sup>167</sup> the name *Exogyra costata spinifera* is herewith proposed to replace the preoccupied one.

The left valve of this variety differs from the more typical representatives of the species in the prominent development of concentric growth lamellae which, along the crests of the costae, are upfolded into

<sup>&</sup>lt;sup>164</sup>See synonymy, 1913.

<sup>&</sup>lt;sup>165</sup>See synonymy, 1906.

<sup>108</sup>See synonymy.

<sup>&</sup>lt;sup>167</sup>Matheron, M. Philippe, Catalogue Méth, et Desc, des Corps Organ, Fossiles du Dép, des Bouches du Rhone, Marseille, p. 192, pl. 32, figs. 6, 7, 1842.

spine-like projections. The folds vary in prominence, but reach maximum heights of 6 or 8 millimeters above the costae; they are easily broken, so that all specimens are imperfect. The spines may be distributed over most of the surface of the left valve, as in the holotype, and the one shown in Plate 21, figure 1 of this volume, or they may be present only over parts of the surface. The right valves vary in form and sculpture on different individuals; they range from flat or concave, to strongly convex and massive; some lack costae and projecting folds, while others have them rather strongly developed on the posterodorsal part of the surface; on some specimens the concentric lamellae on the anterior and ventral portions of the surface are distinctly wavy.

The dimensions of the shell shown in Plate 21, figure 1, are: Length 83 mm., height 78(?), thickness 54 mm. The largest shell from Texas is 110 mm. high.

Specimens which combine the characters of Exogyra ponderosa var. erraticostata Stephenson and E. costata spinifera are not uncommon in the E. ponderosa zone, and some individuals can be assigned to one or the other variety only with difficulty. Indeed the relationships among E. ponderosa, E. costata, and their varieties, seem to suggest the following evolutionary history of the group: The variety erraticostata evolved from the smooth E. ponderosa; the variety spini/era evolved from erraticostata; and the typical E. costata evolved from *spinifera*. The latter variety did not cease to exist with the appearance of the typical E. costata but continued to live alongside of it for some time, the costae becoming more regular from generation to generation.

Type.--Collection of the U.S. National Museum, cat. no. 31231; from lower part of Peedce formation, at Robinson's Landing, Cape Fear River, North Carolina. One plesiotype from Texas, U.S.N.M. no. 76413.

Distribution in Texas.—Taylor marl: Colorado River, 1 mile northeast of Delvalle, Travis County (12892); a small arroyo 1/3 mile east of the Staples store road, 2<sup>1</sup>/<sub>4</sub> miles south of San Marcos, Hays County (7617); San Marcos River below the mouth of Blanco River, Hays County (7618); San Marcos River, 3 miles southeast of San Marcos (7620). Anacacho limestone: A cliff 1/5 mile north of Cliff, Medina County (12906). Anacacho Mountain, 5 miles southwest of Cline (Uvalde County), in Kinney County (7718); bluff on Muela Creek at Flowers ranch house, Kinney County (8266).

San Miguel formation: Scarp on the Carter ranch, overlooking the Rio Grande, 12 miles northwest of Eagle Pass, Maverick County (8227); Del Rio road, 12½ miles northwest of Eagle Pass, Maverick County (8226); northward-facing slope of Agua de Fuera Creek valley, 5 miles southeast of Spofford, Kinney County (8262); a tank ½ mile cast of the Uvalde road, 18 miles northeast of Eagle Pass (8249).

Navarro group, Neylandville marl: 17/10 miles south of Burlington (14133); 1 mile west of Pettibone station (14132, 15540).

Navarro group, Corsicana marl: 4 or 5 miles north by west of Castroville (10627, 1 specimen figured); 2 miles south of Cliff (10870).

Outside distribution.—Arkansas: Ozan formation and upper part of Marlbrook marl.

Northern Mississippi: Upper part of Coffee sand and Selma chalk (*Exogyra cancellata* zone).

The Carolinas: Snow Hill member of Black Creek formation and Peedee formation (*Exogyra cancellata* zone).

New Jersey: In the collection of the Academy of Natural Sciences of Philadelphia is a fairly good example of this variety labeled "*Exogyra costata* Say, Burlington County, N.J., received from Dr. Chas. H. Budd."

Range.—In Texas the variety first appears sparingly well down in the Taylor marl and beds of Taylor age, and ranges upward into the Corsicana marl of the Navarro group.

## Superfamily TRIGONIACEA

## Family TRIGONHDAE

## Genus TRIGONIA Bruguière, sensu lato

The name *Trigonia* is here used in its broad sense. The genotype accepted by Stewart,<sup>108</sup> Dietrich,<sup>169</sup> and others (but not

<sup>105</sup>Stewart, Ralph, Acad, Nat, Sci, Philadelphia Special Pub. no. 3, pp. 88-90, 1930.

<sup>10</sup>Dietrich, W. O., Satzungsberichte der Gesellschaft, Naturforschender Freunde zu Berlin, pp. 326-332, 1933. by Crickmay<sup>170</sup>) is *Trigonia nodulosa* Lamarck (1801). If the new group names proposed by Deecke<sup>171</sup> in 1925, and favored by Stewart,<sup>172</sup> and later by Dietrich,<sup>173</sup> be adopted, the Upper Cretaceous Trigonias described in this paper would appear to fall in the genus *Scabrotrigonia* Deecke, the genotype (designated by Dietrich) of which is *Trigonia scabra* Lamarck from the Cretaceous of France.

I have not been able to determine from the poor figures of Van Hoepen,<sup>174</sup> to which ones, if any, of his African genera the Texas species belong.

#### TRIGONIA STANFONI Stephenson, n.sp.

## Pl. 20, fig. 3

Shell of medium size, equivalve, inequilateral, subtrigonal, moderately ventricose anteriorly, becoming compressed posteriorly. Beaks small, incurved, opisthogyrate, situated only slightly back of the anterodorsal extremity. Hinge and other internal features concealed in the type material by hard sandstone matrix, except the upper side of the posterior tooth of a right valve, which is strongly striated normal to the plane of contact of the two valves. Anterior and ventral margins broadly and evenly rounded, the latter fullest anteriorly, rising high posteriorly to meet the short, subtruncated, oblique posterior margin; the ventral margin is coarsely notched, each notch corresponding to an intercostal space; dorsal margin broadly concave. The dorsal surface of each valve is a broadly concave band normal to the plane of contact of the two valves; in the holotype this band is 45 mm. long, and has a maximum width of 6 mm.; the band is ornamented with a series of rather rugged. fairly sharp-crested, transverse ridges; at their outer ends these ridges bend down and forward 1 to 6 mm., to a radiating groove which separates this dorsal area from the main surface of the shell. The latter is ornamented with 15 or 16 radiating ribs which centrally are strong, rugged and coarsely nodose, and are separated by wide deep interspaces; anteriorly the successive ribs become weaker and the same is true posteriorly; posteriorly the ribs become more and more oblique, the last ones approaching a horizontal position; they also have a broad curve, convex upward, in their trend; the 9 or 10 anterior ribs may be traced upward and forward well toward the beak and presumably they connect with the transverse ribs on the dorsal area; the 6 or 7 posterior ribs come to an end along the radiating groove which separates the main surface from the dorsal surface.

Approximate dimensions of the holotype, a somewhat imperfect left valve: Length 63 mm., height 52 mm., convexity 16 mm.

This species differs from *Trigonia* thoracica Morton, from the Prairie Bluff chalk in Alabama, chiefly in its fewer, coarser and more oblique ribs. The species has a close analogue in the shell from the Ripley formation (Coon Creek tongue) at Coon Creek, Tennessee, which Wade<sup>175</sup> described under the name *T. thoracica*, but which is obviously not that species. Wade's species differs from *T. stantoni*, in its narrower, sharper, and less coarsely nodose ribs, and in the steeper upturn of its posteroventral margin.

The shell from the Marshalltown formation of the Matawan group of New Jersey, which Weller<sup>176</sup> referred to *T. thoracica*, is too coarsely ribbed for that species, and is a shorter species than either *T. thoracica* or *T. stantoni*.

*Types.*—Holotype, U.S.N.M. no. 76416; 3 unfigured paratypes, U.S.N.M. no. 76417; 4 unfigured paratypes, U.S.N.M. no. 76418.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, loc. of holotype and 3 unfigured paratypes); north edge of Corsicana (518, loc. of 4 unfigured paratypes); north of Rock Branch 3 miles northeast of Corsicana (9560); vicinity of Chatfield (762).

<sup>&</sup>lt;sup>150</sup>Crickmay, C. H., Amer, Jour, Sci., 5th ser., vol. 24, pp. 446-453, 1932.

<sup>&</sup>lt;sup>171</sup>Deecke, W., Palaeontologische Zeitschrift, Band 7, Heft 2, p. 68, 1925.

<sup>&</sup>lt;sup>172</sup>Stewart, Ralph. op. cit., p. 89,

<sup>173</sup>Dictrich, W. O., op. cit., p. 330.

<sup>&</sup>lt;sup>154</sup>Van Hoepen, E. C. N., Palcontologiese Navorsing van die Museum, Bloemfontein, Deel 1, Erste Stuk, 38 pp., 7 pls., 1929.

<sup>&</sup>lt;sup>175</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 60, pl. 20, figs. 1, 2, 1926.

<sup>&</sup>lt;sup>176</sup>Weller, Stuart, Geol. Survey New Jersey, Paleontology, vol. 4, pl. 48, figs. 1, 2, 1907.

# TRIGONIA CASTROVILLENSIS Stephenson, n.sp.

### Pl. 19, figs. 3-7

Shell of medium size, equivalve, inequilateral, moderately ventricose anteriorly, becoming compressed posteriorly. Beaks small, incurved, approximate, slightly opisthogyrate, situated a little back of the anterodorsal extremity. Hinge of right valve with two prominent thin. transversely striated teeth diverging from the beak, with a deep triangular space between opening into the interior; the anterior tooth is the shorter and thicker of the two and is supported by a thick platform which is deeply sunken below the margin of the shell. Two deep, diverging, striated sockets on the hinge of the left valve accommodate the teeth of the right valve: these sockets are separated by a very prominent. thick, bifid tooth which fits into the triangular space separating the teeth of the right valve: the outer margin of each socket is bordered by a sharp, nonprominent carina. The anterior adductor scar on the right valve is small and narrow, and occupies the end of the platform on which the anterior cardinal tooth is seated: the anterior adductor of the left valve is seated on a thick deeply submerged platform which protrudes from the side of the shell just below and a little in front of the inner end of the anterior tooth socket; the posterior adductor scar is small, triangular and situated high in the shell; a small retractor muscle scar lies closely above the adductor. Inner posterior surface divided by a short, sharp, longitudinal ridge which comes to the truncated posterior margin near its center. Ligamental grooves short but deep and narrow. The dorsal area back of the beaks is normal to the plain of contact of the two valves, is broadly concave from front to rear and is 24 mm. long and 6 mm, wide in the holotype; a well defined radiating sulcus, which extends from the beak to a point slightly above the middle of the posterior truncation, approximately separates the dorsal ornamentation from that of the main body of the shell. The dorsal area is crossed transversely by 14 or 15 prominent ribs, separated by wider interspaces; at the outer margin of the dorsal area each rib bends forward and downward, becoming smaller,

and joins the upper end of a lateral rib at an acute angle a little above the radiating sulcus.

The anterior margin rounds down regularly into the rather full ventral margin which curves up sharply posteriorly: posterior margin obliquely truncated above the midheight, meeting the hinge line at an angle 125 degrees; dorsal margin broadly concave. The main surface of each valve is ornamented with about 20 radiating, acute, spinose ribs which decrease in strength and in length both anteriorly and posteriorly; many of the spines are brokn away but a few unbroken spines are bluntly rounded and rise to maximum heights of 2.5 or 3 mm. above the crests of the ribs. Along a line somewhat below the posterodorsal radiating sulcus the upper part of each of the lateral ribs bends forward in a broad curve or broad obtuse angle, becoming much smaller and spineless, and meets a rib of the dorsal surface at an acute angle a little above the sulcus; several additional fine. spineless, radiating ribs intervene between the last of the coarser ribs and the sulcus.

Dimensions of the holotype: Length 44 mm., height 37 mm., thickness about 30 mm.

Compared with *Trigonia stantoni*, this species has more and finer ribs, and the ornamentation on the dorsal and posterodorsal areas is much finer; the shell also bends up in a somewhat stronger curve posteriorly. *T. thoracica* Morton is a more clongated species with fewer ribs, the finer ornamentation of which is too incompletely preserved on the types for critical comparison.

*Types.*—Holotype, U.S.N.M. no. 76419; 2 figured paratypes, U.S.N.M. no. 76420: 8 selected unfigured paratypes, U.S.N.M. no. 76421.

Distribution in Texas.---Navarro group, Corsicana marl: Near Castroville (7665, loc. of holotype); well 7/20 mile south by west of St. Mary's University, Bexar County (16353, loc. of 2 figured and 8 unfigured paratypes: 16408); arroyo 2/5 mile south by west of St. Mary's University, Bexar County (16354; Tex. Bu. 744); 1 3/10 miles south-southeast of Marion (13389); poorly preserved molds questionably referred to the species were found in No. 1 Redus well, G. A. Harper 92-acre survey, Medina County (13844); ?4 or 5 miles north by west of Castroville (Tex. Bu. 747).

# TRIGONIA EUFAULENSIS GABBI Stephenson, n.var.

### Pl. 19, figs. 8, 9

Shell relatively small, equivalve, inequilateral, subtrigonal, strongly ventricose anteriorly, becoming strongly compressed in the posterior third of the length. Beaks small, incurved, approximate, situated only a few millimeters back of the anterodorsal extremity. Hinge concealed. Adductor scars deeply impressed, the posterior one the larger. Pallial line simple with the exception of a shallow inward swing where it passes up to meet the distal end of the posterior adductor scar. Inner posterior surface nearly equally divided by a short, pronounced longitudinal ridge which comes to the margin about midway of the short posterior truncation. Anterior margin broadly rounded, passing regularly down into the rather full ventral margin which in turn curves up steeply, becoming slightly concave as it approaches the distal end of the shell; posterior margin short, truncated, strongly inclined forward: dorsal margin broadly concave. A narrow radiating channel or sulcus extends from the beak to about the middle of the posterior truncation, approximately separating the dorsal from the lateral ornamentation. The broadly concave dorsal band is about 2 mm. wide centrally, and is crossed by 14 or 15 sharply defined transverse ridges; at their outer ends these ridges turn downward and forward and, though not well preserved, each ridge seems to meet the upper end of a corresponding lateral rib at an acute angle near the radiating sulcus. The lateral ribs, which number 15 or 16, are strongest centrally and, with the exception of 3 or 4 of the posterior ones, they curve around rather strongly toward the front as they approach the ventral margin; the crests of the ribs are broken into bluntly rounded nodes of medium coarseness; toward its upper end each of the ribs becomes smaller and bends forward at an obtuse angle meeting one of the dorsal ribs at an acute angle.

Dimensions of the holotype, a right valve: Length 32 mm., height 25.5 mm., convexity about 9 mm.

This variety differs from the typical *T.* eufaulensis Gabb in its greater proportional height, in its greater breadth in the upturned posterior portion of the shell, and in its fewer and less strongly curved lateral ribs. It is a much more coarsely ornamented variety than *T. eufaulensis* moorei.

*Types.*—Holotype, U.S.N.M. no. 76423; 1 figured paratype, U.S.N.M. no. 76424; 3 unfigured paratypes, U.S.N.M. no. 20955.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); northwest corner of Franklin County (12931); 6 miles southcast of Cooper (12929).

# TRIGONIA EUFAULENSIS MOOREI Stephenson, n.var.

## Pl. 20, figs. 4, 5

The type specimens of this variety are moderately well preserved external molds of a left and a right valve. On these the ribs are somewhat more numerous and more closely spaced, and the finer ribs on the dorsal and posterodorsal surfaces are sharper, and are not so completely broken into fine nodes, than are the corresponding features on the typical *T. cufaulensis* Gabb. The ornamentation is in general much finer than on the variety, *T. cufaulensis gabbi.* 

Approximate dimensions of the holotype, a left valve: Length 20 mm., height 16 mm., convexity not measurable.

Types.—Holotype, U.S.N.M. no. 76425; 1 figured paratype, U.S.N.M. no. 76426; 3 unfigured paratypes, U.S.N.M. no. 76427. Named for Mr. Wm. H. Moore, the original owner of the survey bearing his name.

Distribution in Texas.—Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924, type loc.); 3 7/10 miles southwest of Campbell 130

(15547): 1/3 mile below Martindale (15527).

## Unidentified specimens of TRIGONIA

An incomplete external mold of a medium-sized left valve of Trigonia (pl. 20, fig. 6) from the Neylandville marl in a cut of the Texas Midland Railroad, 1/2 mile north of Cooper, Delta County (14062, U.S.N.M. no. 76428), differs from T. stantoni in the finer character of the nodes surmounting the radiating ribs, in which respect it is more like the shell from the Ripley formation on Coon Creek, Tennessee, which Wade177 described under the name *T. thoracica* Morton. An internal mold of a right valve in the same lot probably belongs to the same species. Two internal molds of about the same size, from the same zone, near Cooper (4064, U.S.N.M. no. 76429), present no diagnostic specific characters.

Several fragments of Trigonia from the Kemp clay near Deatsville, 2 miles northwest of Webberville, Travis County (764, U.S.N.M. no. 21184), are too incomplete for satisfactory identification, but enough of the ornamentation is preserved on the dorsal and posterodorsal areas to indicate that the material does not represent either T. stantoni or T. castrovillensis, and probably belongs to an undescribed Two fragments that probably species. represent this same undescribed species were found in the Kemp clay on Cibolo Creek, 112 miles west of Zuehl. Bexar County (7721, U.S.N.M. no. 76430).

## Superfamily PECTINACEA

#### Family PECTINIDAE

## Genus PECTEN Müller, sensu lato

The family Pectinidae is represented in the Navarro group by 10 species, which are referable more or less questionably to at least 6 subgenera, one of which is new. The Upper Cretaceous Pectinidae are in need of monographic treatment.

#### Subgenus PECTEN Müller, 1776

species .-- Pecten maximum (Linné) Type (= "Ostrea" maxima Linné, designated by Schmidt, Versuch, Conch.-

Samml. 1818, p. 67, and by Children, Lamarck's Genera Shells, 1823, p. 66, fig. 89.

Of the ten species of Pectinidae only one is assigned, questionably, to the typical Pectens.

### PECTEN (PECTEN?) VENUSTUS Morton (variety?)

# Pl. 22, figs. 3 6

- 1833. Pecten renustus Morton, Am. Jour. Sci.,
- lst ser., vol. 23. p. 293, pl. 5, fig. 7. 1831. Pecten venustus Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 58, pl. 5, fig. 7.
- 1885. Pecten venustus Morton. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 45, pl. 7, figs. 1–4. (Geol. Survey New Jersey, Palcontology, vol. 1, p. 45, pl. 7, figs. 1-1, 1886.)
- 1905, Pecten renustus Morton, Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 11.
- 1907. Pecten venustus Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 478, pl. 51, figs. 1-5.
- 1916. Pecten renustus Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 591, pl. 34, figs. 6, 7. (In part.)
- 1923. Pecten venustus Morton. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 204, pl. 57, figs. 1-5.

The description which follows is based mainly upon 3 left valves and 1 incomplete right valve from the Corsicana marl near Marion, Guadalupe County. Shell small, subcircular in outline, subequilateral, inequivalve, thin in the umbonal region. Beak small, not projecting above the hinge line, situated slightly back of the midlength. About the posterior threefourths of the one available right valve is preserved; this shell is ornamented with 15 medium to strong, broadly rounded to squarish-topped ribs, three of which from the center forward are more or less bifid: the ribs are crossed by fine incrementals, and toward the dorsal and posterior parts each rib is surmounted by a row of small weak nodes; ribs are weak or wanting on a small area near the margin of the posterodorsal slope; the ears are broken away. On a small right valve from Bexar County the right ear is separated from the main shell by a sharp radial sulcus terminating in a moderately deep byssal notch: this ear bears 2 or 3 weak radial costae.

<sup>&</sup>lt;sup>377</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 60, pl. 20, figs. 1, 2, 1926.

The left valves are depressed convex and are ornamented with 17 to 20 narrow sharply developed full length ribs, separated by wider interspaces, and a few small intercalated ribs may appear toward the margin; the ribs are elegantly ornamented with small crestal spines formed by the upfolding of thin growth layers: these spines number about 3 to the millimeter. The incrementals are fine and sharp. The anterior ear of the left valve is larger than the posterior ear and is ornamented with 2 or 3 rather weak costae; it is separated from the main part of the shell by a proportionately wide radial sulcus of moderate depth. The posterior ear is ribless and rounds up to the main shell surface. The hinge is narrow and edentulus, but one or two weak crural ridges are present subparallel to the hinge line. The ribs are reflected on the interior of both valves.

Dimensions of one of the left valves: Length 7.3 mm., height 8.1 mm., convexity about 2 mm. Dimensions of another of the left valves: Length 7.9 mm., height 7.8 mm., convexity about 1.5 mm.

The shells of this species from different localities, and even from a single locality, exhibit some variation in outline, in the degree of bifurcation of the ribs, and in the development of intercalated ribs, but on the whole the group is a compact and well characterized one: it may later be possible to subdivide the group when a more adequate supply of material becomes available. The figured shells from Texas have fewer and coarser ribs than have the cotypes, and perhaps should be treated as a variety.

Types.—Cotypes, Academy of Natural Sciences of Philadelphia; 4 right valves, including the one originally figured by Morton. From "New Jersey." Three plesiotypes from Texas, U.S.N.M. no. 76431.

Distribution in Texas. --Navarro group, Nacatoch sand: ?Near Avery (13534).

Navarro group. Corsicana marl: 2 miles east of Marion (Tex. Bu. 2395, 3 specimens figured); well 7/20 mile south by west of St. Mary's University, Bexar County (16353).

Navarro group, Kemp clay: ?4 miles southeast of Zorn (10877).

*Outside distribution.* --- Mississippi: Prairie Bluff chalk and Owl Creek formation.

Alabama: Prairie Bluff chalk.

South Carolina: Peedee formation (well at Charleston, at depth of 1540 to 1550 feet, probably *Exogyra cancellata* zone).

Delaware: The reported occurrence of the species in the Matawan group of Delaware is questionable.

New Jersey: Questionably from the Marshalltown formation of the Matawan group, and from the Navesink marl and the Redbank sand of the Monmouth group.

Range.—-With the exception of the questionable occurrence of the species in the Marshalltown formation of New Jersey, and its reported occurrence in the Matawan formation of Delaware, it is restricted in its known geologic range to the *Exôgyra costata* zone, chiefly the upper part of that zone, in the Atlantic and Gulf Coastal Plain.

## Subgenus CAMPTONECTES Agassiz in Meek, 1864

Type species, Pecten lens Sowerby,

According to Article 21 of the International Rules, Agassiz (not Meek) is the accredited author of this subgenus (Meek, Smithsonian Misc. Coll. No. 177, p. 39, 1864).

### PECTEN (CAMPTONECTES) BUBONIS Stephenson, n.sp.

Pl. 21, figs. 3-6

?1916. Pecten argillensis Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 588, pl. 34, figs. 3-5.

Shell thin, subcircular in outline, subequilateral. subequivalve, depressed con-Beaks small, direct, depressed, vex. scarcely projecting above the hinge line, situated at about the midlength of the shell. Hinge straight, more than half as long as the shell, with 1 or 2 long, parallel crural ridges which interlock on opposite valves, and a deep central, triangular resilifer in each valve. The anterior ear of the right valve is longer than the posterior one and is separated from the main body of the shell by a deep anterior byssal notch, and by a narrow, deep channel which extends from the notch to the hinge margin at the beak; anterior ear of left valve a little larger than the posterior one: each of the four ears sharply separated from the main body of the shell by a radiating sulcus; these sulci diverge from the beak at an angle of about 96 degrees, and are slightly concave upward in their trend away from the beak. The surface is ornamented with numerous, crowded, nearly flat-topped, low, radiating bifurcating ribs which are separated by much narrower, sharp depressions; the ribs are somewhat irregular in their trend, and quite irregular in their width, which averages less than 0.5 mm., and rarely exceeds that amount; the ribs on the ears are similar to those on the body of the shell, though in general somewhat more irregular, and those on the anterior ears are The surface exhibits fine concenfiner. tric growth lines, but a few remnants indicate that in addition to these the surface originally possessed thin, concentric lamellae spaced 0.5 to 2 mm. apart, which outwardly curved downward, touching the shell, thus forming round-crested, crenulated ridges, the crenulations corresponding to the radiating ribs (see pl. 21, fig. 5); on most shells practically no evidence remains of the former existence of these ridges.

Dimensions of the holotype, a right valve from Mississippi shown in plate, 21. figure 3: Length 27 mm., height 27 mm. convexity about 4 mm.

Because of their fine state of preservation shells from the Owl Creek formation at Owl Creek,  $2\frac{1}{2}$  miles northeast of Ripley, Tippah County, Mississippi, are selected as types. The Texas shells are scarcely distinguishable from the Mississippi ones, though the ribbing averages a little finer.

Pecten (Camptonectes) argillensis Conrad,<sup>178</sup> the type of which came from somewhere in Tippah County, Mississippi, is a much smoother shell, as described and illustrated, and has a much wider angle of divergence at the beak; the whereabouts of the type is unknown. Pecten (Camptonectes) bellisculptus Conrad, which several authors have regarded as synonomous with P. argillensis, is a distinct species characterized by fine distinct radiating sculpture all over the surface.

The shell from the lower part of the Ripley formation at Coon Creek, Tennersee, which Wade referred incorrectly to *P. argillensis*, exhibits much finer sculpture than that of the present species, and in this respect is more like *P. bellisculptus* Conrad.

The shell described by Gardner from the Monmouth formation of Maryland under the name *P. argillensis* Conrad, is like *P. bubonis* except that the radiating ribs are more subdued, producing a smoother surface.

Pecten virgatus Nilsson,<sup>179</sup> from the Cenomanian of France, and Pecten (Camptonectes) curvatus Geinitz,<sup>180</sup> from the Cenomanian of England, are closely related species.

Types.—Holotype, a right valve from the Owl Creek formation, Owl Creek, 2½ miles northeast of Ripley, Mississippi, U.S.N.M. no. 76432; 2 figured paratypes, U.S.N.M. no. 76433; 5 selected unfigured paratypes, U.S.N.M. no. 76434; 1 example from Texas, U.S.N.M. no. 76435.

Distribution in Texas.—Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924); about 4 miles east-northeast of Greenville (10886); ½ mile below Martindale (7621, 15526, 15527); 1 3/10 miles north of McQueeney (7637, 1 specimen figured; 15524); 1 3/10 miles southeast of Marion (13389).

Navarro group, Kemp clay: Near Deatsville (764); ?near old Garfield (7603): 1½ miles northwest of Texas Hill, Travis County (15533); 2 7 '8 miles west southwest of Staples (10878); west of Zuehl (7085): 4/5 mile north of Zuehl (16489).

Navarro group, Escondido formation: Questionably on eastward-facing slope of Medina River valley, 2 miles below (?)

<sup>&</sup>lt;sup>178</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 283, pl. 47, fig. 3, 1860. (See Amer. Jour. Sci., vol. 5, p. 99, 1869.)

<sup>&</sup>lt;sup>179</sup>D'Orbigny, Alcide, Paléontologie Française, Terrain Crétacé, vol. 3, p. 692, pl. 434, figs. 7-10, 1843-1847.

<sup>&</sup>lt;sup>150</sup>Woods, Henry, A monograph of the Cretaceous Lamellibranetia of England, vol. 1, p. 159, pl. 29, figs. 7a, b, and pl. 37, fig. 16, 1904.

Castroville, Medina County (589); questionably 2 miles northwest of Nucces River crossing of Eagle Pass-Uvalde road, Uvalde County (1759).

Outside distribution. -Mississippi: Owl Creek formation.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Providence sand.

Maryland: Monmouth formation.

Range .- .- The species has been satisfactorily identified only from the Navarro group and formations of Navarro age, that is from the Exogyra costata zone. Closely related species, however, range downward through the Exogyra ponderosa zone, and perhaps still lower.

### PECTEN (CAMPTONECTES) KAUFMANENSIS Stephenson, n.sp.

#### Pl. 21, figs. 7-9

Shell small, very thin, subcircular in outline, subequivalve, subequilateral, both valves moderately convex. Beaks small, incurved, scarcely rising above the hinge line, situated at about the midlength of the shell and a little back of the midlength of the hinge; there is a faint twist of the beak and the umbonal portion of the shell toward the front. Anterior ears much larger than the posterior ones, and separated from the main body of the shell by narrow rather deep sulci; corresponding sulci on the posterior ears are shallow and not very well defined. Byssal sinus on anterior right ear deep and narnow, and the sulcus which extends from this sinus to the beak is deeper and broader than the corresponding sinus on the left ear. Hinge edentulous, but presenting a long narrow crenulated channel parallel to and closely bordering the hinge line. Resilifer not clearly seen. The available specimens are all internal molds from which the shell material is practically gone, but small portions adhering to two specimens, one a right and the other a left valve, show the surface to be ornamented with fine, close-set, low, broad-topped ribs of the kind seen on P. bubonis Conrad, but very much finer and fainter.

Dimensions of the larger figured left valve: Length 8.5 mm., height 8.6 mm., convexity 2 mm.? Dimensions of the

figured right valve: Length 7.1 mm., height 7.3 mm., convexity about 1.5 mm.

This species is about as large as P. simplicius Conrad. but it is much more convex, has a much deeper byssal sinus, exhibits a slight forward twist in the umbonal region, and is ornamented with faint costae.

Types.---3 figured cotypes, U.S.N.M. no. 76436; 6 unfigured cotypes, U.S.N.M. no. 76437.

Distribution in Texas.-Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); 4 miles north of Corsicana (17366).

#### Subgenus SYNCYCLONEMA Meek

Type species .- Pecten halli Gabh (== Pecten rigida Hall and Meek), Meek, Smith-sonian Misc. Coll. No. 177, p. 31, 1864.

Pecten rigida Hall and Meek<sup>181</sup> is described as having the surface of the right valve marked with concentric ridges and furrows, and that of the left valve smooth. Should the two valves prove to belong to different species, as seems probable, it would be necessary to select one of them as the type of rigida. This leaves the true nature of the subgenus in doubt until the selection has been made.

### PECTEN (SYNCYCLONEMA?) SIMPLICIUS Conrad

# Pl. 20, figs. 10, 11

- 1860. Pecten simplicius Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 283, pl. 46, fig. 44.
- 1864. Sincyclonema? simplicus (Conrad). Meek, Smithsonian Misc. Coll., vol. 7, no. 177, p. 7.
- 1876. Sincyclonema simplicius (Conrad). Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 319.
- 1885. Amusium simplicum (Conrad). Whitheld, U.S.Geol. Survey Mon., vol. 9, p. 51, pl. 7, figs. 11, 12. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 51, pl. 7, figs. 11, 12, 1886.)
- 1907. Pecten simplicius Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 480, pl. 51, fig. 6.
- 1916. Pecten simplicius Conrad. Gardner, Mary-1930. Perten simplicius contait. Upper Cretacous (2 vols.), p. 595, pl. 34, figs. 8, 9.
  1923. Pecten simplicius Conrad. Stephenson, North Carolina Geol. and Econ. Survey,
- vol. 5, pt. 1, p. 199, pl. 55, figs. 6-11.

<sup>1S1</sup>Hall, James, and Meek, F. B., Amer, Acad, Arts and Sci. Mem., n. ser., vol. 5, p. 381, pl. 1, figs. 4a-c, 1856.

## 1926. Peeten simplicius Conrad. Wade, U. S. Geol. Survey Prof. Paper 137, p. 62, pl. 20, fig. 7.

Shell small, thin and papery, subcircular to broadly subovate in outline, the height in some specimens being slightly greater than the length. Subequivalve, subequilateral, both valves depressed con-Beaks small, rising slightly above vex. the hinge line, situated at about the midlength of the shell and a little back of the midlength of the hinge line. Ears sharply separated from the main body of the shell by narrow sulci; anterior ears a little larger than the posterior ones; byssal sinus on anterior ear of right valve very shallow. The sulci at the lower margins of the ears diverge from the beaks at angles of 90 to 95 degrees on different individuals. Hinge of left valve, as seen in a Mississippi shell, edentulous, but presenting a long, narrow, shallow channel bounded by thin crural ridges, parallel to the hinge line. Resilifer triangular, deep, opening inward. Adductor scar large, broadly subovate, situated slightly above the midheight, and a little back of the midlength. Surface of both valves smooth, with a shiny transparent surface glaze which overlaps the margins. Incremental lines very fine.

Dimensions of the left valve shown in plate 20, figure 11: Length 7.9 + mm., height 7.5 + mm., convexity about 0.5mm. The right valve shown in plate 20, figure 10, is 8 mm. long and 9 mm. high.

Types.—The original description cites Eufaula, Alabama, and Tippah County. Mississippi, as the known occurrences of the species. The types are probably lost. It is not known from which of the two localities the figured specimen came. Two plesiotypes from Texas, U.S.N.M. no. 20961.

Distribution in Texas.—Taylor marl: Little River, below Cummins Bridge, 5½ miles south by west of Buckholtz, Milam County (12897); Salado Creek, 3½ miles east of Alamo Heights, Bexar County (7649).

Upson clay: A "tank" east of the railroad, 3½ miles south of Darling, Maverick County (8254). Navarro group, Nacatoch sand: Vicinity of Kaufman (761, 2 specimens figured); field 3/5 mile west of Kaufman (14103); vicinity of Chatfield (762); north edge of Córsicana (518).

Navarro group, Corsicana marl: Near Terrell (15544); Onion Creek, 2½ miles west of old Garfield (14156); ½ mile below Martindale (7621, 15527); Salado Creek, upstream from Highway 90, Bexar County (16671).

Navarro group, Kemp clay: 2 miles northwest of Deatsville (14128).

Outside distribution.- Arkansas: Nacatoch sand and Arkadelphia clay.

Mississippi: Ripley formation, Owl Creek formation.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Blufftown formation, Ripley formation (upper part), and Providence sand.

The Carolinas: Snow Hill member of Black Creek formation, and Peedee formation (upper part).

Maryland: Matawan formation and Monmouth formation.

Delaware: Crosswicks clay, Marshalltown formation, and Mount Laurel sand.

New Jersey: Red Bank sand.

Range.—In the Coastal Plain the species ranges from the Taylor marl and beds of Taylor age (*Exogyra ponderosa* zone), upward to the upper part of the Navarro group and beds of Navarro age (*Exogyra* costata zone),

# PECTEN (SYNCYCLONEMA?) ARCHERI Stephenson, n.sp.

# Pl. 20, figs. 8, 9

Shell small, thin, subcircular to broadly subovate in outline, the height in most specimens being slightly greater than the length. Only right valves are available, and these are subequilateral and only slightly couvex. Beaks small, scarcely rising above the hinge line, situated at about the midlength of the shell. Ears separated from the main body of the shell by well defined sulci, the anterior ear apparently a little larger than the posterior one. Byssal sinus of anterior ear well defined but relatively shallow. Hinge not

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clearly exposed. Surface ornamented with well defined, round-crested concentric folds, becoming successively more widely spaced away from the beak, separated by wider, broadly concave depressions. The folds become weak toward the dorsal margins. Some shells faintly show a thin depressed line near the crest of each concentric fold. The better preserved shells exhibit a thin, transparent, surface glaze which slightly overlaps the margins.

Dimensions of the holotype: Length 7 mm., height nearly 7.7 mm., convexity scarcely 1 mm. Dimensions of a larger unfigured shell from near Chatfield: Length 10.8 mm., height 11.2 mm., convexity about 1 mm.

This species is clearly distinct from *Pecten simplicius* Conrad, the right valves of which are plain and smooth. *P. conradi* (Whitfield)<sup>182</sup> is a closely related species but compared with the type its concentric markings are more sharply defined, and are separated by broad, flat-bottomed depressions. The concentrically ribbed right valve of *Pecten (Syncyclonema)* halli Gabb (== Pecten rigida Hall and Meek) appears to be closely allied to archeri.

Types.—Holotype, U.S.N.M. no. 76438; 1 paratype, U.S.N.M. no. 20896. Named for the Hon. Branch T. Archer, Commissioner of the Republic of Texas to the United States.

Distribution in Texas.—Navarro formation, Nacatoch sand: North edge of Corsicana (518, type loc.); vicinity of Corsicana (763); 4 miles north of Corsicana (17366); 2½ miles west by south of Corsicana (17368); vicinity of Chatfield (762); field south of Chatfield (7569); ¾ mile east of Chatfield (7571); vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103).

Range.—From the Nacatoch sand of the Navarro group in Navarro and Kaufman counties, Texas; questionably in the Corsicana marl of the Navarro group in Caldwell County, Texas.

## PECTEN (SYNCYCLONEMA?) KINGI Stephenson, n.sp.

## Pl. 20, fig. 7

The description is based on one right valve. Shell small, depressed, thin, subcircular in outline, subequilateral. Beak small, nonprominent. Ears sharply separated from the main shell by sulci which diverge from the beak at an angle of about 100 degrees. Surface ornamented with numerous small, closely spaced, low, broad-topped, concentric ribs which are formed by thin lamellae attached at the upper edge and folded down closely upon the shell below; the lower edge of each lamella laps up a little onto the next rib below; the ribs are continued upward across the ears where they are narrower and more closely spaced. On the main shell the ribs number 3 or 4 to the millimeter, and on the ears 5 or 6 to the millimeter. The anterior ear is obscurely preserved but apparently the byssal sinus is shallow.

Length 11.4 mm., height 11.2 mm.

This shell is not apt to be confused with other described species of *Pecten*. Compared with *P. archeri* it is larger, is longer in proportion to the height, and the concentric ribbing is conspicuously stronger.

Holotype.---U.S.N.M. no. 76439. Named in honor of the collector, Philip B. King.

Distribution in Texas.—Navarro group, Corsicana marl: Salado Creek, below St. Hedwig road, Bexar County (16669).

# PECTEN (SYNCYCLONEMA?) TRAVISANUS Stephenson, n.sp.

#### Pl. 22, figs. 1, 2

Shell small, thin, subcircular in outline, depressed convex, the two valves of about equal ventricosity. As in most other species of *Pecten* the different individuals of this species vary slightly in the proportion of length to height; some individuals are approximately equal in length and breadth. Beaks small, flattish, barely projecting above the hinge line; angle of umbonal shoulders about 95 degrees near the beak, the angle increasing somewhat distally. Hinge edentulous; a narrow, rather weak ridge closely parallels

<sup>&</sup>lt;sup>382</sup>Whitfield, R. P., U. S. Geol, Survey Mon., vol. 9, p. 52, pl. 7, figs. 8-10, 1885.

the hinge margin; resilifer small, trigonal. Internal features obscure, but the surface of the internal mold faintly reflects the sculpture of the outer surface. The margin of the main shell is approximately circular; the ears are relatively large; anterior ear of right valve separated from the main shell by a narrow, deep sulcus; byssal sinus shallow. Surface of left valve, including the ears, nearly smooth but marked by faint, fine, irregular radiating lines, and by very fine growth lines; these vary in strength, some shells appearing very smooth; the surface of the internal mold shows faint, broad, very shallow, irregular, radiating undulations. Surface of right valve ornamented with fine, sharp, concentric lines spaced 2 or 3 to the millimeter; these are much stronger than those on the left valve; fine radiating lines can be detected but are exceedingly faint; ears marked only with fine growth lines; broad, exceedingly faint, radiating undulations are also noticeable on this valve.

Dimensions of the holotype, a left valve: Length 15.7 mm., height 15.1 mm., convexity about 1 mm.

This species is larger and has more surface ornamentation than *Pecten simpli*cius Conrad. *Pecten parvus* (Whitfield), reported to have come from the Navesink marl at Freehold, New Jersey, is a closely related species, but apparently has more pronounced, and more regularly developed radial sculpture of the *Camptonectes* type.

*Types.*—Holotype, U.S.N.M. no. 76440; 1 figured paratype, U.S.N.M. no. 76141; 7 unfigured paratypes, U.S.N.M. no. 76442.

Distribution in Texas.—Navarro group, Corsicana marl: 2<sup>4</sup>/<sub>5</sub> miles cast of Cooledge (13832); 2 miles south of Corsicana (16167); 5 miles southwest of Quinlan (15546).

Navarro group, Kemp clay: Webberville (7601, type loc.; 13910); well near old Garfield (1641).

# PECTEN (SYNCYCLONEMA?) sp.

One internal mold of a small *Pecten* with a fragment of the shell adhering, from the Kemp clay on Colorado River at Webberville (7601) is about the same size as *P. (Syncyclonema) archeri*, but it is not quite so high, the height and length being about equal, and the interspaces between the concentric ridges appear to be a little wider and there is a well defined line in the bottom of each interspace. U.S.N.M. no. 76443.

## Subgenus NEITHEA Drouet<sup>183</sup>

Type species. Pecten aequicostatus Lamarck (designated by Chenu, Man. Conchyl. Pal., vel. 2, p. 186, figs. 941–944, 1862).

## PECTEN (NEITHEA) BEXARENSIS Stephenson, n.sp.

# Pl. 22, figs. 7, 8

Shell of moderate size, subcircular in outline, right valve strongly convex, greatest ventricosity central above the midheight, nearly equilateral, strongly inequivalve. Dorsal slopes steep, overhanging the ears. Beak of right valve prominent. strongly incurved, direct, slightly overhanging the beak of the left valve. The hinge line is straight and about 12 mm. long. The species belongs to a group of strongly inequivalve shells in which the right valve exhibits six major ribs with two or more smaller, subequal ribs in the interspaces between the larger ones. In this species there are two intermediate ribs, and the major ribs are only slightly more prominent than the intermediate ones. All the ribs are rather prominent, broadly rounded over the crests, and are wider than the interspaces. Each of the ribs is further ornamented with 2 to 5 subribs which are low and broadly roundcrested; these tend to become obscure and die out toward the beak. The interspaces are rather broadly rounded and are either without subribs or may have one or two very obscure subribs. The space between any two intermediate ribs is a little narrower than the spaces on either side of the major ribs. The space between the anterior major rib and the anterior ear presents one central narrow, shall subrib and back of this is a still smaller very obscure subrib. The space between the posterior major rib and the posterior ear presents 4 subribs and several intermediate

<sup>&</sup>lt;sup>183</sup>Drouet, C., Mém. Soc. Linnéenne, Paris, vol. 3, p. 186, 1825.

very obscure subribs. The external interspaces are reflected on the inner surface of the shell as square-topped internal ribs, narrower than the interspaces; the subribs are only obscurely reflected internally. The anterior ear is of moderate size and is convex in a sinuous manner outward from the beak; it is separated from the main shell by a narrow, sinuous groove, and is ornamented with 7 or 8 small, narrow, unequal, radiating ribs. The posterior ear is subequal to the anterior one, and is similarly ornamented, except that on the holotype 4 of the centrally located ribs are so spaced as to form two pairs. The concentric markings consist of fine sharp, somewhat irregularly spaced ridges of submicroscopic size, numbering 5 to 10 to the millimeter. The left valve is not represented in the type material.

Dimensions of the holotype. a right valve: Length 23 mm., height 23.5 mm., convexity about 9 mm.

This species has its nearest ally in *Pecten (Neithea) austinensis* (Kniker), from the Austin chalk at Austin, Texas, but differs mainly in that the two ribs between the major ribs are less closely crowded together; there is also a more obscure development of subribs in the bottoms of the interspaces. According to the measurements given for the Austin species, *P. (Neithea) bexarensis* appears to be more convex, and more nearly subcircular in outline.

*Types.*—Holotype, U.S.N.M. no. 76444; 2 unfigured paratypes, U.S.N.M. no. 76445.

Distribution in Texas.—Navarro group, Corsicana marl: 14 miles west by south of San Antonio (Tex. Bu. 742); 6 miles east of Castroville (15502, 16156, and Tex. Bu. 3282, type loc.); ?near Castroville (7665).

#### Subgenus AMUSIUM Bolten<sup>184</sup>

Type species. - Pecten pleuronectes Linné.

# PECTEN (AMUSIUM?) DANEI Stephenson, n.sp. Pl. 22, figs. 9, 10

Shell small, thin and fragile, subcircular to broadly subovate in outline, somewhat inequilateral due to large posterior ear. depressed convex. Beaks small and flattish, nonprominent, not well preserved, situated about midway of the length of the shell. Anterior ear of left valve of modcrate size, smooth, separated from the body of the shell by a narrow, moderately deep sulcus. Posterior ear of left valve, large, broad, triangular, smooth, not limited by a sulcus below, but passing upward in a gentle slope into the body of the shell. The hinge is edentulous and overhangs inwardly along the dorsal margin. The inner surface bears 10 or 12 narrow sharply defined radiating ribs which are loosely attached to the shell and are easily separated from it in the form of rod-like bodies; in the available material these ribs do not bear a definite relationship to the exterior ribs, for some of them occur beneath the interspaces of the exterior, and others beneath the exterior ribs; on the basis of these internal ribs the species is referred questionably to the subgenus Amusium, but the large posterior ear and the strong radiating ribs throw doubt on the correctness of this assignment. Outer surface ornamented with about 12 irregularly spaced, narrow, sharply defined radiating ribs which are reflected on the inner surface as radiating depressions; incremental lines numerous, sharp, becoming fine, overlapping lamellae toward the ventral margin, where they produce closely spaced serrations on the tops of the ribs.

The holotype as it originally broke out of its marl matrix revealed only the interior of the shell. A photograph of the interior was made (pl. 22, fig. 10), after which melted wax was pressed into the cavity and an attempt was made to clean the matrix from the exterior; as the shell was fragile and did not completely adhere to the wax, the attempt was only partly successful (pl. 22, fig. 9); however, the ribs are well shown and enough shell fragments remain to reveal the character of the surface ornamentation.

Dimensions of the holotype: Length 14 mm., height 12 mm.

Types.—Holotype, U.S.N.M. no. 76446; 1 paratype, U.S.N.M. no. 76447; 2 paratypes, U.S.N.M. no. 76448. Named in honor of Carle H. Dane, who assisted the

<sup>&</sup>lt;sup>154</sup>Bolten, J. F., Museum Boltenianum, 1st ed., p. 165, 1798. (Ed tod with supplementary references, by Peter Friedrich Roeding.)

writer in collecting fossils at this and other localities in east-central Texas.

Distribution in Texas. – Navarro group, Corsicana marl: 2 ½ miles east of Cooledge (13832, 14137, type lots).

# PECTEN (AMUSIUM) sp.

Two poorly preserved specimens of Pecten (14130), found in the Kemp clay on San Gabriel River 2/5 mile above the Gabriel-Thorndale road crossing. San Milam County, exhibit 6 irregularly spaced, but well defined internal ribs, and a smooth outer surface: they therefore belong to the subgenus Amusium. These shells are small, about 10 mm, long, and occur in a phosphatic, strongly glauconitic. chalky conglomerate at water level at the base of a bluff: the overlying beds appear to belong to the Kemp clay and the conglomerate is therefore referred to that division. U.S.N.M. no. 76449.

#### Subgenus RADIOPECTEN Stephenson, new subgen.

Type species.—*Pecten (Radiopecten) weeksi* Stephenson, n.sp.

Etymology. -Radius, a ray; pecten, a comb.

The subgenus *Radiopecten* is based on the well preserved material from Coon Creek, McNairy County, Tennessee, described by Wade<sup>185</sup> under the name *Pecten quinquenarius* Conrad (U.S.N.M. no. 32761), and here renamed *Pecten (Radiopecten) weeksi*, in honor of Mr. Dave Weeks, owner of the Coon Creek fossil locality. This species is nearly related to *Pecten (Radiopecten) mississippiensis* (Conrad), from either the Ripley or the Owl Creek formation, in Tippah County, Mississippi.

The distinguishing characters of the subgenus are, the slight convexity of the valves, the irregularity of the ribbing, and the narrow, sharply defined ribs on the left valve, contrasting with the broadly rounded ribs of the right valve. The incremental lines are fine, sharp, and densely crowded. The left valve is noticeably more convex than the right valve. In outline the shell is broadly subovate, the length slightly exceeding the height.

## PECTEN (RADIOPECTEN) MISSISSIPPIENSIS Conrad?

### Pl. 22, figs. 11-13

- 1860. Pecten mississippiensis Conrad. Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 283.
- ?1885. Pecten quinquenarius Conrad. Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 47, pl. 7, figs. 13-16. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 47, pl. 7, figs. 13-16, 1886.)
- 1905. Pecten mississippiensis Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 11.
- 1907. Pecten quinquenaria Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 476. pl. 50, fig. 13 (questionably figs. 10–12).
- 1923. Pecten mississippiensis Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 201, pl. 55, figs. 12–15.
- 1926. Pecten quinquenarius Conrad. Wade, U. S.Geol. Survey Prof. Paper 137, p. 65, pl. 21, figs. 6 9.

Shell thin, subequilateral, inequivalve, subcircular to broadly subovate in outline, adults generally a little longer than high, both valves only slightly convex. Beaks small, flattish, barely rising above the hinge line, situated at about the midlength of the shell. Ears moderately large. triangular, subequal, marked only by fine transverse growth lines; the lower bounding lines of the cars diverge from the beak at an angle of 100 degrees or more; byssal sinus of right ear well developed, but not profound: a shallow sulcus extends from the byssal notch to the beak. Hinge long, narrow, edentulous with a shallow groove paralleling the upper margin. Resilifer triangular, opening inward, bordered by narrow, diverging crural ridges. The inner surface of the shell reflects the ribs and folds of the outer surface. Surface of left valve marked by five broad, low folds each of which supports a prominent, narrow central rib; on the sides of the folds and in the intermediate depressions are smaller, sharp ribs which number 2 to 4 between any two of the larger ribs; of these smaller ribs the ones nearest the major ribs are the larger and this is especially true on the second, third, and fourth folds from the anterior end. Surface of right valve marked by unequal,

<sup>&</sup>lt;sup>185</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 65, pl. 21, figs. 6-9, 1926.

broad, radiating folds, each fold corresponding to one of the major depressions on the left valve. Sharp radiating ribs are wanting, but on adults each of the ribs of the left valve is reflected as a shallow more or less distinct depression on the outer surface of the right valve.

Dimensions of a medium sized left valve from Chatfield: Length 38 mm., height 38 mm., convexity about 3 mm.

This species has been referred by several authors to *Pecten quinquenarius* Conrad, from the Upper Cretaccous exposed on the Chesapeake and Delaware Canal. The latter is based on an internal mold of an obviously related form, which is specifically indeterminable, but which appears to be much more strongly plicated.

Types.—Two rather small specimens, one a left and the other a right valve, in the collection of the Academy of Natural Sciences of Philadelphia, from Tippah County, Mississippi, probably from the Owl Creek formation on Owl Creek  $2^{1}\frac{1}{2}$ miles northeast of Ripley. Two plesiotypes, left valves, from Texas, U.S.N.M. no. 76450; 1 plesiotype from Texas, U.S.N.M. no. 76451.

Distribution in Texas.—Taylor marl: ?Gully south of the Clear Springs road, 4 miles southeast of New Braunfels, Guadalupe County (7626).

San Miguel formation: ?Westward-facing slope east of the railroad, 1½ miles northeast of Paloma, Maverick County (8253); ?Del Rio road, 12½ miles northwest of Eagle Pass, Maverick County (1513); ?Uvalde road, 12½ miles northeast of Eagle Pass, Maverick County (8257).

Navarro group, Neylandville marl:  $3\frac{1}{2}$  miles west-northwest of Corsicana (16166).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761, loc. of 2 plesiotypes); road 3/5 mile west of Kaufman (12923; 14098, loc. of 1 plesiotype); vicinity of Chatfield (762); 2½ miles north of Corsicana (14114).

Outside distribution.—Arkansas: Nacatoch sand.

Mississippi: Ripley formation and Prairie Bluff chalk. North Carolina: Peedee formation (upper part).

Range.—The species ranges questionably from the upper part of the Taylor marl, and beds of upper Taylor age (upper part of *Exogyra ponderosa* zone), upward through the Nacatoch sand of the Navarro group, and through beds of corresponding age (*Exogyra costata* zone) elsewhere in the Coastal Plain.

## Family SPONDYLIDAE

## Genus SPONDYLUS Linné

#### SPONDYLUS MUNITUS Stephenson, n.sp.

# Pl. 24, figs. 8, 9

Shell of moderate size, subovate in outstrongly convex, subequilateral, line. strongly inequivalve. The two valves differ markedly in form and sculpture. The left valve is depressed convex: shell destroyed except the ears, and parts of the dorsal slopes; it is thin about the beak, and thickens toward the margins; the portion of shell remaining on the posterodorsal slope exhibits 7 low ribs of somewhat irregular trend. narrower than the interspaces and supporting a few scattered low, blunt spines; the posterior ear is of moderate size and is marked by 3 or 4 very obscure ribs, and along its lower margin is a row of 6 very unequal closely spaced spines; the 3 outer spines are partly broken away, but are strong and prominent, while the 3 inner ones are smaller and, though broken, are probably shorter; the anterior ear is slightly smaller and is wanting in radial ribs; one low strong rib on the upper border of the main shell surface, borders the lower margin of this ear: impressions on the internal mold indicate that the left valve is completely ornamented with numerous, radiating ribs of unequal size and spacing, the ribs in general being narrower than the interspaces; the mold also exhibits numerous, fine radiating lines between and on the rib impressions; the beak is small, incurved, direct, and projects only slightly above the hinge line. About the posterior half of the right valve is preserved and exhibits a series of prominent, wall-like, concentric ridges rising nearly at right

angles to the surface, or tilted slightly upward, averaging about 1 millimeter in thickness and spaced somewhat irregularly but reaching a maximum of 8 mm. apart toward the outer margin; all these ridges are more or less broken away, but one can be seen to rise fully 5 mm. above the surface: the surface of the shell between the concentric ridges is marked by low, obscure radiating ribs, 11 or 12 to the centimeter, wider than the shallow interspaces, and the whole surface exhibits fine radiating lines; both ribs and lines are reflected on the internal mold; the beak is strongly incurved and strongly prominent; its tip is obscured by the attachment of the shell over a large area to one or more irregular shell fragments; the ears are small and are ornamented only with growth lines. The hinge is straight and about 14 mm. long. With the exception of the rib markings on the internal mold, the internal features are not observable.

Dimensions of the holotype: Right valve, length 23 mm., height 32 mm., thickness about 22.5 mm.; left valve, length 22 mm., height 26.7 mm., convexity about 4.5 mm.

The only American Upper Cretaceous species at all like this one is *Spondylus* gregalis (Morton), from the Navesink marl, New Jersey. It is a larger, more elongated and less ventricose species, and has flatter, more irregular, concentric laminae.

Holotype .-- U.S.N.M. no. 76452.

Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (15524).

# SPONDYLUS sp.

The inner surface of a right valve of an indeterminate species of *Spondylus*, the entire outer surface of which is attached to a shell of *Gryphaca*, was found in the Corsicana marl on Mesquite Creek, 4 miles north of Castroville, Medina County (Tex. Bu. 747). The inner surface reflects numerous unequal ribs of unequal but rather close spacing.

# Genus PLICATULA Lamarck

# PLICATULA MULLICAENSIS Weller

Pl. 22, figs. 14, 15

1907. Plicatula mullicaensis Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 485, pl. 52, figs. 3-5.

1926. Plicatula urticosa Morton. Stephenson, Geol. Survey Alabama Special Rept. no. 14, p. 248, pl. 91, fig. 3.

Shell thin, subcircular to broadly subovate in outline, the height generally greater than the length, depressed convex. Hinge not seen well preserved in the Texas material. As seen in molds from Alabama the resilifer lies between two crural ridges which diverge slightly from above down-A large subcircular adductor ward. muscle scar is situated a little above the mid-height, and a little back of the midlength. Surface ornamented with numerous, closely spaced, irregularly arranged, illdefined, radiating ribs which are set with slender spines formed by numerous tightly rolled upfolds of the growth lamellae; these folds project obliquely downward and outward, and may attain as much as 3.5 or 4 mm. in length. The spines on the right valve are coarser and somewhat more irregularly distributed than those on the left valve; as seen in a large suite of specimens from Alabama, there is considerable individual variation in the coarseness of the ornamentation.

Dimensions of the shell with both valves shown in plate 22, figures 14, 15: Length 22 mm., height 24 mm., thickness 6.5 mm. The largest shells attain a length of 35 mm.

The Texas material has been compared with the type of Weller's species, *Plicatula mullicaensis*, from the stratigraphically lower Navesink marl of New Jersey and the ornamentation on the Texas specimens appears to be essentially identical. The ornamentation on *P. urticosa* Morton, from New Jersey, is coarser, though Morton's Alabama specimens may have been the same as Weller's species.

Types. - Weller's figured cotypes are in the Walker Museum at the University of Chicago, U.C. 18631: they are from the Navesink marl at Mullica Hill, Gloucester County, New Jersey; in the same museum are topotypes, U.C. 18630. Plesiotype from Texas, U.S.N.M. no. 76453.

Distribution in Texas.—Navarro group, Corsicana marl: 2 miles east of Marion (Tex. Bu. 2395); near Castroville (7665, 7796): 4 or 5 miles north by west of Castroville (10627, Tex. Bu. 747); 2 miles south of Cliff (10870, 1 specimen figured): well 7/20 mile south by west of St. Mary's University. Bexar County (16353, 16408): arroyo 2 5 mile south by west of St. Mary's University, Bexar County (16354, Tex. Bu. 744); well on G. A. Harper Survey, Medina County, at depth of 1045 feet (13844).

Outside distribution. - Mississippi: Prairie Bluff chalk.

Alabama: Prairie Bluff chalk.

New Jersey: Navesink marl.

## PLICATULA TETRICA Conrad?

### Pl. 22, fig. 16

- 1860. Plicatula tetrica Conrad. Acad. Nat. Sci. Philadelphia Jour., vol. 4, 2d ser., p. 283, pl. 46, fig. 26.
- 1905. Plicatula tetrica Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 12.

Shell extremely irregular in form but in general subovate in outline, higher than long, attached valve generally flattish, free valve flattish to moderately convex. None of the specimens is perfect enough for accurate measurement, but one is 36 mm. high, and a small attached valve is 15 mm. long and 18 mm. high. Hinge not well preserved. Inner surface smooth or faintly reflecting the exterior ribs. Surface of free valve ornamented with 10 or 12 prominent, extremely irregular, radiating ribs, set with numerous, irregularly distributed, low to prominent spines which are formed by sharp unfolds of prominent growth lamellae; some of the spines are as much as 5 mm. high: on some specimens finer ribs may appear between the larger ones, and these may become large and prominent as they pass toward the ventral margin. The ribs on the unattached part of the lower valve appear to be smaller, more numerous and somewhat more regular than those on the upper valve; they are also spinose. Both

the ribs and spines exhibit great variability on different individuals.

Compared with the type this specimen is more finely and more elaborately sculptured. *Plicatula clarki* Stephenson from the Snow Hill member of the Black Creek formation of North Carolina is a similar, though more regularly ornamented species.

Types.—Holotype, Academy of Natural Sciences of Philadelphia; from Tippah County, Mississippi. One questionable plesiotype from Texas, U.S.N.M. no. 76454.

Distribution in Texas.—Navarro group, Corsicana marl: 23/5 miles north by east of Malta (12933, 1 specimen figured); 11/4 miles south by east of Oak Grove (16160); 2 miles south of Oak Grove (12932); 21/2 miles west of McQueeney (15523); ?fuller's earth pit 14 miles west of San Antonio (15520); well on G. A. Harper Survey, Medina County, at depth of 1045 feet (13844).

Outside distribution.—Arkansas: Questionably in the Nacatoch sand.

Mississippi: From "Tippah County," from the Ripley formation or the Owl Creek formation.

Range.—Corsicana marl of the Navarro group in Texas; Nacatoch sand in Arkansas; questionably the Ripley and Owl Creek formations in Mississippi.

# Unidentified specimens of PLICATULA

Two indeterminate imprints of *Plicatula* were found in the Corsicana marl on Medina River at the lower crossing at Castroville, Medina County (7796). U.S.N.M. no. 76455.

A print of a small, poorly preserved, ribbed *Plicatula* was found in a gray calcareous clay matrix near Webberville, Travis County (1612); from its geographic position it presumably came from the Kemp clay of the Navarro group. U.S.N.M. no. 76456.

The phosphatic mold of the exterior of a *Plicatula*, found by Mr. and Mrs. D. A. Saunders of Greenville, about 50 yards northeast of the Lone Oak pike, on the east side of Cowleach Fork of Sabine River, about 12 miles southeast of Greenville, Hunt County (11247), is ornamented with fine spines resembling those of *P. mullicaensis* Weller. (Pl. 22, fig. 17.) The spines, however, are set on more definitely developed radiating ribs, and the mold may represent a varietal form. The containing bed is a phosphatic conglomerate at the base of the Eocene (Midway group), in which fossils from the underlying Kemp clay are present as a mechanical mixture. U.S.N.M. no. 76457.

### Family LIMIDAE

#### Genus LIMA Bruguière,156 sensu lato

Type species. Ostrea lima Linné, a Recent species from the Mediterranean.

#### LIMA SELLARDSI Stephenson, n.sp.

#### Pl. 24, figs. 10, 11

Shell subovate in outline, oblique, equivalve, inequilateral, moderately convex. Beaks moderately prominent, strongly incurved, direct, situated somewhat advance of the midlength. Ears small, the posterior one a little larger than the anterior one, both curving upward into the dorsal slopes without sharp delincation. Dorsal slopes steep, the posterior one the steeper. Hinge line nearly straight and about 6 mm. long in the holotype. Anterior margin slightly sinuous near its junction with the hinge line, becoming broadly rounded below, fullest above the midheight, passing broadly and regularly into the ventral margin; the lower posterior margin is more sharply rounded than the ventral, and passes upward into a long forward sloping posterodorsal margin which is slightly convex, and becomes a little sinuous as it meets the hinge line. Dorsal margin slightly arched. Surface ornamented with 20 to 24 moderately prominent ribs, of which the ones on the dorsal slopes become progressively weaker toward the ears; the ears are nearly smooth; the ribs are a little wider than the broadly V-shaped interspaces. in the bottom of each of which is a small, fairly distinct subrib; the main ribs are smooth and round-crested from the beak well down over the shell, but as they approach the margin they become more sharp-crested and bear small tubercles; the subribs are smooth near the beak,

but as they pass downward they exhibit first faint, then distinct, tubercles which are smaller and closer together, but more distinct, than those on the main ribs. The fine growth lines become a little stronger toward the margins.

Dimensions of the holotype, a left valve: Length 14 mm., height 15 mm., convexity about 4 mm. A paratype, a right valve, on matrix near the holotype, is 14.4 mm. high.

This species belongs to a subgroup of the genus Lima of which L. oxypleura (Conrad), L. pelagica (Morton), and L. pelagica covensis Stephenson,<sup>187</sup> are closely related members. L. geronimoensis also exhibits a similar though very much coarser type of ribbing. L. sellardsi agrees most closely in the number of its ribs, with L. oxypleura, from the Snow Hill member of the Black Creek formation of North Carolina, but the latter attains a larger size and has sharpercrested ribs on which the serrations begin to appear at a lesser distance from the beak.

Types.—Holotype, U.S.N.M. no. 76458; 1 figured paratype, U.S.N.M. no. 76459; 6 selected unfigured paratypes, U.S.N.M. no. 76460.

Distribution in Texas.—Navarro group, Kemp clay: 2% miles west-southwest of Staples (10878, type loc.); near Deatsville (764, 14125).

# LIMA PELAGICA WOOLSEYI Stephenson, n.var.

### Pl. 23, figs. 5, 6

This varietal form is closely related to Lima pelagica covensis Stephenson,<sup>188</sup> but differs in having smoother dorsal slopes and more weakly developed subribs between the main ribs. The holotype is ornamented with 35 ribs which are V-shape in cross section and are faintly and finely tuberculated, especially toward their distal ends: the tubercles are not well preserved in the holotype but may be more clearly seen on the paratype shown in plate 23, figure 6. At the bottom of each interspace between the main

<sup>&</sup>lt;sup>186</sup>Bruguière, J., Tabl. Encycl. Méth. Vers. Coq. etc., vol. 2. pl. 206, 1797. See also Stewart, R. B., Acad. Nat. Sci. Philadelphia Spec. Pub. No. 3, p. 124, 1930.

<sup>&</sup>lt;sup>157</sup>Stephenson, L. W., North Carolina Geol, and Econ. Survey, vol. 5, pt. 1, pp. 210-212, pl. -8, figs, 1-3 and 16-18, 1923.

<sup>155</sup>Step'senson, L. W., op. cit., p. 211.

ribs is a faint raised line or subrib which is minutely tuberculated. The ribs on the posterodorsal slope become very weak and practically fade out before the dorsal margin is reached: almost the lower half of the anterodorsal slope is smooth except for the fine, sharp growth lines.

Dimensions of the holotype, a right valve: Length 13 mm., height 15.8 mm., convexity about 5 mm.

*Types.*—Holotype, U.S.N.M. no. 76461; 1 figured paratype, U.S.N.M. no. 76462.

Distribution in Texas.—Navarro group, Corsicana marl: ½ mile below Martindale (7621, 15526, type lots: 15527): I 3/10 miles north of McQueeney (15524).

## LIMA DEATSVILLENSIS Stephenson, n.sp.

#### Pl. 23, figs. 7, 8

Shell of moderate size, subovate in outline, oblique, inequilateral, moderately convex. Beak prominent, strongly incurved, direct, situated considerably in advance of the midlength. Ears relatively small, the posterior one the larger, not sharply delimited but curving upward into the steep dorsal slopes. The umbonal ridge is broadly rounded and extends from the beak to the lower posterior extremity. Hinge line straight, about 11 mm. long in the holotype. Interior of shell not uncovered. Dorsal margin slightly arched: anterior margin a little sinuous near its junction with the hinge line, broadly rounded below, fullest above the midheight, passing in a broad curve into the ventral margin; the latter is rather sharply rounded as it curves around into the posterior margin which is fullest above the midheight; posterodorsal margin long and a little convex, becoming slightly sinuous as it passes up to the hinge line. The surface is almost completely covered with radiating ribs which, including small and large ones, number 23 or 24. Ten or 12 of the main ribs are broadly roundcrested, and are separated by wider, broadly concave interspaces; each of these larger ribs as it leaves the beak is prominent, squarish in cross section, and smooth, but as it passes downward the crest rounds off, faint subribs appear, and these become more distinct downward; on the fully developed major ribs the subribs number 3 to 5 and are rather evenly distributed over the crests and down over the sides. Subribs appear in the interspaces also; they number 1 or 2 in the interspaces on the umbonal ridge, but increase to 3 or 4 from the umbonal ridge forward. The ribs become successively more simple down over the dorsal slopes, and the few small ribs on the ears The surface is further are undivided. marked by numerous small, closely spaced, sharp, concentric laminae which are produced into small tubercles where they intersect the subribs and the smaller undivided ribs, thus giving to the surface a finely lined and granulated appearance.

Dimensions of the holotype, an incomplete left valve: Length 22 + mm., height 25 mm., convexity 8 mm.

The ribs on this species are broader, more rounded and much more completely broken up into subribs than are the ribs on *Lima geronimoensis*. *Lima squarosa* (Gabb) (*— Ctenoides squarosa* Gabb) from "Alabama" is a related species, but the major ribs are fewer and coarser and the minor ribs on the larger ribs are very weak.

Types.--Holotype, U.S.N.M. no. 76463;

 figured paratype, U.S.N.M. no. 76464. Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637, loc. of paratype); 21/2 miles west of McQueeney (15523).

Navarro group, Kemp clay: Near Deatsville (764, loc. of holotype); 3 miles northwest of Lockhart (Tex. Bu. 1174).

### LIMA COKEI Stephenson, n.sp.

Pl. 24, figs. 12, 13

This species resembles *L. deatsvillensis* in form and type of sculpture, but is more simply ribbed. The concentric ornamentation is finely laminar, closely spaced, and sharply defined; there is one fine, sharp subrib running down the crest of each larger rib, and on some ribs of some specimens the rudimentary beginning of a subrib on one or both sides of a major rib is indicated by indistinct rows of nodes on the concentric laminac. One subrib only appears in each interspace. Small, more or less distinct nodes appear on the subribs where they are crossed by the concentric laminae.

The dimensions of the holotype, a medium-sized right valve, are: Length, about 12 mm., height 14 mm., convexity about 5 mm. The largest specimen in the collection, a right valve is about 20 mm. Iong and 22 mm. high.

*Type.*—Holotype, U.S.N.M. no. 76465: 2 figured paratypes, U.S.N.M. no. 76466, 5 unfigured paratypes, U.S.N.M. no. 76467. Named for the Hon. Richard Coke, Governor of Texas, 1874 to 1877.

Distribution in Texas.--Navarro group, Corsicana marl: 2½ miles west of Mc-Queeney (15523).

# LIMA GERONIMOENSIS Stephenson, n.sp.

## Pl. 23, fig. 11

Shell of moderate size, subovate in outline, oblique, inequilateral, moderately convex. The distinguishing characters of the species lie in the surface ornamentation which consists of about 25 ribs, counting those of both small and large size. All except a few of the ribs on the lower dorsal slopes and ears are prominent and subsquarish in cross section, and are separated by deep squarish interspaces a little narrower than the ribs. The ribs continue smooth and subsquarish well down over the shell, but toward the ventral margin tend to sharpen up on the crests and to become finely tuberculated; these features begin farther up on the ribs on the umbonal ridge and on the posterodorsal slope, than they do on the rest of the shell. In the bottom of each interspace is a fine riblet which may become finely tuberculated as it passes toward the ventral margin; some of the wider interspaces exhibit 1 or 2 still finer additional riblets toward the ventral margin.

Dimensions of the holotype, a left valve whose form and outline have been somewhat distorted by the oxidation of the ferruginous matrix: Length 22 - mm., height 22 mm., convexity 7(?) mm.

This species exhibits a simpler type of ornamentation than that on *Lima deatsvillensis*; the ribs stand up more prominently and are more squarish than on that species. The ribbing is similar to that of *L. sellardsi* except that it is very much coarser.

Holotype .---- U.S.N.M. no. 76468.

Distribution in Texas.---Navarro group. Corsicana marl: 2 miles south of Cliff (10370, type loc.): 6 miles east of Castroville (15502).

## LIMA GUADALUPENSIS Stephenson, n.sp.

### Pl. 23, figs. 9, 10

This shell is similar in form and outline to L. deatsvillensis. The ribbing is similar to that on L. geronimoensis except that the ornamentation is less simple. The ribs number about 24; on the main part of the shell they are prominent, subsquarish, and slightly narrower than the interspaces; they are simple from the beak to a point about halfway to the ventral margin where, on 6 or 8 of the central more prominent ribs, 1 or 2 obscure, fine subribs appear near the crest, and these become somewhat more distinct toward the margin; on some shells 3 subribs are present on the upper part of these major ribs near the shell margin; subribs are not distinguishable on the larger ribs on the anterior and posterior slopes. One or two fine subribs appear in the bottoms of the interspaces between the larger ribs on the main part of the shell, and these subribs extend more than halfway to the beak; they become fainter both toward the front and rear and are wanting between the ribs on the dorsal slopes. The fine concentric laminae are much weaker than on L. deatsvillensis, but they produce small, distinct nodes where they cross the intercostal subribs, and much weaker nodes where they cross the costal subribs.

Types. -- Holotype, a left valve, U.S.N.M. no. 76469; 1 figured paratype, U.S.N.M. no. 76470; 3 unfigured paratypes, U.S.N.M. no. 76471.

Distribution in Texas.--Navarro group, Corsicana marl: 1 3 10 miles north of McQueeney (7637, 15524, type lots).

Navarro group, Kemp clay: ?from near Deatsville (764).

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# LIMA? ACUTILINEATA TEXANA Stephenson, n.var.

## Pl. 23, figs. 1, 2

Shell thin, subovate, elongate, very oblique, equivalve, very inequilateral. moderately convex. Beaks small, incurved direct, scarcely projecting above the hinge line, situated about the middle of the hinge line, and about  $\frac{1}{4}$  the length of the shell from the anterior extremity. A broad, very shallow depression extends from the beak almost directly downward to the anteroventral margin. Anterior ears small and bent inward almost at right angles to the plane separating the valves; posterior ears small, not sharply delimited, the surface curving upward into the steep dorsal slopes. A well defined byssal opening produces a sharply defined notch in the anterodorsal margin of each valve just below the end of the hinge. Hinge not clearly uncovered, length 6 or 7 mm. in adults. Anterior margin rather broadly rounded above, passing downward into a long, very broadly convex ventral margin; posteriorly the ventral margin becomes less broadly rounded and passes upward into a rather sharply rounded posterior extremity: posterodorsal margin long, strongly inclined forward, straight or slightly concave anteriorly, curving upward at the end to meet the hinge line. Surface incompletely ornamented with fine, acute, radiating, faintly tuberculated ribs of unequal strength and spacing on the different parts of the shell; on the posterior, most inflated part the ribs are most widely spaced, their maximum separation along the ventral margin being 1 to 1.5 mm. on large individuals; on the depressed area below the beak, the ribs are practically wanting, though exceedingly fine, closely spaced, radiating lines can be detected; in front of this nearly smooth area the ribs are fine, distinct, closely spaced on the type, but more widely spaced on some other individuals: the interspaces between the main ribs on the posterior part of the shell are broadly concave and nearly smooth, though very faint. closely spaced radial interlining can be detected on some specimens. The posterodorsal slope lacks

radiating ribs. The radiating sculpture is somewhat variable on different individuals. The shell is further marked by fine, sharp, concentric growth lines, which have a pronounced development on the ribless posterodorsal slope. The ribs are reflected on the interior of the shell as radiating depressions.

Approximate dimensions of the holotype, a rather small right valve: Length 17.3 mm., height 15 mm., convexity about 3.5 mm. Large individuals attain a length and height of 25 mm. or more.

This variety is essentially like the typical L.? acutilineata (Conrad), except that the radiating sculpture is much less strongly developed, and this difference holds for all the specimens examined. The species differs much from typical *Lima* and should perhaps be separated from it.

Types.--Holotype, U.S.N.M. no. 76472: 1 figured paratype, U.S.N.M. no. 76473.

Distribution in Texas.- Navarro group, Corsicana marl: ½ mile below Martindale (7621): 1 3/10 miles north of Mc-Queeney (7637; 15524, holotype); 2 miles cast of Marion (Tex. Bu. 2395); 14 miles west of San Antonio (Tex. Bu. 743); near Castroville (7665, 1 figured paratype; 7796); 6 miles east of Castroville (15502, 16156); 4 or 5 miles north by west of Castroville (Tex. Bu. 747).

Navarro group, Kemp clay: Near Deatsville (764): 3 miles northwest of Lockhart (Tex, Bu, 1173).

#### LIMA KIMBROENSIS Stephenson, n.sp.

# Pl. 23, figs. 3, 4

The holotype is a left valve which is imperfectly preserved in the umbonal portion, and along the anterior and ventral margins. Shell of moderate size, subovate in outline, inequilateral, somewhat oblique, and moderately ventricose. Umbonal ridge broadly rounded. The beaks, hinge, and internal features cannot be observed, and the margins are imperfect. The surface is ornamented with at least 30 radiating ribs; these are strongest on the central and umbonal portions, and become weaker on the dorsal slopes, though they are distinct almost to the

upper margins; the interspaces are V-shaped and on the main surface there is a distinct line on the bottom of each interspace; the ribs are all more or less distinctly, though finely, tuberculated; those on the anterior portion of the shell are round crested, and the tubercles are blunt and elongated a little in the direction of the growth lines; the ribs on the umbonal inflation are rather sharp-crested and V-shaped in cross section and the tubercles are finer and more pointed; on the posterodorsal slope the ribs and tubercles become duller and more like those on the anterior part of the shell.

Approximate dimensions: Length 8 mm., height 9 mm., convexity 2.5 mm.; one fragment questionably referred to this species pertains to a shell more than twice as large as the holotype.

This shell has the form of *Lima pelagica woolseyi* Stephenson, but the concentric markings are sharper and more pronounced, the ribs are more strongly developed on the dorsal slopes, and the tubercles on the dorsal slopes are much more strongly developed.

Types.—Holotype, U.S.N.M. no. 76474; 1 figured paratype, U.S.N.M. no. 76475.

Distribution in Texas.—Navarro group, Corsicana marl: 1/4 mile west of Kimbro (14129, type loc.); 11/4 miles south by east of Oak Grove (16160); ?6 miles east of Castroville (15502).

# LIMA? SAYREI Stephenson, n.sp.

## Pl. 23, figs. 12, 13

Shell very large, subovate in outline, oblique, inequilateral, equivalve, depressed convex; shell wall thin, greatest inflation below the beaks well above the midheight, from which place the surface rounds off very gently to the anterior, ventral and posterior margins. Beaks and ears not preserved except that a small portion of one ear, the right anterior, remains. Internal features not uncovered. Anterior margin broadly rounded; ventral margin more sharply rounded than the anterior margin; posterior margin rather sharply rounded well below the midheight; posterodorsal margin long. broadly concave. The surface is ornamented with about 38 narrow, low, but

sharply distinct, round-crested, radiating ribs, separated by nearly flat-bottomed interspaces which are somewhat variable in width, but which are 3 or 4 times as wide as the ribs. Each of the interspaces is traversed by 3 to 6 fine, closely-spaced subribs, which are crowded out one after another by the convergence of the larger ribs in the direction of the beak. The concentric growth lines are not conspicuous, except on the crests of the major ribs, where certain of the growth lamellae are sharply upfolded into small, distinct spines which number 4 to 10 per centimeter; these spines are best developed toward the margins, and are most closely spaced toward the anterior of the shell. The growth lines also produce very fine, low, more or less obscure tubercles where they cross the intercostal subribs, but these tubercles are scarcely visible except under a magnifying glass. The small remaining portion of the right anterior ear bears 4 strong, tuberculated, radiating ribs. Attached to the outer surface of the holotype are numerous clusters of encrusting bryozoa. Seven or 8 small individuals of Gryphaea cf. belli Stephenson, are also attached to the shell.

All the margins are broken and incomplete, so that the dimensions cannot be accurately determined. Approximate dimensions: Length 84 mm., height 95 mm., thickness 33 mm.

This beautiful shell is the largest species assigned to *Lima* known from the Upper Cretaceous of the Coastal Plain. Its features perhaps call for separation from that genus, but for the present it is left in it. The only other species that approaches it in size is *L. insolita* Stephenson. from the Peedee formation, near Rocky Point, Pender County, North Carolina, which is 60 mm. high. The major ribbing of that species is very similar in spacing to that of *L. sayrei*, but the minor features of the sculpture are not well enough preserved in the North Carolina species for satisfactory comparison with the Texas species.

Types.—Ĥolotype, U.S.N.M. no. 76476; 2 unfigured paratypes, U.S.N.M. no. 76477. Named in honor of Dr. A. N. Sayre of the United States Geological Survey. Distribution in Texas.—Navarro group, Corsicana marl: Ravine east of Medio Creek,  $\frac{4}{5}$  mile south of Castroville road (15621); bluff on Medio Creek about  $\frac{4}{5}$ mile below Castroville road (15622); 6 miles east of Castroville (Tex. Bu. 53, loc. of holotype).

#### Unidentified specimens of LIMA

The Neylandville marl in the Corsicana road 21/2 miles north of Corbet, Navarro County (17365), yielded one small incompletely preserved shell which appears to be closely related to *Lima acutilineata* (Courad). U.S.N.M. no. 76483.

Several incompletely preserved specimens of *Lima*, all apparently belonging to one species, have been found in the Nacatoch sand as indicated below. In form and size the species is like Lima pelagica woolseyi but the details of sculpture cannot be clearly seen on any of the specimens. As determined by impressions on the internal molds (pl. 24, fig. 14), the surface is ornamented with 18 or 20 radiating ribs which are strongest on the umbonal ridge and become weak to obscure on the antero- and posterodorsal slopes; so far as can be ascertained the ribs are simple and the interspaces are flat-bottomed and as wide or wider than the ribs, with no intermediate riblets or lines. The figured specimen measures: Length 11 mm., height 12.5 mm., convexity about 4 mm. The largest shells attain a height of about 18 mm. The species is similiar to Lima reticulata Forbes, from the Upper Cretaceous of "New Jersey," which, if it has been correctly identified by American authors, is much more finely ornamented and bears 10 or 15 more ribs than the Texas shells. The type of Forbes' species, which presumably is in the British Museum, has not been compared with the Coastal Plain shells which are commonly referred to it. The material was obtained at the following places: Vicinity of Corsicana (763, U.S.N.M. no. 76478);  $2\frac{1}{2}$  miles north of Corsicana (14114, U.S.N.M. no. 76179); 3 miles northeast of Corsicana (9545, U.S.N.M. no. 76480); vicinity of Kaufman (761, U.S.N.M. no. 20968); Kaufman of (14098,figured, west U.S.N.M. no. 76482.

One internal mold of *Lima*, with a few fragments of shell adhering to it, from the Corsicana marl, public road,  $1\frac{1}{4}$ , miles south by east of Oak Grove, Bowie County (16160), is similar to *L. deats-villensis cokei*, except that the details of the sculpture are noticeably coarser. It probably should be treated as another variety of *L. deatsvillensis*, but the specimen is scarcely complete enough to serve as a type. U.S.N.M. no. 76185.

A fragment of a small unidentified Lima was found in a concretion in the Kemp clay in a gully west of public road, 2 miles north-northwest of Deatsville, Travis County (14128). About 16 sharply defined ribs may be counted on the internal mold and on the inner surface of the shell which is preserved in the matrix of the counterpart; but the dorsal slope is wanting and the character of the ribs on the outer surface cannot be ascertained. U.S.N.M. no. 76484.

## Superfamily ANOMIACEA

#### Family ANOMIIDAE

# Genus ANOMIA (Linné) Müller

### ANOMIA TELLINOIDES Morton

#### Pl. 24, figs. 5-7

- 1830. Anomia ephippium (Lamarck)? Morton, Am. Jour. Sci., vol. 17, p. 284.
- 1833. Anomia tellinoides Morton, Am. Jour. Sci., vol. 23, p. 294, pl. 5, fig. 11.
- 1834. Anomia tellinoides Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 61, pl. 5, fig. 11.
- ?1885. Anomia tellinoides Morton. Whitfield, U. S. Geol. Survey Mon., vol. 9, p. 43, pl. 4, fig. 12, questionably fig. 13, (Geol. Survey New Jersey, Palcontology, vol. 1, p. 43, pl. 4, fig. 12, questionably fig. 13, 1886.)
- 1905. Anomia tellinoides Morton. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 12.
- 1907. Anomia argentaria Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 496, pl. 54, fig. 15 (not figs. 11-14).
- 1916. Anomia tellinoides Morton. Gardner, Maryland Geol. Survey. Upper Cretaceous (2 vols.), p. 610, pl. 35, figs. 3, 4.
- 1923. Anomia tellinoides Morton. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 223, pl. 60, figs. 1-7.
- 1926. Anomia tellinoides Morton. Stephenson, Geol. Survey of Alabama Special Rept. No. 14, p. 242, pl. 87, figs. 1, 2.

All the available specimens are left valves. Shell inequilateral, thin to moderately thick and firm, variable in outline in different individuals, but in general broadly subovate with a tendency to a roughly triangular outline; depressed to moderately convex in form, most strongly inflated anteriorly, becoming somewhat compressd posteriorly. Beaks small, pointed, projecting slightly above the dorsal margin, opisthogyrate, situated somewhat back of the midlength. In gencral the anterior margin is regularly rounded, the ventral margin broadly rounded, and the posterior margin rather sharply rounded at about the midheight; in typical specimens the posterodorsal margin is truncated to slightly concave. Hinge edentulous and developed only in front of the beak; it is 10 to 15 mm. long, 1 to 3 mm. broad, and roughly striated with concentric growth lines. Resilifer submerged within the margin, deeply impressed, flaring inwardly, and marked on the sides with fine striae. The scar of the anterior retractor muscle is small and is situated just below the forward end of the resilifer, and centrally well above the midheight the byssal, posterior retractor and adductor scars are closely crowded together, apparently forming one large, irregular scar, as the material is preserved. Surface marked with fine concentric growth lines which in some specimens develop into fine overlapping lamellae; some shells are marked by irregularly spaced, shallow growth undulations; rare specimens exhibit fine, rather obscure radiating lines, but these were not observed on any of the Texas shells.

Dimensions of a large shell: Length 36.5 mm., height 30 mm., convexity about 8 mm.

The following characters separate this species from Anomia argentaria Morton: The surface is as a rule wanting in radiating lines, but when present they are relatively very weak; the hinge is limited to that part of the dorsal margin in front of the beak; the beak is marginal, more pointed and projects a little; the posterodorsal margin is generally either nearly straight or a little concave; and the three larger muscle scars are closely crowded simulating one large irregular scar.

The shell described by Wade<sup>189</sup> as Anomia tellinoides Morton, is a slightly distorted left valve of A. argentaria Morton.

Types.---Holotype, collection of the Academy of Natural Sciences of Phila-delphia. From "New Jersey." Although inadequately labeled, it seems likely that the holotype came from the Mount Laurel sand, the lowest formation of the Monmouth group. Two plesiotypes from Texas, U.S.N.M. nos. 76186, 76487.

Distribution in Texas.-Navarro group, Neylandville marl: 7 1/10 miles northcast of Cooper (14083); 1/2 mile north of Cooper (14062); 2 miles southwest of Cooper (7511, 1 specimen figured); 8 miles southwest of Greenville (11251, 1 specimen figured; 17382); 21/2 miles northeast of Royce City (13834); 1 mile east of Gastonia (7550); 3 miles northeast of Drane (16161); 2 7/10 miles northwest of Cooledge (16169).

distribution. — Mississippi: Outside Selma chalk (in Exogyra cancellata zone).

Tennessee: Selma chalk (in Exogyra cancellata zone).

Central west-central Alabama: and Ripley formation (in Exogyra cancellata zone); Selma chalk (in Exogyra cancellata zone).

East-central Alabama and Chattahoochee region (Alabama-Georgia): Lower part of Ripley formation (Exogyra cancellata zone).

North Carolina: Lower part of Peedee formation (Exogyra cancellata zone).

Delaware: Mount Laurel sand.

New Jersey: Common in the Mount Laurel sand.

Range.—The species is known only from the Exogyra cancellata zone (lower part of Exogyra costata zone), throughout the Coastal Plain from New Jersey to Texas. In Texas the species is recorded from 8 localities in the Neylandville marl.

### ANOMIA ARGENTARIA Morton

### Pl. 24, figs. 1-4

1833. Anomia argentaria Morton, Am. Jour. Sci.,

 1st ser., vol. 23, p. 293, pl. 5, fig. 10,
 1834. Anomia argentaria Motton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 61, pl. 5, fig. 10.

189Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 69. pl. 23, figs. 3, 4, 1926.

- 1858. Anomia sellaeformis Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 330, pl. 34, fig. 6.
- 1876. Anomia argentaria Morton. Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 319.
- 1885. Anomia argentaria Morton. Whitfield, U. S.Geol. Survey Mon., vol. 9, p. 42, pl. 4, figs. 10, 11 (not fig. 9, which is Ostrea plumosa Morton). (Geol. Survey New Jersey, Paleontology, vol. 1, p. 42, pl. 4, figs. 10, 11, 1886.)
- 1885. Diploschiza cretacea Conrad. Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 43, pl. 4, figs. 4, 5 (not figs. 6-8). (Geol. Survey New Jersey, Paleontology, vol. 1, p. 43, pl. 4, figs. 4, 5, 1886.)
- 1905. Anomia argentaria Morton. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 12.
- ?1906. Anomia argentaria Morton. Böse, Bol. Inst. Geol. Mexico, No. 24, p. 38, pl. 1, fig. 8.
- 1907. Anomia argentaria Morton. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 496, pl. 54, figs. 12-14 (not fig. 15, which is A. tellinoides Morton).
- 1916. Anomia argentaria Morton. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 608, pl. 35, figs. 1, 2.
- 1923. Anomia argentaria Morton. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 226, pl. 60, figs. 10–14.
- 1926. Anomia argentaria Morton. Wade, U.S. Geol. Survey Prof. Paper 137, p. 68, pl. 22, figs. 10-13.
- 1926. Anomia tellinoides Motton. Wade, U.S. Geol. Survey Prof. Paper 137, p. 69, pl. 23, figs. 3, 4.
- 1926. Anomia argentaria Morton. Stephenson, Geol. Survey Alabama Special Rept. no. 14, p. 250, pl. 92, fig. 10. (Figures only.)
- 1929. Anomia argentaria Morton. Dane, Arkansas Geol. Survey Bull. 1, pt. 27 (op. p. 150), figs. 7, 8. (Figures only.)

The following description pertains to left valves only: Shell thin to moderately thick, inequivalve, typically subequilateral, more or less irregular in outline in different individuals but in general subcircular to broadly subelliptical; varies in ventricosity from concave to strongly convex. Beak small, depressed to slightly prominent, situated centrally and generally 1 to 2 mm. back from the margin. Hinge edentulous and about equally developed in front and behind the beak, except as modified on many individuals by crowding; striated by fine growth lamellae. Resilifer a submerged elongated pit, deeply impressed, flaring inwardly, finely striated on the sides,

notched in the middle of the upper mar-The four muscle scars, named in gin. order from above downward, are the anterior retractor, the byssal, the posterior retractor, and the adductor; the 3 lower scars are not always sharply separated from each other (pl. 24, fig. 4). The anterior retractor scar is small and is situated just in front of the resilifer: the byssal scar is relatively large and is crossed from above downward by a shallow depression: the posterior retractor scar is just below the byssal scar and is not more than half as large: the adductor scar is about the same size or a little smaller than the posterior retractor. and is situated just back of it: the byssal. posterior retractor and adductor scars cannot be readily differentiated in many weathered or otherwise poorly preserved shells. Surface marked by fine concentric growth lines and lamellae and, on well preserved shells, by fine, almost microscopic, closely spaced, radiating lines; on many worn or corroded specimens the fine lines have been destroyed and the surface appears smooth.

The right valves of this species are extremely thin and fragile. and are rarely found preserved. One specimen from the Nevlandville marl in a ditch of the Texas Midland Railroad, 41/2 miles west of Cooper, Delta County (7512), consists of a left valve of Anomia argentaria fitting snugly down into and conforming to the contour of the interior of a fragment of a young shell of Exogyra cancellata (see pl. 24, fig. 1). When this left valve was lifted out there was found beneath it, closely adhering to the inner surface of the Exogyra, a thin film of shell with broken outside edges; this is a part of the right valve of the Anomia. Most of the remainder of the right valve adheres to the inner surface of the left valve, though some of the fragile fragments were lost in cleaning. The right valve is nearly as large as the left valve which overlaps it slightly. A large, oval opening appears in the thin shell layer adhering to the Exogyra at about the right position for the byssal foramen.

Dimensions of the flattish shell shown in plate 24, figure 3: Length 30.8 mm., height 23.3 mm., convexity 4.1 mm. Dimensions of the moderately convex shell shown in plate 21, figure 2: Length 22.3 mm., height 22.2 mm., convexity 7 mm.

This is one of the most common and widely distributed molluscan shells of the zones of *Exogyra ponderosa* and *E. costata* in the Atlantic and Gulf Coastal Plain; it is not, however, abundantly represented in the collections from the Navarro formation.

The species is easily distinguished from *A. tellinoides* by its radiating sculpture, the position of the beak back from the dorsal margin, and by the continuation of the hinge area back of the beak.

The species described by Conrad under the name *Diploschiza cretacea*, which in 1923 I included in the synonymy of *Anomia argentaria*,<sup>190</sup> is not an *Anomia*. As shown in a recent paper by me, *Diploschiza cretacea* Conrad is a valid genus and species.<sup>191</sup>

*Type.*—Collection of the Academy of Natural Sciences of Philadelphia. "From New Jersey." Three plesiotypes from Texas, U.S.N.M. nos. 76488, 76489, 76490.

Distribution in Texas.—Taylor marl: Paris-Enloe road, 5 miles southeast of Howland in Delta County (7500); San Marcos River, below mouth of Blanco River, Hays County (7618); small arroyo, 1/3 mile east of Staples road, 2<sup>1</sup>/<sub>1</sub> miles south of San Marcos, Hays County (7617); Guadalupe River, 4 miles southeast of New Braunfels, in Guadalupe County (7627); gully south of Clear Springs road, 4 miles southeast of New Braunfels in Guadalupe County (7626); a mile north of Marion, Guadalupe County (13388).

Wolfe City sand member of Taylor marl: Cut of Santa Fe Railroad, 11/4 miles east by north of Wolfe City, Hunt County (9562); cut of same railroad, 11/2 miles east by north of Wolfe City (9710); cut of same railroad, 2 miles east by north of Wolfe City (9709). Pecan Gap member of Taylor marl: Texas Midland railroad, 2 miles north of Enloe, Delta County (5317); cut of Santa Fe Railroad, 1/2 mile east of Pecan Gap, Delta County (9714).

Anacacho limestone: From a cliff, 1/5 mile north of Cliff, Medina County (12906).

Upson clay: Westward-facing bluff on Sauz Creek, 3 miles northwest of Paloma, Maverick County (8256).

Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (4064, 1 specimen figured; 7509, 14062);  $4\frac{1}{2}$  miles southwest of Cooper (7512, 1 specimen figured); 3/5 mile northeast of Royce City (13835); 1 mile east of Gastonia (7550, 1 specimen figured);  $1\frac{1}{2}$  miles east of Gastonia (7549); 10 miles north of Cameron (13864).

Navarro group, Nacatoch sand: West of Kaufman (761); field 3/4 mile west of Kaufman (14103); vicinity of Chatfield (762).

Navarro group, Corsicana marl: 1<sup>1</sup>/<sub>4</sub> miles south by cast of Oak Grove (16160); about 5 miles east by north of Greenville (12924); 1 mile southeast of Moore's store, Travis County (Hill coll. no. 46); 2 miles cast of Marion (Tex. Bu. 2395); 6 miles east of Castroville (Tex. Bu. 3282).

Navarro group, Kemp elay: 10 miles south-southeast of Greenville (Tex. Bu. 739): Buckman Survey, 4 miles south of Manor (Tex. Bu. 2399); near Deatsville (14125); near Garfield (7603); 27/8 miles west-southwest of Staples (10878); near McQueeney (7631).

Outside distribution. Arkansas: Questionably in the Tokio formation, and in the Brownstown marl. Ozan formation, Marlbrook marl, and Nacatoch sand.

Tennessee: Sand facies representing Selma chalk, and Coon Creek tongue of Ripley formation.

Mississippi: Tombigbee sand, Selma chalk, Coffee sand, Ripley formation, Owl Creek formation, and Prairie Bluff chalk.

Central and west-central Alabama: Tombigbee sand, Selma chalk (*Exogyra cancellata* zone and upper part), and Prairie Bluff chalk.

<sup>&</sup>lt;sup>180</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 226, 1923.

<sup>&</sup>lt;sup>191</sup>Stephenson, L. W., Jour. Paleontology, vol. 8, pp. 273-280, pl. 38, 1935.

East-central Alabama and Chattahoochee region (Alabama-Georgia); Blufftown formation, Cusseta sand, Ripley formation, and Providence sand.

Carolinas: Snow Hill member of Black Creek formation and Peedee formation.

Maryland: Matawan formation and Monmouth formation.

Delaware: Crosswicks clay, Marshalltown formation, and Mount Laurel sand.

New Jersey: Magothy formation, Merchantville clay, Woodberry clay, Marshalltown formation, Navesink marl, and Red Bank sand.

Range. --With the exception of a questionable occurrence in the Tokio formation (Austin age) of Arkansas, the species ranges through the Taylor and Navarro formations and beds of equivalent age, throughout the Atlantic and Gulf Coastal Plain.

#### Family PULVINITIDAE

The taxonomic position of this family has not been established.

## Genus PULVINITES Defrance

- 1824 and 1826. Pulvinites Defrance, Dictionnaire des Sciences Naturelles, vol. 32, p. 316 (1824); vol. 44, p. 107 (1826), pl. 88 in separate volume on Zoologie-Conchyliologie et Malacologie, fig. 3.
- 1827. Pulvinites Defrance. Blainville, Man. de Malacologie et de Conchyliologie, p. 530, pl. 62, bis., fig. 3.
  1838. Pulvinities Defrance. Bronn, H. G.,
- 1838. Pulvinities Defrance. Bronn, H. G., Lethaea Geognostica (2d ed.), Band 2, p. 697, pl. 32, fig. 12. (See Atlas, 3d edition, same pl. and fig., 1850–1856, in U.S.Geol. Survey Library.)
- ?1853. Hypotrema d'Orbigny, Jour. Conch., tome 4, p. 435.
- 1858. Pulvinites Defrance. Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 330.
- 1869. Pulvinites Defrance. Stoliczka, Mem. Geol. Survey India, Palaeontologia Indica, Cretaceous fauna of southern India, vol. 3, p. 394.

1887. Hypotrema d'Orbigny. Fischer, Manuel de Conchyliologie, p. 934, 2 text figures.

Type species .- Pulvinites adansonii Defrance.

The original figure illustrating *Pul-vinites adansonii* Defrance, the type species of the genus, shows transverse ligamental grooves very much like those on *P. ar-genteus* Conrad, but it does not show the muscle scars which, as stated in the text, were not preserved. Fischer (see

synonymy) states that *Pulvinites* is perhaps a synonym of *Hypotrema* d'Orbigny which, however, was not described until 1853. It is not possible from the figures alone to determine positively that these two genera are identical, but if they are *Pulvinites* has priority.

A comparison of the original illustrations of *Hypotrema* and *P. argenteus* Conrad suggests that they are congeneric.

In the original description of the genus in volume 32 of the Dictionnaire (p. 316), no locality is given, but in vol. 44 (p. 107), the locality is stated to be "Fréville, Départment de la Manche," France. Stoliczka says (p. 394), "The geologic position of this species is unknown; it is said to have been found at Favrille, and is either from Jurassic or Cretaceous beds."

### PULVINITES? ARGENTEUS Conrad

#### Pl. 24, figs. 15, 16

- 1858. Pulvinites argentea Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 330, pl. 34, fig. 5.
- 1860. Pulvinites argentea Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 298, pl. 46, fig. 51.
- 1867. Pulvinites argentea Conrad, Am. Jour. Conch., vol. 3, pp. 9, 10.
- 1871. Pulvinites argentea Conrad. Stoliczka, India Geol. Survey Mem. Palaeontologia Indica, Cretaceous fauna of southern India, vol. 3, pp. 394, 395.
- 1926. Pulvinites argentea Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 52, pl. 15, figs. 5, 6, 8, 9.
- 1926. Pulvinites argentea Conrad. Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 248, pl. 91, figs. 5, 6. (Figures only.)

Shell inequilateral, inequivalve, flattish, somewhat irregular in different individuals, but roughly subcircular with a tendency to a subtriangular outline: shell wall of moderate thickness, firm. Beak of left valve small, nonprominent, projecting only slightly above the hinge; beak of right valve obscure. The hinge in adults is rather broad, is about 15 mm. long and is crossed transversely by 12 to 14 sharply impressed, flat-bottomed ligamental grooves which are a little wider than the flat-topped interspaces. On the interior of the left valve are two large muscle scars. The upper scar is situated several millimeters below the hinge and is ornamented with riblets: this scar marks the attachment of the byssus, which passes through a foramen just below the beak of the right valve, to some foreign object of attachment. The other large scar is the adductor: it is subcircular and is situated subcentrally. On the left valve a small muscle scar is situated just below the hinge and slightly back of its midlength. On the right valve the place of the upper large scar is taken by the byssal foramen; the adductor scar is similar to that on the left valve; a small, irregular muscle scar is situated just below and a little back of the foramen, and there are several small, irregular pits a little back of the upper part of the foramen. In front of the adductor on each valve, and about 10 mm. back of the anterior margin of the shell, are several obscure, broadly curved ridges which are subparallel to the margin. The margins of the shell tend to form a subcircle, but many shells show a tendency to slight elongation posteriorly a little below the midheight, and most shells have a truncated posterodorsal margin which may be straight, slightly concave, or slightly convex. The surface is smooth with the exception of a rather vigorous development of incremental lines and overlapping lamellar layers.

Approximate dimensions of the plesiotype shown in plate 24, figure 15: Length 53.5 mm., height 52 mm., thickness 6 mm.

The Texas material includes three left valves which show only the external surface, and one internal mold of a left valve, all from the same locality. The foregoing description is based chiefly on perfect shells from the type locality on Owl Creek,  $2\frac{1}{2}$  miles northeast of Ripley, Tippah County, Mississippi.

Types.—The original types, which should have been preserved in the collections of the Academy of Natural Sciences at Philadelphia, are lost. Good topotypes are in the collections of the United States National Museum at Washington, U.S.N.M. nos. 20667, 73635. Two plesiotypes from Texas, U.S.N.M. no. 76491.

Distribution in Texas.---Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637, 2 specimens figured; 15524).

*Outside distribution.*—Arkansas: Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Owl Creek formation.

Chattahoochee region (Alabama-Georgia): Ripley formation (upper part) and Providence sand.

Range.—In Texas the species has been recorded only from the Corsicana marl. But the known stratigraphic range of the species in the Gulf region is somewhat longer than this, it having been recorded from the Nacatoch sand of Arkansas, from the lower part of the Ripley formation (Coon Creek tongue) of southern Tennessee, from the Owl Creek formation of Mississippi, and from the Ripley formation and Providence sand of the Chattahoochee region. The species has not been found stratigraphically lower than the *Exogyra costata* zone.

# Superfamily MYTILACEA

Family MYTILIDAE

## Genus VOLSELLA Scopoli

Type species .-- "Mytilus" modiolus Linné.

The validity of *Volsella* Scopoli versus *Modiolus* Lamarck, seems to have been satisfactorily settled by Gray,<sup>192</sup> Meek,<sup>193</sup> and Stewart.<sup>194</sup>

#### VOLSELLA UDDENI Stephenson, n.sp.

## Pl. 25, figs. 18, 19

Shell very thin, small, greatly elongated, becoming oblique posteriorly, moderately ventricose anteriorly and centrally, thinning out wedge-like posteriorly, gaping a little at the lower posterior extremity. A broadly rounded, slightly sinuous umbonal ridge extends from the beak to the lower posterior extremity and a broad, shallow radiating depression lies in front of the ridge. Beaks small, incurved, approximate, projecting well above the hinge

<sup>&</sup>lt;sup>192</sup>Gray, J. E., Zool, Soc. London Proc., vol. 15, p. 198, 1847.

<sup>&</sup>lt;sup>133</sup>Meek, F. B., Rept. U. S. Geel, Survey Terr., vol. 9, pp. 69-71, 1870.

<sup>&</sup>lt;sup>101</sup>Stewart, Ralph B., Acad. Nat. Sci. Philadelphia Proc., Special Pub. No. 3, pp. 98-99, 1930.

line, prosogyrate, situated less than 2 mm. back of the anterior extremity. The hinge is not clearly uncovered, but is about 10 mm. long; it is probably edentulous, and some of the broken edges suggest that there may be a long, narrow, shallow channel closely paralleling the hinge margin. Both lunule and escutcheon wanting. Dorsal margin nearly straight or very slightly arched; anterior margin rather sharply rounded; ventral margin long, slightly convex, becoming broadly concave a little back of the midlength; posterior extremity sharply rounded well below the midheight, passing upward into a long, broadly arched posterodorsal margin which is strongly inclined forward and passes in a broad curve, convex upward, into the hinge line. The surface is covered with a series of closely, though somewhat irregularly spaced, gentle, concentric undulations; the impressions on the molds and the markings on the thin shell fragments adhering to the molds suggest that these undulations are strongest in the umbonal region, and on the posterodorsal slope, and tend to fade out somewhat toward the margins. Numerous fine, very faint radiating lines, scarcely visible to the naked eye appear on the internal mold beneath the umbonal ridge of most specimens.

Dimensions of the holotype: Length 22 mm., height 14 mm., thickness 7.8 mm. A few of the largest shells attain a length of as much as 24 mm.

At the type locality the shells of this species were found in one or more concretions. The collection includes 60 or more individuals most of which are complete or nearly complete internal molds, with more or less of the thin shell adhering.

Types.—Holotype, U.S.N.M. no. 76492; 20 selected unfigured paratypes, U.S.N.M. no. 76493. Named in honor of Dr. J. A. Udden.

Distribution in Texas.—Navarro group, Neylandville marl: ?3½ miles west-northwest of Corsicana (16166); ?2½ miles north of Corbet (16170).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); field 2 miles southwest of Kaufman (7547); 4 miles north of Corsicana (17366).

#### Genus CRENELLA Brown

#### **CRENELLA SERICA Conrad**

Pl. 25, figs. 13–15

- 1860. Crenella (Stalagmium) serica Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 281, pl. 46, fig. 23.
  1907. Crenella serica Conrad. Weller, Geol. Sur-
- 1907. Crenella serica Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 510, pl. 56, figs. 7, 8.
- 1916. Crenella serica Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 624, pl. 36, figs. 16–18.
- 1923. Crenella serica Contad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 241, pl. 62, figs. 1, 2.
  1929. Crenella serica Contad. Dane, Arkansas
- 1929. Crenella serica Conrad. Dane, Arkansas Geol, Survey Bull, 1, pl. 24 (op. p. 136), fig. 7. (Figure only.)

Shell small, equivalve, inequilateral, strongly ventricose, with very steep dorsal slopes, ovate in outline, with greatest dimension in the direction of the height. Beaks strongly prominent, incurved, approximate, prosogyrate, situated centrally. The hinge is formed by a slight thickening of the shell just below the beak, and on the area thus formed are several small teeth slightly elongated vertically; these appear to be modifications of the marginal crenulations. The ligament (or resilium) is set in a long, narrow submerged groove which extends from the margin just back of the teeth, backward and inward for about a millimeter. The margins form a nearly regular oval, and are finely crenulated on the inner side. The adductor scars are not very sharply outlined; the anterior one is large and greatly elongated, extending from well above the midheight, downward nearly to the ventral margin; the posterior one is much smaller, subovate in outline, situated below the midheight. The outer surface is delicately reticulated by numerous fine, radiating ribs, crossed by evenly spaced, concentric ridges which are more prominent and much more widely spaced than the ribs.

Dimensions of the shell shown in plate 25, figures 14, 15: Length 4.7 mm., height 5.8 mm., thickness 4.5 mm.

The sculpture on the Texas specimens appears to be a little more pronounced than that on typical shells from Eufaula, Alabama, though otherwise they appear identical.

The shell described by Wade<sup>195</sup> as Crenella serica Conrad, is a young Corbula, not a Crenella.

Type.—The type, which came from Eufaula, Alabama, is probably lost. There are numerous well preserved specimens from Eufaula, in the collections at the United States National Museum. Two plesiotypes from Texas, U.S.N.M. nos. 76494, 76508.

Distribution in Texas.-Navarro group, Corsicana marl: 23/5 miles north by east of Malta (16159); 11/4, miles south by east of Oak Grove (16160); 5 3/10 miles east by north of Greenville (16161); 3 7/10 miles southwest of Campbell (15547); 5 miles southwest of Quinlan (15546); near Terrell (15544); 2 miles south of Corsicana (14118, 16167); 24/5 miles east of Cooledge (13832, 14137);  $8\frac{1}{2}$  miles north of Cameron (13865); 7 7/10 miles west of Cameron (14131); 1/4 mile west of Kimbro (14129); 31/4 miles east by north of Manor (14127); Onion Creek, 21/2 miles west of old Garfield (7605, 14049; 14156, 1 specimen figured; 15532);  $\frac{1}{2}$  mile below Martin-dale (7621, 15527); 1 3/10 miles north of McQueeney (15524); 1 3/10 miles south-southeast of Marion (13389); 2 miles east of Marion (Tex. Bu. 2395); Green road, 3/4 mile southwest of Highway 90, Bexar County (16491); Salado Creek upstream from Highway 90, Bexar County (16671); well 7/20 mile south by west of St. Mary's University, Bexar County (16353, 16408); near Castroville (7665); well on G. A. Harper Survey, Medina County, at depth of 1045 feet (13844).

Navarro group, Kemp clay: Branch  $6\frac{1}{2}$  miles southwest of Currie (17377); 1 mile west of Odds (17373); 3 miles southwest of Stranger (17372); 2 miles northwest of Deatsville (14128); near Deatsville (764, 1 specimen figured; 14125); at depth of 800 feet in well 2 miles west of Groesbeck (13124).

Outside distribution.—Arkansas: Nacatoch sand and Arkadelphia marl. Mississippi: Ripley formation, Owl Creek formation, and Prairie Bluff chalk.

Central and west-central Alabama: Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Ripley formation (upper part) and Providence sand.

South Carolina: Upper part of Peedee formation.

Maryland: Monmouth formation.

New Jersey: Recorded (but not confirmed) from the Marshalltown formation; Red Bank sand.

Range.-In Texas the species has not been recorded from any beds stratigraphically lower than the Corsicana marl but it has been found at several localities in the Nacatoch sand of Arkansas. Elsewhere in the Coastal Plain the species occurs chiefly in the bcds having the stratigraphic position of the upper part of the Exogyra costata zone, except in northern Mississippi where it is present in the lower Ripley (Coon Creek tongue). In New Jersey Weller<sup>196</sup> records it from the Marshalltown formation (upper part of Exogyra ponderosa zone), but the illustrations of shells from the latter formation do not show the surface ornamentation in sufficient detail for critical comparison with typical shells of the species.

# Unidentified specimens of CRENELLA

The internal and external molds of a single individual of *Crenella* (pl. 25, fig. 16), found in the Neylandville marl at a locality on the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170), appears to be nearly smooth, but very fine radial striations can be faintly seen on the external mold. In form and size it is like *C. serica*, except that the beak is much less strongly prosogyrate. The specimen is too poorly preserved to serve as a type. U.S.N.M. no. 76495.

An incomplete internal mold of a pelecypod, probably the right value of a *Crenella* (pl. 25, fig. 17) from the Nacatoch sand, at a locality  $\frac{3}{4}$  mile east of Chatfield, Navarro County (7571), is similar in form and outline to *Crenella* 

<sup>&</sup>lt;sup>105</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 71, pl. 23, figs. 9, 10, 1926.

<sup>&</sup>lt;sup>196</sup>Weller, Stuart, Geol. Survey New Jersey, Palcontology, vol. 4, p. 510, pl. 56, figs. 7, 8, 1907.

elegantula Meek and Hayden,197 a large species from the Fox Hills sandstone of Wyoming. The mold is about 7 mm. long and is considerably larger than any known specimen of Crenella serica, but is smaller than the type specimens of *C. elegantula*. The impressions of fine, closely spaced radial ribs appear on the mold and a narrow remnant of shell just above the ventral margin preserves the ends of the ribs which appear to be very much like those of the Fox Hills species. The ribs are low, are wider than the interspaces, and number 7 or 8 to the millimeter. (U.S.N.M. no. 76496.) The left valve from the Monmouth formation of Maryland, which Gardner<sup>198</sup> referred to C. elegantula, appears to be proportionately a little shorter, narrower in the umbonal portion, and perhaps a little more convex than that species, though a good suite of specimens might show these to be individual variations. The Texas specimen, though it cannot be referred with certainty to C. elegantula, is very close to it, and should be given considerable weight in the correlation of the Navarro group with the Fox Hills sandstone of Wyoming, and with the Monmouth formation of Maryland.

An incomplete specimen of *Crenella*, larger than *C. serica*, but smaller than *C. elegantula*, and having fine radial ribs like the latter species, was secured from the Kemp clay at an earthern tank west of a public road, 2 miles south-southeast of Schumansville, 9/10 mile south-southeast of the crossing of Long Creek, Guadalupe County (16668). U.S.N.M. no. 76497.

#### Genus LITHOPHAGA Bolten

#### LITHOPHAGA CAROLINENSIS (Conrad)

#### Pl. 22, figs. 18, 19

- 1875. Arcoperna carolinensis Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 5, pl. 1, fig. 6.
- 1923. Lithophaga carolinensis (Conrad). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 243, pl. 62, figs. 4-9.

<sup>107</sup>Meek, F. B., and Hayden, F. V., Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 441, 1862; Rept. U. S. Geol. Survey Terr., vol. 9, p. 75, pl. 28, figs. 6, a, b, c, 1876.

108Gardner, Julia A., Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 625, pl. 36, fig. 19, 1916.

Shell thin, elongate, subcylindrical in form, subelliptical in outline, thinning wedge-like posteriorly. Beaks nearly terminal, strongly incurved, prosogyrate. The umbonal region back from the beak is broad and flattened, the flattened area passing downward into a broad, shallow depression which becomes somewhat pronounced toward the ventral margin. A broadly rounded, inflated umbonal ridge extends backward curving gently downward to the extremity; the anterior end is less strongly inflated. The hinge is not exposed in the Texas shells but in closely related species is edentulous and thin, and the inner surface of the shell is smooth. The anterior margin is evenly rounded; the ventral margin is long and broadly concave; the posterior margin is rather sharply, though evenly rounded, below the midlength, and passes upward into a broadly arched posterodorsal margin; the dorsal margin is gently arched. The surface is smooth with the exception of fine growth lines and somewhat irregularly developed growth plications.

Dimensions of the shell shown in plate 22, figures 18, 19: Length 12.6 mm., height 6 mm., thickness 6 mm.

Lithophaga ripleyana Gabb, 199 from the "Ripley group" of New Jersey, may be identical with L. carolinensis (Conrad), but it has not been possible to make a The Texas satisfactory identification. shells seem to agree fairly well with his description but he did not figure his type material. A specimen in the Academy of Natural Sciences of Philadelphia, marked type in Gabb's handwriting, is so thoroughly enclosed in a secreted covering that the form of the shell cannot be seen. A specimen figured by Whitfield as one of the originals (his pl. 17, fig. 4), is also encased in a secreted covering which obscures the form of the shell. A group of molds of the same kind from Mullica Hill, New Jersey, figured by the same author (his pl. 17, fig. 5), are said by him to have been borings in wood. The shells from North Carolina and Texas are borers in the thick shells of other mollusks.

<sup>&</sup>lt;sup>109</sup>Gabb, Wm. M., Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 326, 1862.

Lithophaga lingua Gardner,<sup>200</sup> a rather thin and an unusually high species posteriorly, may be a Volsella.

The shell from Tennessee referred by Wade<sup>201</sup> to *L. ripleyana*, appears to be proportionately too high and too thin for that species; the specimen shows evidence of lateral crushing, but it seems doubtful if it ever could have been as plump as that species.

Type.—The whereabouts of Conrad's figured specimen from Snow Hill, North Carolina, is unknown. Topotypes were figured by the present writer in 1923, U.S.N.M. nos. 31713–31715. One plesiotype from Texas, U.S.N.M. no. 76498.

Distribution in Texas.—-Navarro group, Nacatoch sand: West of Campbell (12925); ?vicinity of Kaufman (761).

Navarro group, Corsicana marl: 2 miles south of Oak Grove (12932); 1¼, miles south by cast of Oak Grove (16160); 4 miles southwest of Quinlan (17385); Onion Creek, 2½ miles west of old Garfield (14156, 1 specimen figured); 2½ miles west of McQueeney (15523); 2 miles east of Marion (Tex. Bu. 2395); ?Salado Creek, upstream from Highway 90, Bexar County (16671).

Navarro group, Kemp clay: 2 miles northwest of Deatsville (14128);  $?4\frac{1}{2}$ miles east-northeast of Cooledge (17374); ?branch  $6\frac{1}{2}$  miles southwest of Currie (14139).

*Outside distribution.*—North Carolina: Snow Hill member of Black Creek formation.

Range.—The range of the species appears to be from the upper part of the *Exogyra ponderosa* zone through the *E. costata* zone.

#### Genus CUNEOLUS Stephenson, n.gen.

Type species.--Dreissena tippana Conrad. Etymology.- Diminutive of cuneus, a wedge.

In form and general appearance this genus is very much like *Dreissena* Van Beneden (emend *Dreissensia* of authors), the genotype of which is the Recent *Mytilus polymorphus* Pallas. Evidence has been given, however, to show that this resemblance is only superficial. Discussing the relationship of the Cretaceous Dreissena tippana Conrad to the Recent genera Congeria and Dreissena. Boggild<sup>202</sup> says: "An entire contrast to the above-named, recent forms is a Dreissensia tippana from the Senonian Ripley formation, the shell of which is nacreous throughout; there is no trace left of any calcitic layer."

Cox<sup>203</sup> discusses the same subject as follows:

The more or less rhomboidal, obliquely elongated shape of the shell and the terminal or subterminal position of the umbones in *Mytilus* and similar genera may be considered an adaptation to the particular mode of growth of these forms, which are suspended from other objects by a byssus protruding from between the anteroventral margins. That shells so characterized may have originated, by convergence, from unrelated stocks is shown by the Recent genus *Dreissena* lor *Dreissensia*, whose anatomical characters indicate it to be quite unrelated to *Mytilus* and even to belong to a different order, the Eulamellibranchiata.

## Again on page 346 Cox says:

In these forms 1Dreissena tippana Conrad and others], however, the structure of the hinge-region agrees with that of normal representatives of the Mytilidae, and a further new subgenus of Mytiliasshould probably be established for their reception. 1 do not consider them to be related to Dreissena, which probably evolved in Tertiary times from some genus of the Eulamellibranchiata which was not at all mytiliform in shape.

Accepting the opinion of these authorities that Dreissena tippana Conrad is generically distinct from the Recent Dreissena Van Beneden, and in view of the great time interval that separates them, I am proposing the new generic name Cuneolus to include Conrad's species and other closely related Cretaceous species, among them Mytilus lanceolatus J. de C. Sowerby,<sup>204</sup> and M. tegullatus Müller.<sup>205</sup>

<sup>&</sup>lt;sup>200</sup>Gardner, Julia, Maryland Geol. Survey, Upper Cretaceous (2 vols.), pp. 619, 621, 1916.

<sup>&</sup>lt;sup>201</sup>Wade, Bruce, U.S. Geol, Sut.ey Prof. Paper 137, p. 70, pl. 23, figs. 5, 6, 1926.

<sup>&</sup>lt;sup>202</sup>Böggild, O. B., The shell structure of the mollusks: Mém. Acad. Roy. Sci. Lettres Denmark, Sec. des Sciences, ser. 9, vol. 2, pp. 273, 1930.

<sup>&</sup>lt;sup>20G</sup>Cox, L. R., On a new subgenus of *Mytilus* and a new *Mytilus*-like genus: Proc. Malac. Soc., London, vol. 22, pt. 6, p. 339, 1937.

<sup>&</sup>lt;sup>201</sup>Woods, H., Monograph of the Cretaceous Lamellibranchia of England, vol. 1, p. 110, pl. 19, figs. 1-11. (Referred to *Dreissensia.*)

<sup>&</sup>lt;sup>205</sup>Müller, Joseph, Monographie der Petrefacten der Aachener Kreideformation, p. 35, pl. 2a, b, 1847.

*Cuneolus* is a falcate, mytiliform shell of moderate size, convexity, and terminal, pointed beaks. An acutely angular ridge extends in a broad curve convex upward, from the beak to the posteroventral margin; this ridge slightly overhangs the broadly concave, downward-facing anteroventral surface. The hinge is narrow, edentulous and bears a long, narrow, shallow, broadly arched, partly submerged ligamental groove. The anterior adductor scar is seated on a well developed triangular umbonal septum resembling that of Dreissena, but less deeply sunken below the margins of the shell. On the figured neotype the bottom of this shallow septal depression is nearly smooth, but on other specimens it is obscurely marked with irregular radial lines: at the forward end of the septum of the right valve of the neotype is a slightly more sunken, small ovate shallow pit, and at a corresponding position on the left valve a transverse nonprominent protuberance. On each valve the ligamental groove is separated from the septal depression below by a long narrow ridge or nymph, and the groove extends forward reaching the anterior margin just below and a little back of the tip of the beak. The posterior adductor scar as seen on the right valve of the neotype is narrow, greatly elongated, and somewhat irregular in width: its posterior end lics within 4 mm. of the sharply rounded posterior margin, and its forward end reaches nearly to the posterior end of the hinge.

In form and in the shallowness of its septal depression this genus resembles *Lycettia* Cox,<sup>206</sup> from the Inferior Oolite, England, but it lacks a medium toothlike protuberance on the septum in the umbonal angle. Cox is undecided as to whether *Lycettia* should be included in the Mytilidae, or should be regarded as a descendant of the Ambonichiidae or the Myalinidae of the Paleozoic.

### CUNEOLUS TIPPANUS (Conrad)

## Pl. 25, figs. 20-26

1858. Dreissena tippana Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d set., vol. 3, p. 328, p. 34, fig. 14.

206Op, cit., p. 315.

- ?1916. Dreissena tippana Conrad. Gardner, Maryland Geol. Survey. Upper Cretaceous (2 vols.), p. 628, pl. 37, figs. 8-11.
- ?1926. Dreissensia tippana Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 72, pl. 23, figs. 11, 12.

Shell of moderate size, falcate, clonequivalve, inequilateral, strongly gate, convex; posteroventral margins of the two valves gaping slightly about midway of their length; shell wall of moderate thickness. Beaks acute, terminal, pointed forward. An acutely angular ridge extends in a broad curve, convex upward, from the beak to the ventral margin; this ridge slightly overhangs the anteroventral surface which is broadly concave, facing downward and forward: back of the ridge the surface rounds off regularly and steeply to the dorsal and posterior margins. The hinge is not exposed in the Texas material, but in well preserved shells from Mississippi it is narrow, edentulous, and is 10 mm. or more in length in adults; the hinge bears a long, narrow, shallow, partly submerged ligamental groove. In the Mississippi material there is a well developed umbonal septum on which the auterior adductor muscle is seated; the inner surface is smooth and pearly. The posterior muscle scar is long, narrow, and of irregular width; it extends from near the posterior end of the shell nearly to the terminus of the hinge. Anteroventral margin broadly concave; posteroventral margin sharply rounded; the posterior and posterodorsal margins form a broad, regular curve which passes upward into the short nearly straight dorsal margin. The outer surface is smooth with the exception of fine growth lines and numerous rather weak plications which mark resting stages.

Dimensions of the specimen shown in plate 25, figures 25, 26: Length 26 mm., height 28 mm., thickness 16.5 mm.; greatest measurable dimension 33 mm.

The Texas shells from the Nacatoch sand are very similar in size and form to the few available shells from the type locality on Owl Creek in Tippah County, Mississippi. The specimens figured by Wade under this name are proportionately broader and less inflated than the typical shells. The shell from the Monmouth formation of Maryland, described by Gardner under this specific name, is also broader and less inflated than the typical shells. If these differences should prove to be constant they would seem to justify the separation of the Tennessee and Maryland shells as a subspecies or species.

Types.—The holotype, which should be in the collection of the Academy of Natural Sciences of Philadelphia, is apparently lost. Neotype from the type locality on Owl Creek, 2½ miles northeast of Ripley, Tippah County, Mississippi, U.S.N.M. no. 76499: 2 topotypes, U.S.N.M. nos. 21683. 76500. One plesiotype from Texas, U.S.N.M. no. 76501.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, 1 specimen figured; 14098).

Navarro group, Corsicana marl: <u>1/2</u> mile below Martindale (15527).

Outside distribution.---Mississippi: Ripley and Owl Creek formations.

Chattahoochee region (Alabama-Georgia): Questionably in the Ripley formation (upper part), and in the Providence sand.

Maryland: Questionably in the Monmouth formation.

Range.—In Texas the species has been found in the Nacatoch sand and in the Corsicana marl, of the Navarro group. The same or closely related varietal forms occur in the *Exogyra costata* zone of the Atlantic and Gulf Coastal Plain at least as far north as Maryland.

#### Order ANOMALODESMACEA

# Superfamily ANATINACEA

## Family PHOLADOMYACIDAE

# Genus PHOLADOMYA Sowerby

# PHOLADOMYA LITTLEI Gabb

# Pl. 17, fig. 7

- 1876. Pholadomya littlei Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 305.
- 1905. Pholadomya littlei Gabb. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 13.
- 1923. Pholadomya littlei Gabb. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 247, pl. 63, figs. 1, 2 (not figs. 3, 4); pl. 64, pl. 65, fig. 10.

Shell large, subequivalve, inequilateral, subelliptical in outline, most ventricose centrally, rounding down steeply toward the front and thinning gradually toward the rear; valves gaping a little both anteriorly and posteriorly; shell wall thin. Beaks broad, moderately prominent, incurved, approximate, situated one-third the length of the shell from the anterior ex-Hinge margin long, straight; tremity. hinge not uncovered in available material. Anterior adductor scar obscure; the pallial line is marked by a band of transverse corrugations, 6 to 8 mm. wide, and ascends steeply anteriorly; pallial sinus profound, extending to center of shell, low on inner surface, nearly horizontal. On one of the cotypes the ligament, the form and substance of which are in part preserved, is paravincular, opisthodetic, short, and stands prominently above the margins of the valves: its surface is marked by fine transverse lines, and its structure is fibrous. The ligamental groove is a narslit. Anterior margin sharply TOW rounded above the midheight; ventral margin long and broadly rounded; posterior margin sharply rounded at about the midheight. Surface marked by rather coarse concentric growth lines and undulations, and by 10 to 13 strong, narrow, acute, somewhat irregularly spaced costae which are closest together centrally. The anterodorsal slope is ribless. The ribs are reflected on the inner surface as radiating depressions.

Dimensions of the largest cotype: Length 152 + mm., height about 100 mm., thickness about 80 mm.

This species is represented in the collections from Texas by one large, badly crushed individual in which both valves are present but incompletely preserved. The description is based chiefly on the cotypes from Pataula Creek, Georgia. The species is the largest recorded representative of the genus in the Upper Cretaccous series of the Atlantic and Gulf Coastal Plain.

Types.— Two cotypes in the collection of the Academy of Natural Sciences of Philadelphia. They are imperfect internal molds from the upper part of the Ripley formation on Pataula Creek, Clay County, Georgia: on the smaller specimen portions of the shell still adhere. Plesiotype from Texas, U.S.N.M. no. 76502.

Distribution in Texas. -Navarro group, Nacatoch sand: 6 miles southeast of Cooper (12929, figured).

Outside distribution. --- Chattahoochee region (Alabama-Georgia): Providence sand.

North Carolina: Upper part of Peedee formation.

Range.—The species is restricted to the *Exogyra costata* zone of the Upper Cretaceous in the Gulf region and the Carolinas.

# PHOLADOMYA sp.

The internal mold of the anterior portion of a small left valve, with some thin shell substance adhering, from the Kemp clay on Guadalupe River. a third of a mile upstream from the Galveston, Harrisburg, and San Antonio Railroad bridge at McQueeney, Guadalupe County (7632), is rather plump, somewhat elongated, and evenly rounded on the anterior margin; it exhibits on the preserved portion 13 or 14 irregularly spaced, sharp, narrow ribs, and rather coarse growth plications. The beak is not preserved, but is evidently situated well toward the front. The specimen is inadequate for a complete specific description, and it may be a young individual. U.S.N.M. no. 76503.

### Genus HOMOMYA Agassiz

# HOMOMYA? THRASHERI Stephenson, n.sp.

## Pl. 25, fig. 12

Shell small, thin, subtrapezoidal in outline, inequilateral, probably equivalve, moderately convex; umbonal ridge broadly rounded, dorsal slopes moderately steep. Beaks not well preserved but apparently broad, not very prominent, incurved, situated about one-fifth the length of the shell from the anterior extremity. Hinge and internal characters not uncov-Anterior margin sharply rounded ered. above the midheight, rounding upward to the beak; ventral margin rounding upward toward the front, becoming nearly straight posteriorly; posterior margin sharply rounded below at the end of the

umbonal ridge, subtruncated and inclined forward above, rounding regularly into the dorsal margin; posterodorsal margin long, nearly straight, horizontal. Surface ornamented with somewhat irregular growth ridges, separated by interspaces 0.5 to 1 mm. wide; these are weak on the anterior part of the shell and become much stronger, and sharp-crested both toward the ventral and posterior margins.

Dimensions of the holotype: Length 14.5 mm., height 9 mm., convexity about 2 mm.

The species is represented by one individual, which includes the internal and external molds, with shell partly adhering to each.

*Holotype.*—U.S.N.M. no. 76504. Named for Mr. Thomas Thrasher, owner of the well from which the specimen was obtained.

Distribution in Texas.—Navarro group, Kemp clay: Well near old Garfield (1641).

#### Family LATERNULIDAE

#### Genus LATERNULA Bolten

#### LATERNULA? SULCATINA (Shumard)?

#### Pl. 25, fig. 10

1861. Anatina sulcatina Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 204.

Shumard described this species as follows:

Shell large, ovate, thin, inequivalve, very inequilateral; length not quite equal to the width[?]: anterior end broadly rounded; posterior end short, contracted, narrowly rounded; pallial margin gently convex: beaks small, but little elevated, situated posterior to the middle; cardinal margin straight, or very slightly convex before the beaks, and very slightly arched behind; a narrow, distinctly impressed and very gradually expanding sulcus, extending from beak to pallial margin, which it cuts a little behind the middle; surface with from twenty to twenty-five rounded, concentric folds, becoming indistinct on the posterior part of the shell. There are also many fine, concentric lines of growth visible to the naked eye.

Length, 31/2 inches; width, 11/2 inches; thickness, 61/2 lines [0.54 inch].

Ripley group, Chatfield Point, Navarro County.

One imperfect left valve in the collections of the National Museum, from Chatfield (pl. 25, fig. 10), may be this species. Shumard did not figure the species, nor is the type available for comparison. The specimen is somewhat smaller than the type, has a well defined sulcus extending from the beak centrally down to the ventral margin, and is similarly, though apparently more finely sculptured. The beak is cut by a fissure which extends for 6 or 7 mm. obliquely backward about halfway between the sulcus and the posterodorsal margin, a feature which Shumard does not mention. The posterior end is rather sharply rounded, with a truncation above the midheight and the posterodorsal margin is gently arched. The hinge and internal characters are not exposed.

Dimensions: Length 35 + mm., height 32 + mm., convexity about 9 mm.

Type.—The type, which presumably should have been preserved in the collections of the Boston Society of Natural History, is not listed among the types now in that institution, and it apparently is lost. The specimen here figured (U.S.N.M. no. 21053) is too imperfect, and hardly fits the original description closely enough, to justify its designation as a neotype.

Distribution in Texas.—Navarro group. Nacatoch sand: Vicinity of Chatfield (762).

## LATERNULA? SUBLEVIS Stephenson, n.sp.

# Pl. 25, fig. 4

This species is represented by one specimen with the two valves attached, both of which are, however, imperfect in the posterior part, and by one young shell from another locality. Shell thin, elongate, depressed-convex, most inflated somewhat in advance of the umbone and well up toward the dorsal margin, slightly bent to the right posteriorly, as in Tellina. The beaks are fissured obliquely backward. Beaks low, broad, incurved, opisthogyrate, approximate, apparently situated well back of the midlength. The internal features are not clearly seen. The surface exhibits fine growth lines which are most pronounced anteriorly, and somewhat irregularly spaced growth undulations. On the right valve the narrow

space between the fissure and the postcrodorsal margin is markedly excavated, and the corresponding space on the left valve is slightly excavated.

Dimensions of the holotype: Length 25 + mm., height 14 mm., thickness about 6 mm.

Although the holotype is not as perfect as a type should be, it is sufficiently complete to permit satisfactory identification of specimens from the type locality. The species is smaller, smoother, and proportionately more elongated than *L.? sulcatina* Shumard?, and lacks the radiating sulcus of that species.

Holotype.---U.S.N.M. no. 21009.

Distribution in Texas. --Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); 4 miles north of Corsicana (17366).

# LATERNULA? ROBUSTA Stephenson, n.sp.

# Pl. 25, figs. 5, 6

Shell of medium size, depressed convex. inequivalve, subequilateral; anteriorly the two valves appear to be slightly gaping, and posteriorly they are markedly separated; posteriorly the shell is slightly bent to the right. Beaks low, broad, slightly prominent, incurved, opisthogyrate, the beak of the right valve rising above, and slightly overtopping that of the left valve; the beaks appear to be situated slightly in advance of the midlength, and are fissured obliquely backward. A rather sharp radial sulcus back of the fissure, fades out about halfway between the beak and the posterior extremity; the posterodorsal slope is broadly excavated on each valve. Hinge and internal features not uncovered. Anterodorsal margin broadly arched; anterior margin rather sharply and evenly rounded; ventral margin very broadly rounded; posterior margin imperfect, but appears to be sharply rounded below, becoming subtruncated above. The surface, as impressed on the internal mold, is ornamented with numerous small, somewhat irregularly developed, closely spaced concentric ridges.

Dimensions of the holotype: Length 52 + mm., height 36 mm., thickness 6.5 mm.

The species is represented by one internal mold with the surface sculpture rather clearly impressed upon it.

Holotype.---U.S.N.M. no. 76505.

Distribution in Texas.—Navarro group, Corsicana marl: 6 miles east of Castroville (16156).

#### LATERNULA? BARTONI Stephenson, n.sp.

## Pl. 25. fig. 7-9

Shell small, broadly subovate in outline, inequilateral, inequivalve, plump in an anteroventral direction, bent to left posteriorly. Beaks small, incurved, nearly direct, approximate, situated about twothirds the length of the shell from the anterior extremity; beak of right valve most prominent and most strongly incurved. From the inflated part the surface rounds broadly down to the anterodorsal, anterior, and ventral margins; posteriorly the shell pinches down rather abruptly to a sharp, wedge-like edge. Right valve markedly more inflated than the left, its umbonal region rising noticeably higher. Anterodorsal margin broadly arched, descending steeply; anterior margin regularly rounded below the midheight; ventral margin broadly rounded; posterior margin sharply rounded below posterodorsal margin the midheight; steep, nearly straight, slightly keeled. Hinge not uncovered. Both the holotype and paratype are internal molds with thin fragmentary portions of the shell adhering, and the internal features are obscure. The posterior adductor scar is small and the pallial sinus is broad and deep. Beak cleft with a short, shallow fissure, strongly oblique backward. Surface of shell not preserved, but probably smooth, with the exception of gentle growth undulations.

Dimensions of the holotype: Length 7.5 mm., height 6.2 mm., thickness 3.9 mm.

The shell is proportionately shorter and more inflated than *L*.? robusta.

Types.—Holotype, U.S.N.M. no. 76506; 1 unfigured paratype, U.S.N.M. no. 76507. Named in honor of the late Dr. Donald C. Barton, Geologist.

Distribution in Texas.—Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

#### Genus ANATIMYA Conrad

# ANATIMYA ANTERADIATA TEXANA Stephenson, n.var.

#### Pl. 25, fig. 11

Shell of moderate size, ovate-elongate, depressed-convex, most inflated a little back of the midlength, slightly gaping both posteriorly and anteriorly; shell wall thin. Beaks of moderate size and prominence, strongly incurved, approximate, slightly prosogyrate, obscurely fissured obliquely downward and backward, situated slightly back of the midlength. The hinge and internal features are not uncovered in the available material. The holotype shows a short, shallow, external, opisthodetic ligamental groove. A topotype of A. anteradiata Conrad from Owl Creek, Tippah County, Mississippi, shows a pair of prominent, spoon-shaped chondrophores, directed downward on the interior; each of these curves backward and passes into a buttress which spreads obliquely downward and backward for 7 or 8 mm. on the interior of the shell; both the concentric and radiating ribs of the outer surface are strongly reflected as depressions on the interior. Dorsal margin long and nearly straight; anterior margin regularly rounded; ventral margin very broadly convex, becoming nearly straight centrally; posterior margin subtruncated below the extremity, which lies well above the midheight, curving sharply forward into the dorsal margin just above the extremity. The anterior half of the outer surface is strongly marked by regularly spaced, broadly roundcrested concentric folds, which in the holotype number 34 or 35. The posterior half is marked by coarse growth lines and obscure folds, and by 8 to 10 irregularly spaced, sharp, narrow, radiating ribs which are closest together about midway of the posterior half.

Dimensions of the holotype: Length 33 mm., height 16 mm., thickness 7.5 mm. Length of one of the paratypes, 44 mm.

Compared with the type of the species, this variety is more elongated, the surface is a little more coarsely sculptured, and the beak is situated a little farther back on the dorsal margin. The two forms are, however, closely related. *Types.*—Holotype, U.S.N.M. no. 76509; 1 paratype, U.S.N.M. no. 76510; 2 paratypes, U.S.N.M. no. 20960.

Distribution in Texas.—Navarro group, Nacatoch sand:  $\frac{3}{4}$  mile east of Chatfield (7571); field  $\frac{3}{5}$  mile west of Kaufman (14103, holotype and 1 unfigured paratype); vicinity of Kaufman (761, 2 unfigured paratypes);  $1\frac{4}{5}$  miles northeast of Quinlan (16162).

#### Family PERIPLOMIDAE

## Genus PERIPLOMA Schumacher

# PERIPLOMA? EDWARDSI Stephenson, n.sp.

#### Pl. 25, figs. 2, 3

Shell small, subtrigonal, depressed convex, strongly inequilateral with greatest elongation in front of the beaks; greatest inflation below the beaks, thinning rapidly to the rear and gradually to the front, slightly gaping posteriorly; shell wall apparently very thin. Beaks fissured, moderately prominent, incurved, approximate. situated only slightly in advance of the posterior extremity. Hinge and other internal features not exposed; adductor scars very obscure on the mold. Dorsal margin gently arched, long in front of the beaks; anterior margin regularly rounded except for a slight suggestion of a subtruncation; ventral margin broadly rounded; posterior margin not well preserved, but apparently subtruncated below. Surface marked by fine growth lines and by fairly conspicuous, irregular growth plications. The outer shell layer is mostly wanting, but several adhering fragments show no radiating sculpture; however, a thin inner shell layer and the internal mold exhibit numerous very fine radiating lines which are barely visible to the naked eye.

Holotype.--U.S.N.M. no. 76511. Named for Benjamin Edwards who tried to establish a republic in east Texas in 1826.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); 4 miles north of Corsicana (17366).

### PERIPLOMA? sp.

### Pl. 25, fig. 1

A flattened shell in a gray marl matrix, from the Kemp clay, in a pit of the Seguin Vitrified Paving and Face Brick Company, <sup>1</sup>/<sub>2</sub> mile south of McQueeney, Guadalupe County (7638), probably belongs to the genus *Periploma*. The shell is broadly ovate in outline, inequilateral, much longer anteriorly than posteriorly. Beaks slightly projecting, fissured, situated about 0.7 the length of the shell from the anterior extremity. Surface marked with fine lines of growth and with fairly strong, irregularly developed growth plications. Dimensions: Length 37 mm., height 30 mm. U.S.N.M. no. 76512.

#### Superfamily POROMYACEA

#### Family POROMYACIDAE

#### Genus LIOPISTHA Meek

- 1864. Liopistha Meek, Check list of the Invertebrate fossils of North America, Cretaceous and Jurassic: Smithsonian Mise, Coll., vol. 7, no. 177, p. 32. Type, Cardium elegantulum Roemer.
- Cardium elegantulum Roemer. 1875. Liopistha Meek, Conrad, Geol. Survey North Carolina, vol. 1 (by W. C. Kerr), App. A, p. 28.
- App. A, p. 28. 1876. Liopistha Meek. Rept. U.S.Geol. Survey Terr., vol. 9, pp. 227-236, text figs. 20-22.
- 1923. Liopistha Meck. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 250.

Type species .--- Cardium elegantulum. Roemer.207

In this paper *Liopistha* and *Cymella* are treated as separate genera. The genus *Liopistha* is represented in the Aachen Cretaceous (Senonian) of Germany by *L. aequivalvis* (Goldfuss).

#### LIOPISTHA PROTEXTA (Conrad)

#### Pl. 26, figs. 27-30

- 1853. Cardium protextum Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 2, p. 275, pl. 24, fig. 12.
- pl. 24, fig. 12. 1860. *Fragilia protexta* Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 275.
- 1861. Papyridea elegantula Gabb (in part), Synopsis of the Mollusca of the Cretaceous formation, pp. 108, 162. (Also Am. Philos. Soc. Proc., vol. 8, pp. 164, 218, 1861.)
- 1864. Papyridea (Liopistha) protexta (Conrad). Meek, Check list of the invertebrate fossils of North America, Cretaccous and Jurassic: Smithsonian Misc. Coll., vol. 7, no. 177, p. 12.
- 1875. Liopistha protexta (Conrad), Geol. Survey North Carolina, vol. 1 (by W. C. Kerr), App. A, p. 28.

<sup>247</sup>Roemer, F., Kreideb Idungen von Texas, p. 48, taf. 6, figs. 5a-c, 1852.

- 1876. Liopistha protexta (Conrad). Meck, Rept. U.S.Geol. Survey Terr., vol. 9, p. 226, text figs. 20-24.
- 1885. Liopista protexta (Conrad). Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 140, pl. 20, figs. 1-3, (Geol. Survey New Jersey, Paleontology, vol. 1, p. 140, pl. 20, figs. 1-3, 1886.)
- 1905. Liopistha protexta (Conrad). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 13.
- 1907. Liopistha protexta (Conrad). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 526, pl. 58, figs. 4-6.
- 1916. Liopistha protexta (Conrad). Gardner Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 636, pl. 36, fig. 15.
- ceous (2 vols.), p. 636, pl. 36, fig. 15.
  1923. Liopistha protexta (Conrad). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 250, pl. 65, fig. 3.
- 1926. Liopistha protexta (Conrad). Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 248, pl. 91, fig. 7. (Figure only.)
- ?1926. Liopistha protexta (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 75, pl. 24, fig. 6. (Figure only.)

Shell subovate in outline, equivalve, slightly inequilateral, moderately ventricose, with greatest inflation slightly in advance of the midlength and a little above the midheight, slightly gaping posteriorly: shell wall thin. Beaks prominent, incurved, approximate, feebly prosogyrate, situated a little in advance of the midlength. Hinge not uncovered in the Texas material. Detailed descriptions of the hinges of this species and of Cymella bella (Conrad), accompanied by illustrations, are given by Meek.<sup>208</sup> Anterior margin regularly, almost sharply rounded: ventral margin broadly and regularly rounded; posterior margin subtruncated above the sharply rounded terminus which is at about the midheight; dorsal margin broadly arched. Surface ornamented with 28 to 30 subacute ribs with rather broad sub-V-shaped interspaces: on the crest of each rib is a row of numerous, obscure, small tubercles which on some individuals become somewhat more pronounced; the ribs increase somewhat in size posteriorly: on a very narrow area bordering the anterodorsal margin the

ribs become obsolete, and they are obsolete on a broader area below the posterodorsal margin where, however, they are generally marked by rows of very obscure to moderately distinct tubercles (pl. 26, fig. 30). The umbonal area from the beaks downward for 1 or 5 mm. exhibits gentle, evenly spaced, concentric undulations.

Dimensions of the specimen shown in plate 26, figure 29: Length 26 mm., height 18 mm., thickness 14.5 mm. A few individuals attain a length of 32 mm.

The ribs on the Texas specimens appear to be a little more numerous and a little more acute than they are on the type from New Jersey. A large suite of specimens from the upper part of the Ripley formation on Owl Creek, Tippah County. Mississippi, show considerable individual variation in the coarseness of the ribbing.

The specimen figured by Wade (see synonymy) from the lower part of the Ripley of Tennessee, exhibits a pronounced development of tubercles on the crests of the ribs, which, if found to be a constant feature on shells from that horizon, would justify classifying it as a distinct subspecies or species.

Types.—Type in the collection of the Academy of Natural Sciences of Philadelphia: a mold from "Burlington County," New Jersey. Plesiotype from Mississippi, U.S.N.M. no. 76514. Plesiotype from Texas, U.S.N.M. no. 76513.

Distribution in Texas. -Anacacho limestone: Questionably at King's water hole on Hondo Creek, 3 miles north by west of Hondo. Medina County (7680).

Taylor marl, Wolfe City sand member: ?in artificial channel of North Sulphur Creek, west of the Paris-Greenville highway, 3/20 mile north of the bridge over the old natural channel, Lamar County (14086).

Navarro group, Nacatoch sand: Northwestern corner of Franklin County (12931); vicinity of Kaufman (761); road 3/5 mile west of Kaufman (14098); field 3/5 mile west of Kaufman (14103); field 2 miles southwest of Kaufman (7547); vicinity of Chatfield (762); field south of Chatfield (7569); 3/5 to 4/5 mile northeast of Chatfield (14117); 3

<sup>&</sup>lt;sup>205</sup>Meek, F. B., Rept. U. S. Geol, Survey Terr., vol. 9, pp. 227-236, 1876.

miles northeast of Corsicana (9545); 2 miles north of Corsicana (9551); vicinity of Corsicana (763); north edge of Corsicana (518, 1 specimen figured); 2½ miles north of Corsicana (14114).

Navarro group, Corsicana marl: 2 3/5 miles north by east of Malta (16159): ½ mile below Martindale (15527); 2 miles east of Marion (Tex. Bu. 2395); 6 miles east of Castroville (16156, Tex. Bu. 3282).

Outside distribution.—Arkansas: Saratoga chalk and Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Prairie Bluff chalk and Owl Creek formation.

Central and west-central Alabama: Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Ripley formation (upper part) and Providence sand.

South Carolina: Peedee formation (upper part).

Maryland: Monmouth formation.

New Jersey: Wenonah sand, Navesink marl, and Red Bank sand.

Range.- This species has been collected mainly from the Exogyra costata zone of the Atlantic and Gulf Coastal Plain, but a few specimens which appear to be closely related to, if not identical with, the species, have been found stratigraphically lower in the Exogyra ponderosa zone, in the Anacacho limestone and in the Wolfe City sand member of the Taylor marl, in Texas, and in the upper part of the Matawan group of Maryland.

# LIOPISTHA FORMOSA Stephenson, n.sp.

Pl. 26, figs. 24-26

?1926. Liopistha inflata Whitfield. Wade, U.S. Geol. Survey Prof. Paper 137. p. 76, pl. 24, figs. 7, 8.

Shell similar in form and outline to *L. protexta* but with umbonal region more prominent above the dorsal margin. Hinge not exposed. Ligamental groove external, short, opisthodetic. The adductor scars which can be only obscurely seen on one mold are of moderate size and are situated high up under the dorsal margin. The surface is ornamented with 20 to 26 low, relatively broad, rounded, radiating

ribs on which can be seen the scars of small tubercles; these ribs are larger posteriorly than anteriorly and on one specimen with shell preserved some of the larger ribs each exhibit 9 or 10 very faint, radiating lines; the rather broad anterodorsal and posterodorsal areas are smooth, or only faintly ribbed. This species, like *L. protexta*, exhibits in the umbonal region, 10 or 12 evenly spaced, gentle concentric undulations.

Dimensions of a small, but nearly perfect internal mold: Length 18 mm., height 13 mm., thickness 10 mm.

The specimen figured by Wade as Liopistha inflata Whitfield is very close to L. formosa, but is more sharply rounded and more pointed posteriorly. The species differs from L. protexta (Conrad) in its fewer and less acute ribs, in the obscurity of tubercles on the ribs, and in the somewhat greater prominence of the umbonal region above the dorsal margin; the shell probably also averages a little shorter in proportion to the height, and is more evenly rounded on the upper part of the posterior margin. Compared with L. *inflata* Whitfield this species is much less inflated and is narrower in the umbonal region.

*Types.*—Holotype, U.S.N.M. no. 20397; 1 figured paratype, U.S.N.M. no. 21062; 1 unfigured paratype, U.S.N.M. no. 76516; 1 unfigured paratype, U.S.N.M. no. 76515.

Distribution in Texas.--Navarro group. Nacatoch sand: North edge of Corsicaua (518, 1 specimen figured); vicinity of Corsicana (763, holotype, figured, and 3 paratypes); vicinity of Chatfield (762, 1 figured paratype); field south of Chatfield (7569): 1 4/5 miles northeast of Quinlan (16162).

Outside distribution.--Tennessee: Lower part of Ripley formation (Coon Creek tongue).

Range.— So far as known the species is restricted to the lower and middle parts of the *Exogyra costata* zone of the Gulf Coastal Plain.

## Genus CYMELLA Meek

1864. Cymella Meck, Check list of the invertebrate fossils of North America, Cretaccous and Jurassic: Smithsonian Mise, Coll., vol. 7, no. 177, p. 34.

- 1875. Cymella Meek. Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 10.
- Kerr), App. A, p. 10.
  1876. Cymella Meek, Rept. U.S.Geol. Survey Terr., vol. 9, pp. 227–237, text figs. 25–30. (Subgenus of Liopistha.)
  1923. Cymella Meek, Stephenson, North Caroling Code and Face.
- 1923. Cymella Meek. Stephenson, North Carolina Geol, and Econ. Survey, vol. 5, p. 253. (Subgenus of Liopistha.)
- Type species.—Liopistha (Cymella) montanensis Henderson (= Pholadomya undata Meek and Hayden = Liopistha (Cymella) undata Meek and Hayden).

Meek regards *Liopistha* and *Cymella* as falling within the same generic group, but he rather hesitatingly treats Cymella as a subgenus, the separation being made mainly on differences in external ornamentation. Meck's detailed description of the hinge characters was made with the hinges of both Liopistha and Cymella before him. Although the two groups exhibit a general similarity of form they are strikingly different in their types of ornamentation. On Liopistha the radial ribs are numerous, rather sharp crested, and bear small tubercles or spines more or less distinctly developed on their crests: concentric ribbing is subordinate and is restricted to the umbonal region near the beak. Cymella possesses strong concentric ribs which are crossed on the central part of the shell by a few, relatively weak radials; these radials bear tiny spines similar to those on *Liopistha*, as shown by spine scars on well-preserved specimens from the Western Interior. Each group includes several species. These differences in sculpture are believed to be a sufficient basis for regarding the two groups as generically distinct in spite of the similarity of their hinges.

# CYMELLA BELLA TEXANA Stephenson, n.var.

# Pl. 26, figs. 21-23

1911. Cymella bella Conrad. Miller, Maryland Geol. Survey, Prince Georges County Rept., p. 96, pl. 5, fig. 10. (Figure only.)

Shell subovate in outline, subequivalve, inequilateral, moderately ventricose, most inflated above the midheight and somewhat in advance of the midlength, becoming compressed posteriorly, probably slightly gaping posteriorly; shell wall thin. Beaks moderately prominent, broad, strongly incurved, approximate, slightly

prosogyrate, situated a little in advance of the midlength. Lunule about 8 mm. long in the holotype, rather broad, smooth, and excavated. Escutcheon long, narrow, rather deep, separated from the main surface of the shell by a pronounced, dull-crested carina, outside of and parallel to which is a shallow channel against which the concentric ridges of the main surface end. Hinge and internal features not uncovered. Anterior margin regularly rounded, curving sharply into the dorsal margin above; ventral margin broadly and regularly rounded; posterior margin sharply rounded with a short subtruncation above the extremity; dorsal margins sloping gently away from the beaks, the anterior one slightly arched. Surface ornamented with about 22 rather strong, broad, concentric ridges with narrow interspaces; the ridges become progressively broader from the beak toward the ventral margin, the last one being about 1.5 mm. wide; each of these ridges terminates above at the edge of narrow, unribbed areas bordering the dorsal margins. A group of a dozen or more rather broad, round-crested radiating ribs, with narrower interspaces, extend from the beak down over the central part of the shell, leaving a little more than the anterior fourth and the posterior fourth, unribbed; the channels between the concentric ridges cut the radiating ribs, giving to the central part of the shell a checkered appearance; the radiating ribs exhibit considerable variation in their number and spacing on different individuals, an extreme example of which is afforded by the paratype shown in plate 26, figure 21.

This shell is very similar in size, form, and outline to the typical *Cymella bella* Conrad from the Snow Hill member of the Black Creek formation (upper part of *Exogyra ponderosa* zone) in North Carolina, but it differs in having broader and more numerous radiating ribs with narrower interspaces. In places in the *Exogyra ponderosa* zone, as in the San Miguel formation of the Rio Grande region, the shells of this group show considerable variation, from those having the relatively few and typically narrow costae of *C. bella* to those having more and broader costae like *C. bella texana*, and some of the intermediate forms must be referred to one or the other form rather arbitrarily. But shells from the higher *Exogyra costata* zone, including those from the Navarro group, and beds of corresponding age, appear to be constantly more like *C. bella texana*; it is therefore convenient to have a separate name for this form.

Types.—Holotype, U.S.N.M. no. 76517; 2 figured paratypes, U.S.N.M. no. 76518.

Distribution in Texas.— Upper part of Taylor marl: ?On the Burlington road, 2 3/10 miles west-southwest of Rosebud, Falls County (14135).

Upson clay: ?On Imperialist Creek, 21/2 miles west of Darling siding, Maverick County (8255).

San Miguel formation: Carter Ranch, 12 miles (by road) northwest of Eagle Pass, Maverick County (8227); 1/3 mile southwest of the Spofford-Waters ranch road, 7 miles southeast of Spofford, in Maverick County (8263): private road, 1 7/10 miles east of the old Eagle Pass-Uvalde road, 16 miles northeast of Eagle Pass (10855); ?in the old Uvalde road, about 16 miles northeast of Eagle Pass (8250); tank  $\frac{1}{2}$  mile east of the old Uvalde road, about 18 miles northeast of Eagle Pass (8249); westward-facing slope east of the railroad, about 11/2 miles northeast of Paloma, Maverick County (8253).

Navarro group, Neylandville marl: 7 1/10 miles northeast of Cooper (14083); 3½ miles west-northwest of Corsicana (16166).

Navarro group, Nacatoch sand: Road 3/5 mile west of Kaufman (7545; 14098, loc. of holotype); field 3/5 mile west of Kaufman (14103); vicinity of Kaufman (761, 2 figured paratypes); field 2 miles southwest of Kaufman (7547).

Outside distribution.—Arkansas: Nacatoch sand.

Mississippi: Ripley formation.

Chattahoochee region (Alabama-Georgia): Lower part of Ripley formation (*Exogyra cancellata* zone).

Maryland: The specimen figured by Miller (see synonymy) from Prince Georges County, Maryland, appears to be this variety; it probably came from the Monmouth formation.

New Jersey: Woodbury clay; questionably Wenonah sand.

Range.—Specimens which appear to belong to this variety occur in the Taylor marl and beds of Taylor age (*Exogyra ponderosa* zone) and in the Navarro group at least as high as the Nacatoch sand. The range in the Atlantic and Gulf Coastal Plain is from the *Exogyra* ponderosa zone upward through the *E. costata* zone.

## Family CUSPIDARIIDAE

#### Genus CUSPIDARIA Nardo

## CUSPIDARIA GRANDIS Stephenson, n.sp.

# Pl. 26, fig. 31

Shell large, pyriform, strongly inequilateral, rather strongly ventricose centrally and anteriorly, becoming compressed, narrow, and rostriform posteriorly, with a broad, shallow, sinuous sulcus extending from the beak backward and downward to the posteroventral margin; shell wall thin. Beaks broad, strongly incurved, approximate, slightly opisthogyrate, situated at about the midlength. Hinge and internal features not observed. Anterodorsal margin short; anterior margin regularly, almost sharply, rounded; ventral margin broadly and evenly rounded, rising high posteriorly, becoming slightly concave where the radiating sulcus intercepts it, straightening out again toward the extremity; posterior part of the shell broken, but apparently rather long, narrow, and sharply rounded, or perhaps slightly truncated posteriorly; posterodorsal margin long, slightly concave. Surface ornamented with numerous subregular, sharp, concentric ridges, with much wider interspaces on which 4 or 5 fine, concentric lines can be seen on well preserved parts.

Dimensions of the holotype, a left valve: Length about 29 mm., height 16.8 mm., convexity about 7 mm.

This species is comparable in size, form, and concentric markings to *Cuspidaria jerseyensis* Weller, from the Navesink marl (Monmouth group), New Jersey. The Texas shell, however, is somewhat more finely sculptured, and lacks radiating lines which can be seen obscurely on the umbonal portion of the type of *jerseyensis*.

Internal molds of similar large shells occur in the Prairie Bluff chalk (upper part of *Exogyra costata* zone), in Oktibbeha County, Mississippi; the concentric sculpture on these shells has about the same degree of coarseness as that on *C. jerseyensis.* 

Holotype.-U.S.N.M. no. 76519.

Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637, type loc.).

Navarro group, Kemp clay: ?4 miles south of Corsicana (9550); ?Brazos River, 2 miles above Milam County line (13776).

### CUSPIDARIA GROVENSIS Stephenson, n.sp.

#### Pl. 26, fig. 32

Shell small, thin, strongly bulbose anteriorly, becoming sharply contracted posteriorly, both with respect to inflation and the height of the shell, ending almost in a point at the posterior end of the hinge line. Beaks strongly prominent, incurved, approximate, situated about 0.4 the length of the shell from the anterior extremity; the bulbose portion of the shell is slightly elongated in a line trending upward and downward, but the top of the beak is slightly prosogyrate. Hinge and internal features not uncovered. Posterodorsal margin straight, horizontal, extending from below the beak backward to the extremity; a narrow sharply impressed sulcus closely parallels this margin; posterior extremity subpointed, posteroventral margin broadly concave; the ventral margin below the globose inflation, and the anterior margin together describe almost a semicircle; anterodorsal margin arched. Surface smooth with the exception of fine growth lines which become coarser the contracted posterior on extension.

Dimensions of the holotype, a left valve: Length 8 mm., height 5 mm., convexity about 2 mm. The largest specimen referred to the species is 11 mm. long.

The species is meagerly represented by more or less imperfect material, and some of the specimens here referred to it may be found to belong to different species or varieties when more and better material is available.

Compared with Cuspidaria moreauensis (Meek and Hayden)<sup>209</sup> from the Fox Hills sandstone of the Western Interior, this species appears to be more strongly inflated and the bulbose part more clongated and more oblique. C. ventricosa (Meek and Hayden)<sup>210</sup> is markedly less inflated and more coarsely sculptured.

Holotype.—A left valve, U.S.N.M. no. 76520.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, 17365).

Navarro group, Nacatoch sand: 2 miles north of Corsicana (9554); 2½ miles northwest of Chatfield (Tex. Bu. 17303).

Navarro group, Corsicana marl: 4 miles southwest of Corsicana (16165, type loc.): ?Onion Creek,  $2\frac{1}{2}$  miles west of old Garfield (14156).

*Range.*—Ranges through the three lower members of the Navarro group in Texas.

#### Unidentified specimens of CUSPIDARIA

A small internal mold of a short, only moderately ventricose *Cuspidaria* (pl. 26, fig. 33) was found in the Nacatoch sand in the public road cast of the Houston & Texas Central R.R., near section house,  $2\frac{1}{2}$  miles north of Corsicana, Navarro County (14114). U.S.N.M. no. 76521.

A large internal mold of a right valve of *Cuspidaria?*, from the Nacatoch sand on land of E. A. Stevens, 1½ miles northeast of Quinlan, Hunt County (16162), is strongly inflated anteriorly and strongly contracted posteriorly, but appears to have a much shorter posterior extension than typical species of *Cuspidaria* (pl. 26, fig. 34). Dimensions: Length 14 mm., height 11 mm., convexity 4 mm. U.S.N.M. no. 76522.

A Cuspidaria from the Corsicana marl on the Mexia highway, 24% miles eastsoutheast of Cooledge, Limestone County (14137), is an incomplete external mold of a right valve about 7 mm. long, having

<sup>&</sup>lt;sup>209</sup>Meek, F. B., Rept. U. S. Geol, Survey Terr., vol. 9, p. 239, pl. 17, figs. 11, a, b, c, 1876.

<sup>&</sup>lt;sup>210</sup>Meek, F. B., op. cit., p. 238.

a rather elongated form and only moderate ventricosity (pl. 26, fig. 35); its surface is marked by fine growth lines and by irregularly developed growth plications. U.S.N.M. no. 76523.

## Order TELEODESMACEA

### Superfamily CYPRICARDIACEA

#### Family PLEUROPHORIDAE

#### Genus VENIELLA Stoliczka

Type species .- Venilia conradi Morton.

Roudairia Munier-Chalmas<sup>211</sup> (emend Roudiareia Fischer) from the upper Senonian of Tunis, North Africa, appears to be congeneric with Veniella, although slight differences in its hinge characters may justify its recognition as a subgenus.

#### VENIELLA CONRADI (Morton)

#### Pl. 27, figs. 6-8

- 1833. Venilia conradi Morton, Am. Jour. Sci., vol. 23, p. 294, pl. 8, figs. 1, 2. 1834. Venilia conradi Morton, Synopsis of the
- organic remains of the Cretaceous group of the United States, p. 67, pl. 8, figs. 1, 2.
- 1862. Venilia trigona Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 324.
  1869. Goniosoma inflata Conrad. Am. Jour. Conch., vol. 5, p. 44, pl. 1, fig. 10.
  1870. Venilia dente Conrad. Conch.
- 1870. Venilia elevata Conrad, Am. Jour. Conch., vol. 6, p. 74, pl. 3, figs. 7, 7a.
  1871. Veniella conradi (Morton). Stoliczka, Geol, Survey India Mem., Palaeontologia Indica, Cretaceous fauna of Southern India, vol. 3, p. 190. (Veniella substi-tuted for the preoccupied Venilia.) 1876. Veniella conradi (Morton). Meek, Rept.
- U.S.Geol. Survey Terr., vol. 9, p. 118, text figures.
- 1885. Veniella conradi (Morton). Whitfield, U. S. Geol. Survey Mon., vol. 9, p. 144, pl. 19, figs. 8-10. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 144, pl. 19, figs. 8 10, 1886).
- ?1885. Veniella inflata (Conrad). N idem, p. 147, pl. 19, figs. 4, 5. Whitfield,

- idem, p. 147, pl. 19, figs. 4, 5.
  1885. Veniella elevata (Conrad). Whitfield, idem, p. 148, pl. 19, figs. 6, 7.
  1885. Veniella trigona (Gabb). Whitfield, idem, p. 149, pl. 19, figs. 11-14.
  1905. Veniella conradi (Morton). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 13. (Also lists V. elevata (Conrad), and V. inflata (Conrad), which he recorded a synonyme of V contradic). gards as synonyms of V. conradi.) ----

- 1905. Veniella trigona (Gabb). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 13.
- 1907. Veniella conradi (Morton). Weller, Geol. Survey New Jersey, Palcontology, vol. 4, p. 537, pl. 59. figs. 1-3. 1916. Veniella conradi (Morton). Gardner,
- Maryland Geol. Survey, Upper Creta-
- Cous (2 vols.), p. 643, pl. 38, figs. 2 7.
   1923. Veniella conradi (Morton). Stephenson, North Carolina Geol. and Econ. Survey. vol. 5, pt. 1, p. 257, pl. 66, figs. 1-5.
- 1926. Veniella conradi (Morton). Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 250, pl. 92, fig. 13. (Figure only.)
- 1926. Veniella conradi (Morton). Wade, U.S. Geol. Survey Prof. Paper 137, p. 77, pl. 24, figs. 14-16.

Shell of medium to large size, equivalve, inequilateral; the outline varies with the age of the individual, from subtrapezoidal in the young to subtrigonal in the adult. Shell wall thick. The shell is only moderately ventricose in the young stages, but it becomes oblique, greatly produced in the direction of the umbonal ridge, and strongly ventricose in the adult. Beaks prominent, strongly incurved, prosogyrate, separated by a space of 2 or 3 mm. in the adult, situated a little in front of the midlength in the young, but on account of the increased obliquity becoming nearly terminal in the adult. Α sharply defined, angular umbonal ridge extends in a sinuous trend from the beak obliquely downward and backward to the lower posterior extremity; near the beak the angle of the posterodorsal slope with the main surface along this ridge is less than a right angle, but away from the beak this angle widens out becoming somewhat greater than a right angle toward the terminus.

The hinge is not exposed in the Texas material, but the hinges of perfect right and left valves from Mississippi were figured by me in 1923 (see synonomy). Hinge of left valve with two strong cardinal teeth, the anterior one heavy, trigonal and distinctly though rather weakly bifid, and the posterior one elongated, narrow, oblique, separated from the anterior one by a deep, wide, oblique socket; the anterior lateral is short and strong with a sharp peak rising at the posterior end, in front of which the crest is transversely striated, and back of which is a deep

<sup>&</sup>lt;sup>211</sup>Munier-Chalmes, M., Note paléontologique sur les fossiles recueillis par M. le Commandant Roudaire dons son expédition scientifique en Tunisie, et description des espèces nouvelles: Arch. des Missions Sci. et Lit., Troisieme serie, Tome 7, p. 303, pl. 4, figs. 1-7, 1881.

socket for the reception of the anterior lateral of the right valve; the deep socket is separated by a narrow low ridge from a small socket which receives the anterior cardinal of the right valve; the posterior lateral is long, narrow, and prominent, and its sides are finely striated at right angles to the plane of contact of the two valves. The two cardinal teeth on the right valve are separated by a wide profound socket; the anterior tooth is small, sharp, oblique downward and backward, and is separated from the inner anterior lateral tooth by a narrow deep cleft; the posterior cardinal is strong, oblique and distinctly bifid and is bordered behind by a deep narrow socket for the reception of the posterior cardinal of the left valve; the inner anterior lateral is short and thick and is closely crowded in below the anterior cardinal; it stands just back of a short deep socket with striated sides, which receives the anterior lateral of the left valve: the outer anterior lateral is low, narrow and weak: the inner one of the pair of posterior lateral teeth is long and strong, and is separated from the long, narrow, weak outer lateral by a deep socket with striated sides. Ligamental groove opisthodetic, short and deep, extending from below the beak backward to the anterior end of the posterior lateral tooth.

Anterior adductor scar subovate, deeply impressed; posterior scar subtrigonal, somewhat larger, and situated lower in the shell. Pallial line distinct, simple. On the inner surface of large individuals a low swell extends radially from the apex obliquely downward and backward, reaching about to the pallial line, and this appears as a depression on the internal mold. Dorsal margin arched, truncated anteriorly; anterior margin sharply rounded; ventral margin broadly rounded, inclined, becoming slightly truncated or even a little sinuous posteriorly on some specimens; posterior margin sharply angular below at the end of the umbonal ridge, strongly truncated above this angle, rounding broadly into the posterodorsal margin above. Lunule expanded into a broad subellipse with greatest dimension transverse to the plane of contact of the two

valves, faintly to rather strongly outlined by an impressed line. Escutcheon distinctly but not sharply outlined. Surface ornamented with 6 to 8 distant, strongly protruding, thin, concentric lamellae which are pronouncedly concave upward; these prominent lamellae end abruptly as such at the lunule in front, and at the umbonal ridge behind, but they are represented on the posterior slope of most shells by faint, thin ridges which continue to the dorsal margin; the lamellae rise as much as 3 mm, above the surface of the shell but they are so thin and frail that they are generally broken off and left behind in the matrix. On large specimens the prominent lamellae are not developed beyond a distance of 20 or 25 mm. from the apex, the rest of the surface being marked by rather coarse irregularly spaced, concentric lines and undulations.

Dimensions of the moderately large shell shown in plate 27, figure 6: Length 48 mm., height 47(?) mm., thickens 38 mm. The largest shell in the collections from Texas is about 80 mm. in its greatest dimension measured in the direction of the umbonal ridge.

Where this species is represented by many individuals, as at the classic Owl Creek locality in Tippah County, Mississippi, the shells exhibit considerable variation in outline, form, and the spacing and development of the prominent concentric lamellae. Although the species has been collected at many localities, at most places only one or at most three or four specimens were obtained, and many of them are imperfectly preserved. The shells from different localities do not all match up well in outline and form, but knowing the variation in the shells from a single stratum at Owl Creek, it seems useless for the time being to attempt to recognize more than one species among the specimens which are here referred to Veniella conradi.' Better suites of specimens from different horizons and localities may in the future justify such a separation.

The species is remarkable for the long continued, vigorous growth of individuals in a favorable environment, after they have lost their characters of youth and middle age. The species is comparable in this respect to some of the ostreid species, as for example *Exogyra ponderosa* Roemer.

Although the species is recorded from 15 localities in the Navarro group, it is represented by only a few individuals from each locality.

Type.—Collection of the Academy of Natural Sciences of Philadelphia. From "New Jersey," probably from the Navesink marl near Arneytown, in Burlington County; the specimen marked "type" is badly broken. Three plesiotypes from Texas, U.S.N.M. nos. 76524, 76525, 76526.

Distribution in Texas.—Blossom sand:  $1\frac{1}{8}$  to  $1\frac{1}{4}$  miles south by west of the courthouse at Paris, Lamar County (13078).

Taylor marl (upper part): Burlington road, 2 3/10 miles west-southwest of Rosebud, Falls County (141.35).

San Miguel formation: Questionably on the Del Rio road, about  $12\frac{1}{2}$  miles northwest of Eagle Pass, Maverick County (8226); ?on a private road, 1 7/10 miles east of the old Eagle Pass road, 16 miles northeast of Eagle Pass (10855).

Navarro group, Neylandville marl: 2½ miles northeast of Royce City (16157); 3½ miles west-northwest of Corsicana (16166).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103); vicinity of Chatfield (762); field south of Chatfield (7569); vicinity of Corsicana (763);  $2^{1}/_{2}$ miles north of Corsicana (14114, 1 specimen figured).

Navarro group, Corsicana marl: 2 3/5 miles north by east of Malta (16159); 1¼ miles south by east of Oak Grove (13568, 16160); ½ mile north of the town of Sulphur Bluff (5321); about 5 miles east by north of Greenville (12924); 3 7/10 miles southwest of Campbell (15547); 1 4/5 miles north, 20 degrees west of Tona siding (15545); 1 3/10 miles north of McQueeney (15524).

Navarro group, Kemp clay: Branch 6½ miles southwest of Curric (14139); 5 miles west by north of Elgin (14162);  $3\frac{1}{4}$  miles east by north of Manor (13861, 1 specimen figured);  $3\frac{1}{2}$  miles east of Manor (15534); 2 2/5 miles southeast of Manor (18196); 2 miles north-northwest of Deatsville (14128, 1 specimen figured); near Deatsville (764);  $2\frac{1}{4}$ miles north by west of Deatsville (16146);  $1\frac{1}{2}$  miles northwest of Texas Hill (15533); west of Zuehl (7085, 7720, 7721).

Outside distribution. -Arkansas: Brownstown marl, Ozan formation, Saratoga chalk, and Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Selma chalk (lower part and *Exogyra cancellata* zone), Coffee sand, Ripley formation, and Owl Creek formation.

Central and west-central Alabama: Tombigbee sand member of Eutaw formation and Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama - Georgia): Blufftown formation, Cusseta sand, Ripley formation (upper part), and Providence sand.

Maryland: Matawan formation and Monmouth formation.

Delaware: Crosswicks clay, Marshalltown formation, and Mount Laurel sand.

New Jersey: Merchantville clay, Wenonah sand, Navesink marl, and Red Bank sand.

Range.—In Texas the species ranges from the Blossom sand, which is interpreted to be of upper Austin age, upward to the top of the Navarro group. The range of the species in general in the Atlantic and Gulf Coastal Plain is through the zones of *Exogyra ponderosa* and *E.* costata.

## VENIELLA LINEATA (Shumard)

# Pl. 26, figs. 16-20

1861. Crassatella lineata Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 201.

1901. Veniella lineata (Shumard). Hill, U.S. Geol. Survey 21st Ann. Rept., pt. 7, pl. 48, figs. 1, 1a. (Figures only.)

The figures given by Hill were subsequently reproduced by authors as follows:
- (1) Hill and Vaughan, U.S.Geol. Survey Geol. Atlas, Ausin Folio (No. 76), illustration sheet, fig. 49, 1902.
  (2) Veatch, U.S.Geol. Survey Prof. Paper 46,
- (2) Planth Castovic Survey Prof. Paper 18, pl. 10, figs. 4, 4a, 1906.
   (3) Deussen, U.S.Geol. Survey Prof. Paper 126, pl. 11, figs. 2, 2a, 1924.

Shell of moderate size, subovate in outline, equivalve, inequilateral, moderately inflated; shell wall thick; umbonal ridge angular, sinuous, extending to the lower posterior extremity. Beaks moderately prominent, broad, incurved, approximate, prosogyrate, situated about 0.3 the length of the shell from the anterior extremity. The hinge is in all its essential features like that of Veniella conradi (Morton), except that the teeth and sockets are all more elongated and slender, and there are other minor differences in detail which resulted from the greater elongation of the shell. Ligament short, opisthodetic, set in a deep narrow groove. Anterior adductor scar small, subovate, deeply impressed, situated a little below the midheight; posterior scar noticeably larger, subovate, not so deeply impressed, situated slightly below the midheight. Pallial line simple. Anterodorsal margin slightly arched; anterior margin sharply rounded; ventral margin broadly and evenly rounded; posterior margin almost squarely truncated, inclined forward, subangular below, rounding broadly and evenly into the gently arched posterodorsal margin above; lunule broadly lanceolate, not sharply outlined: escutcheon long, narrower than the lunule, obscurely outlined. Surface marked with fine growth lines, and with 10 or 12 thin, sharp, concentric lamellae which rise 1 to 2 mm. above the surface, separated by progressively widening interspaces from the beak to the outer margin; the ridges end at the edge of the lunule in front but are generally traceable across the posterodorsal slope to the escutcheon; these ridges are easily broken and are rarely preserved; the growth lines become a little coarser toward the margin, and are also a little coarser on the posterodorsal slope. Large shells take on senile characters in the form of irregular, coarse, concentric undulations toward the margins.

Dimensions of the neotype: Length 34.5 mm., height 24 mm., thickness 20 The maximum observed length of mm. any individual is 40 mm.

This species is represented in the collections by a large suite of excellently preserved shells from the vicinity of Corsicana. They exhibit marked individual variations in the proportions of length to height and in the spacing of the concentric ridges.

The species bears some resemblance to Veniella conradi (Morton), but is much more elongated and has much less prominent concentric ridges. Veniella lineata finds its nearest allied species in V. mullinensis Stephenson from the Snow Hill member of the Black Creek formation in South Carolina, but the latter is in general not quite so high posteriorly, shows a little less obliquity in the direction of the umbonal ridge, and has the concentric ridges somewhat more widely spaced.

Type.-Shumard's type is lost; it came from the bed of a small branch near Corsicana. Hill figured a shell from near Corsicana, and the specimen from that locality shown on plate 26, figures 16, 17, of this volume is here designated neotype (U.S.N.M. no. 76527); 2 examples figured U.S.N.M. no. 76528; one example figured, U.S.N.M. no. 76529.

Distribution in Texas.-Navarro group, Nacatoch sand: North edge of Corsicana (518, includes neotype); vicinity of Corsicana (763, 1 specimen figured); 2<sup>1</sup>/<sub>2</sub> miles north of Corsicana (14114); 31/5 miles north of Corsicana (16168); 5 miles south-southwest of Corsicana (7573); 3 miles northeast of Corsicana (9545); ?from 3 miles north of Powell (9551); vicinity of Chatfield (762); loose pieces of rock in street at Chatfield (7568); ?road 3/5 mile west of Kaufman (14098); 145 miles northeast of Quinlan (16162).

#### Genus ETEA Conrad

- 1875. Etea Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 5.
- 1876. Crassatellina Meek, Rept. U.S.Geol. Survey Terr., vol. 9, p. 118. (Excluding the Kansas material.)
- 1916. Crassatellina Meek. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 645.

## 1923. Etca Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 263. (Subgenus of Veniella.)

*Etea* is raised to the rank of genus because of the pronounced difference in surface features and the marked difference in size and thickness of shell, between it and *Veniella*. *Veniella* is represented in the American Upper Cretaceous by 3 species having the characteristic pronounced concentric lamellae, and *Etea* is represented by 4 or more species and varieties all of which lack these lamellae.

For a discussion of the relationship of *Etea* to *Crassatellina* see Volume 5 of the North Carolina Geological and Economic Survey, pages 263–264, 1923.

## ETEA CORSICANA Stephenson, n.sp.

## Pl. 26, fig. 15

Shell small for the genus, clongate in outline, equivalve, inequilateral, depressed convex: shell wall moderately thin. Umbonal ridge long, obtusely subangular, a little sinuous, extending to the lower posterior extremity. Beaks not strongly prominent, broad, incurved, prosogyrate, approximate, situated about 0.3 the length of the shell from the anterior extremity. Hinge of right valve, rather poorly uncovered, appears to be practically identical with that of Etea carolinensis Conrad, the type species of the genus. Ligament of moderate length, opisthodetic, set in a deep narrow slit. Adductor scars and pallial line obscure in the available material. Anterodorsal margin inclined, nearly straight; anterior margin sharply rounded; ventral margin long and broadly and evenly rounded except toward the posterior extremity where it bends up a little more strongly; posterior margin subangular below, truncated and inclined forward above, passing in a wide subobtuse angle into the long, gently arched posterodorsal margin. Lunule narrow, obscurely outlined; escutcheon long, narrow, deep, but obscurely outlined. Surface smooth, with the exception of fine growth lines and gentle growth undulations; the growth lines are a little coarser on the posterodorsal slope.

Dimensions of the holotype, a left valve: Length 21 mm., height 13 mm., convexity about 3.5 mm. Dimensions of a small paratype: Length 14 mm., height 9 mm., thickness 5 + mm.

This species has a near ally in *Etea* carolinensis Conrad from the Snow Hill member of the Black Creek formation, but the latter is much more strongly extended back of the beak, its posterior truncation is shorter and much lower, and its long posterodorsal margin is more arched and more steeply descending.

*Types.*—Holotype, U.S.N.M. no. 76530; 18 unfigured paratypes, U.S.N.M. nos. 76531, 76532.

Distribution in Texas.--Navarro group, Nacatoch sand: North edge of Corsicana (518); vicinity of Corsicana (763, type loc.); 2<sup>1</sup>/<sub>2</sub> miles north of Corsicana (14114).

## ETEA PEASEI Stephenson, n.sp.

## Pl. 26, figs. 13, 14

Shell small for the genus, subovate in outline, equivalve, inequilateral, moderately convex, most inflated a little above the midheight at about the midlength; shell wall thin. Umbonal ridge long, sinuous, obtusely subangular, extending to the lower posterior extremity. Beaks moderately prominent, broad, incurved, prosogyrate, approximate, situated about 4.5 mm. back of the anterior extremity. Hinge and internal features not clearly exposed. Anterodorsal margin short and apparently excavated; anterior margin rounded; ventral margin broadly rounded, nearly straight centrally; posterior margin truncated, sloping slightly forward; posterodorsal margin long, broadly arched. Shell broken away on the anterodorsal surface, but the lunule is present and is broad and short: escutcheon long. narrow, deep, angulated on margin. Surface marked only by fine sharp lines of growth.

Dimensions of holotype: Length 17 mm., height 10.7 mm., thickness 7.6 mm.

The shell of this species is more convex and more deeply excavated in front of the beak than is that of *Etea corsicana*.

Holotype.—U.S.N.M. no. 76533. Named for the Hon. Elisha M. Pease, Governor of Texas, 1853-1857.

Type species .- Etea carolinensis Conrad.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763).

## Unidentified specimens of ETEA

A small internal mold of a left valve of *Etea*, found in the Nacatoch sand in a field north of the Dallas road,  $\frac{3}{5}$  mile west of Kaufman, Kaufman County (14103), is proportionately much shorter and higher than the Corsicana species. U.S.N.M. no. 76534.

A badly crushed, rather large left valve, preserved as a clay mold, questionably referred to *Etea*, is included in the collection from the Corsicana marl, left bank of San Marcos River,  $\frac{1}{2}$  mile below Martindale, Caldwell County (7621). The mold is about 40 mm. long and has rather coarse, concentric surface sculpture. U.S.N.M. no. 76535.

#### Superfamily ASTARTACEA

#### Family ASTARTIDAE

# Genus ASTARTEMYA Stephenson, n.gen.

Type species.—*Astartemya fentressensis* Stephenson, n.sp.

Etymology.-An Astarte-like mussel (mya)

The shells referred to the proposed genus, Astartemya, have certain features in common with Astarte. They are flattish in form, broadly subovate in outline, exhibit similar concentric surface undulations, have a finely crenulated inner margin, and possess in each valve 2 cardinal teeth which, however, are differently disposed on the hinge plate. In most species of Astarte there is a tendency to elongation of the shell in the direction of the length, whereas Astartemya fentressensis is higher than long; its hinge plate is relatively longer and wider, and occupies a proportionately greater portion of the dorsal region than is true of the hinge of Astarte.

The principal differences between the two genera are to be found in the hinge characters. In *Astartemya* the teeth, sockets, and ligamental groove are proportionately greatly clongated. Starting with the ligamental groove of the right valve there follow in succession forward a moderately broad nymph, a narrow socket, a prominent, narrow cardinal tooth arched in its

trend, a wide, deep, curved socket, a broad, flattish anterior cardinal, a long, narrow, curved groove for the reception of the anterior margin of the left valve, and finally a sharply upraised anterior margin. In the right valve of a typical Astarte, starting with the ligamental groove, there follows a moderately broad nymph with a narrow, much reduced posterior cardinal along its anterior margin, a narrow, deep socket, a broad, prominent cardinal tooth, a wide, deep socket, and finally the sharp upraised anterior margin of the shell bordering the socket. The hinges of the left valves of the two species exhibit corresponding differences. In plate 27, figures 4, 5, the hinges of a typical Astarte from the British Isles, in the collection of the U.S. National Museum, labelled A. sulcata Da Costa, is illustrated for comparison with Astartemya.

The genus is related to *Eriphyla* Gabb, but seems to lack the true lateral teeth of that genus.

## ASTARTEMYA FENTRESSENSIS Stephenson, n.sp.

#### Pl. 27, figs. 1-3

Shell of medium size, thin, broadly subovate in outline in the direction of the height, depressed convex, slightly inequilateral. Beaks prominent, flattish, slightly incurved, prosogyrate, situated a little in advance of the midlength. Hinge of right valve with two cardinal teeth and two sockets; the anterior cardinal is moderately broad but nonprominent and the posterior one is long, broadly arched and prominent; the two are separated by a wide, deep socket, and the posterior one is bordered behind by a long, deep, curved socket. Hinge of the left valve with two cardinal teeth and two sockets; the anterior cardinal is long, narrow, slightly curved and prominent; the posterior cardinal is long, narrow, curved, and is supported on the anterior margin of a broad, moderately prominent nymphlike platform; the two cardinals are separated by a wide, deep, curved socket, and the anterior cardinal is bordered in front by a moderately wide, deep socket. The teeth on both valves are striated on the sides at right angles to the plane of contact of

the two valves. Ligamental groove long, narrow, opisthodetic. On the left valve this groove is bordered behind by a long, narrow marginal groove extending far below the end of the ligamental groove, which receives the sharply upraised margin of the right valve. On the right valve a long, narrow groove paralleling the anterodorsal margin receives the upraised margin of the left valve, which serves as a sort of pseudolateral. On well preserved internal molds the antero- and posterodorsal margins are paralleled on the outer side by broad, flangelike borders which probably represent the mechanically flattened surfaces of the lunule and escutcheon. The internal features are not well preserved on the molds, but the adductor scars can be faintly seen on some specimens; they are of medium size, the posterior one apparently being somewhat the larger. The pallial line appears to be nearly simple, being only slightly bent inward near the posterior adductor scar. Anterodorsal margin broadly excavated: anterior and ventral margins broadly and regularly rounded; posterior margin a little more sharply rounded than the anterior, passing above into the broadly arched posterodorsal margin. The surface is marked by fine growth lines, and by shallow, concentric undulations which, near the beak of the holotype, number 8 or 10 to the centimeter, becoming coarser toward the margin; there is, however, a marked individual variation in the strength and coarseness of the undulations.

Dimensions of the holotype, the internal and external molds of a right value: Length 36 mm., height 39 mm., convexity 3 + mm.(?).

The material on which this new genus and species are based, consists of numerous internal and external molds in a zone of earthy, ferruginous, concretionary sandstone cropping out at two localities about 10 miles apart in Caldwell County. None of the shell material remains intact.

The only representatives of the Astartidae heretofore recorded from the Upper Cretaceous of the Atlantic and Gulf Coastal Plain are 5 or 6 species of the genus *Vetericardia*, all of which are small, scarcely exceeding 10 mm. in length and exhibiting dentition more like that of the typical *Astarte* than of the new genus *Astartemya*.

Types.—Holotypc, internal and external molds of a left valve, U.S.N.M. no. 76536; 1 figured paratype, U.S.N.M. no. 76537; 7 selected unfigured paratypes, U.S.N.M. no. 76538.

Distribution in Texas.—Navarro group, Kemp clay: 3 1/5 miles north-northwest of Fentress (16149, loc. of holotype and 7 unfigured paratypes);  $4\frac{1}{2}$  miles northwest of Lockhart (16151, 1 specimen figured).

Range.—Known only from a restricted zone in the Kemp clay of the Navarro group in Caldwell County.

## Genus ASTARTE Sowerby

## ASTARTE? CULEBRENSIS Stephenson, n.sp.

## Pl. 26, figs. 9, 10

The description is based on the only available specimen, a right valve. Shell small, broadly subtriangular in outline, inequilateral, depressed convex. Beak nonprominent, incurved, prosogyrate, situated about three-fifths of the length of the shell from the anterior extremity. Anterodorsal margin long, descending, broadly concave upward; anterior margin rather sharply rounded, meeting the dorsal margin above at an obtuse angle; ventral margin broadly rounded, rising regularly to the subangular posterior extremity; posterodorsal margin slightly arched, rising steeply to the beak. Hinge and other internal features badly corroded. One cardinal tooth on the right valve is oblique backward, and is strong and robust as on Astarte; the other features of the dentition are obscure. A narrow groove along the inner anterodorsal margin receives the margin of the left valve. Surface ornamented with 7 strong, broadly round-crested concentric undulations which extend to the dorsal margins and end abruptly without curving around toward the beak.

Dimensions.—Length 5.1 mm., height 4.6 mm., convexity 1.2 mm.

Holotype.—A right valve, U.S.N.M. no. 76539.

Distribution in Texas.—Navarro group. Corsicana marl: Well near the Culebra road, 7/20 mile south by west of St. Mary's University, Bexar County (16408).

## Genus VETERICARDIA Conrad

- 1869. Vetocardia Conrad. Am. Jour. Conch., vol. 5, p. 18.
- 1872. Vetericardia Conrad, Acad. Nat, Sci. Philadelphia Proc., vol. 24, p. 52. Type species. Astarte crenalirata Conrad. from
- Eufaula, Alabama.

Conrad explained in the second paper cited in the synonymy, that the original spelling, Vetocardia, of this generic name, was an error, and should have been Vetericardia. All subsequent authors have used the corrected spelling.

The hinge of Vetericardia is strikingly like that of Astarte and, despite its radial sculpture, Wade<sup>212</sup> apparently correctly included the genus under the family Astartidae.

## VETERICARDIA WEBBERVILLENSIS Stephenson, n.sp.

#### Pl. 26, fig. 5-8

Shell small, relatively thick-shelled, subtrigonal in outline, equivalve, inequilateral, depressed convex, umbonal ridge scarcely differentiated. Beaks nonprominent. incurved, prosogyrate, situated slightly in advance of the midlength of the shell. Hinge of left valve with 2 strongly developed cardinal teeth, separated by a deep, triangular socket; the anterior cardinal is short, thick below and chisel-edged upward; the posterior cardinal is elongated, oblique, thick below, thinning to a chisel edge above. The anterior lateral is long, thin and moderately prominent: the posterior lateral dentition is bifid, the inner component long, weak distally, thick and moderately prominent centrally, and the outer one long, thin and nonprominent; the two components are separated by a long, narrow, moderately deep socket. The right valve presents one prominent, faintly bifid cardinal, very thick below, narrowing above, with deep, triangular sockets on either side. The anterior lateral dentition is bifid, the inner component being the

stronger of the two, which are separated by a long socket of moderate width and depth. The posterior lateral is long, thin, and prominent. Ligamental groove short, opisthodetic, and rather weakly developed. Lunule long and broad but weakly out-Adductor scars of moderate size, lined. the anterior one more elongated than the posterior one, situated about midway of the height. Above the anterior adductor is a small, weak pedal scar. Pallial line simple, moderately distinct in some specimens, glazed over and weak in others. Inner margin strongly crenulated. Anterior margin regularly, but rather sharply rounded; ventral margin broadly rounded; posterior margin regularly rounded; anslightly terodorsal slope excavated; posterodorsal slope slightly arched. The surface of the holotype presents about 25 strongly developed concentric ridges, steepest on their upper slopes, which become stronger and more widely separated toward the ventral margin. Crossing the concentric ridges are about 35 weaker radials, separated by much narrower interspaces; these ribs produce broadly rounded nodes at their intersection with the concentric ribs. Comparison of different individuals in the same collection shows that there is considerable variation in the number and the coarseness of both the concentric and radiating ribs.

Dimensions of the holotype, a left valve: Length 5.2 mm., height 5 mm., convexity 1.5 mm. Dimensions of the large left valve shown in plate 26, figure 8: Length 6.3 mm., height 6.1 mm., convexity 2 mm.

Vetericardia crenalirata Conrad, from the Ripley formation at Eufaula, Alabama, is a similar, but much more coarsely sculptured species, particularly with reference to the concentric ridges. Vetericardia subcircula Wade, from the Coon Creek tongue of the Ripley formation, Coon Creek, McNairy County, Tennessee, is also a similar species, but on it the radiating sculpture is obsolete except on the posterior slope where the ribs are very weak; the concentric ribs are sharper above, and pass into a smooth surface below.

<sup>&</sup>lt;sup>212</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 78, 1926.

Two of Wade's<sup>213</sup> species, Vetericardia subangulata W a d e and Vetericardia gregaria (Meek and Hayden) are incorrectly referred to Vetericardia; they probably belong to the genus Crassatella. The second of the two species is also incorrectly referred to Meek and Hayden's species.

*Types.*—Holotype, U.S.N.M. no. 76540; 1 figured paratype, U.S.N.M. no. 76541; 1 figured paratype, U.S.N.M. no. 76542; and 14 unfigured paratypes, U.S.N.M. no. 76543.

Distribution in Texas.—Navarro group, questionably in the Corsicana marl: 5 miles southwest of Quinlan (15546): 2 miles south of Corsicana (16167); 24/5 miles east of Cooledge (13832, 14137);  $\frac{1}{4}$  mile west of Kimbro (14129); Onion Creek. 21/2 miles west of old Garfield (14049, 14156); 1/2 mile below Martindale (15527); well 7/20 mile south by west of St. Mary's University, Bexar County (16353). Navarro group, Kemp clay: Branch 61/2 miles southwest of Currie (17377); well 2 miles west of Groesbeck at depth of 675-700 feet (13131), 730 feet (13132), and 800 feet (13124, 1 paratype figured); ?15 mile west of Odds (15434); 2 miles northwest of Deatsville (14128): Webberville (7601, holotype, 1 figured paratype, and 14 unfigured paratypes); west of Zuehl (7721).

Range.- Specimens found at seven localities in the Corsicana marl are poorly preserved and are questionably referred to this species. The remainder of the material came from the Kemp clay.

## Family CRASSATELLIDAE

## Genus CRASSATELLA Lamarck

The validity of *Crassatella* Lamarck versus *Crassatellites* Krueger is discussed by Stewart,<sup>214</sup> who concludes that the former name, which is in general use in Europe, should be accepted as valid. It is doubtful, however, if unanimity of usage will be reached until the matter

has been passed upon by the International Commission on Zoological Nomenclature.

The genus is represented in the Navarro of Texas by two subgroups each of which, in a subdivision of the genus, would rank as a distinct subgenus. In the first subgroup, which includes 4 varieties of the species Crassatella vadosa Morton, the resilifer on the left valve descends about halfway across the hinge plate, and is bordered below by the prominent lower end of a cardinal tooth which has become bent around to this subligamental position; this tooth bears a distinctly impressed pit along its upper side; in the right valve the resilifer is bordered below by a sunken platform into which fits the aforementioned prominent tooth of the left valve. In the second subgroup, represented by Crassatella quinlanensis, the resilifer descends in each valve to the inner hinge margin, and opens freely to the interior of the shell; this subgroup which is further characterized by its compressed form and pointed posterior extremity, is represented in the castern Gulf region by Crassatella pteropsis Conrad (not C. pteropsis Gabb).

The holotype of Crassatella vadosa Morton<sup>215</sup> is from the Prairie Bluff chalk at Prairie Bluff, Alabama River, Wilcox County, Alabama, and is preserved in the collection of the Academy of Natural Sciences of Philadelphia. This was the first described species of a closely related group of shells of this genus, which occur in great profusion at several localities in the Upper Cretaceous deposits of the Gulf region. Some authors have preferred to include all of them under Morton's species, but in so doing they were obliged to allow a wider range of variation than seems necessary, in view of the fairly consistent differences recognizable in collections from different horizons and localities.

One of the varietal forms is the shell from Coon Creek, Tennessee, described by Wade<sup>216</sup> under the name *Crassatellites* 

<sup>&</sup>lt;sup>213</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, pp. 78, 79, 1926,

<sup>&</sup>lt;sup>211</sup>Stewart, Ralph, Acad. Nut. Sci. Philadelphia Special Pub. No. 3, pp. 134-137, 1930.

<sup>&</sup>lt;sup>215</sup>Morton, S. G., Synopsis of the organic remains of the Cretaceous group of the United States, p. 66, pl. 13, f.g. 12, 1831.

<sup>&</sup>lt;sup>219</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, pp. 79-80, pl. 25, figs. 6-8, 1926.

vadosus (Morton), and for which I here propose the name *Crassatella vadosa ucadei*, designating the shell shown in Wade's monograph on plate 25, figures 7 and 8, as holotype. This subspecies is higher and flatter, and has the beak more distantly removed from the anterior extremity than the typical form of the species.

Another subspecies is the one from Owl Creek, Mississippi, named by Conrad<sup>217</sup> *Crassatella ripleyana*. This form appears to be slightly shorter, more ventricose, has a more prominent umbonal projection, and narrows down to a more pointed posterior extremity than the typical form of the species, but is nevertheless very close to it; it might be treated as a variety under the name *Crassatella vadosa ripleyana* (Conrad).

The shells from the Monmouth formation of Maryland, referred by Gardner<sup>218</sup> to *Crassatellites vadosus* (Morton), are close to the typical form of the species, but the umbonal ridge appears to be less angular and the posterodorsal slopes more inflated, so that with perfect material for comparison they, too, might perhaps be appropriately classed as belonging to a subspecies. Four varietal forms are recognized in Texas.

## CRASSATELLA VADOSA MANORENSIS Stephenson, n.var.

## Pl. 29, figs. 6-9

Individuals of this subspecies are especially numerous at several localities in the Kemp clay in Travis County. Shell large, subtrigonal in outline, equivalve, inequilateral, moderately convex, with greatest inflation about midway of the umbonal ridge. Shell thick. wall Umbonal ridge obtusely subangular, extending to the lower posterior extremity. The individuals exhibit some variation in outline, but in general the shells are characterized by their short and stubby appearance and their moderate inflation. Beaks moderately prominent, incurved,

prosogyrate, approximate, situated well in advance of the midlength. Hinge of right valve with one strong cardinal tooth directed downward and a little backward and bearing striae on the sides; back of this is the resilifer of rather broad triangular shape and extending only about halfway down across the hinge plate; below the resilifer is a sunken platform which receives a bent cardinal of the left a weakly developed anterior valve: cardinal is separated from the subumbonal cardinal by a deep triangular socket of moderate depth. On the hinge of the left valve a deep triangular socket separates a strong anterior cardinal from a weaker subumbonal cardinal; the latter is most prominent below, where it curves around below the short triangular resilifer. On the right valve there is a long dullcrested posterior lateral marginal ridge which fits into a corresponding channel on the margin of the left valve, and seems to function as a lateral tooth. Lunule distinct and deep, most sharply outlined on the left valve. Escutcheon fairly distinct, only moderately deep, most clearly defined on the right valve. Adductor scars small, ovate in outline, subequal, strongly impressed: back of the upper end of the anterior adductor scar is a small, deeply impressed pedal scar, and immediately above the posterior adductor is another similar small scar. Pallial line simple. Margin finely crenulated. Anterior margin regularly rounded; ventral margin broadly rounded, becoming nearly straight posteriorly; posterior margin subangular below, truncated above, rounding into the Surface marked posterodorsal margin. by rather coarse growth lines and ridges of irregular strength.

Dimensions of the holotype: Length 45 mm., height 38 mm., thickness 27 mm.

This variety is less pointed posteriorly, and the radial sulcus in front of the umbonal ridge is much weaker than on the typical form of the species. Compared with other subspecies it is much shorter than *chat fieldensis*; it is shorter and more inflated than *bexarensis*; it is broader, less inflated, and much less pointed posteriorly than *ripleyana*; *wadei* is a flatter and much longer form.

<sup>&</sup>lt;sup>217</sup>Conrad. T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 327, pl. 35, fig. 3, 1858.

<sup>&</sup>lt;sup>218</sup>Gardner, Julia A., Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 649, pl. 39, figs. 1-4, 1916.

*Types.*—Holotype, U.S.N.M. no. 76544; 1 figured paratype, U.S.N.M. no. 76545; 12 unfigured paratypes, U.S.N.M. no. 76546.

Distribution in Texas.--Navarro group, Corsicana marl; ?2 3/5 miles north by east of Malta (5310, 12934); ?about 5 miles east by north of Greenville (12924); 1/2 mile below Martindale (15526); 21/2 miles west of McQueeney (15523); well, 7 20 mile southwest of St. Mary's University, Bexar County (16408).

Navarro group, Kemp clay: 3 miles northwest of Lockhart (Tex. Bu. 1174): miles northwest of Texas Hill 11/3 (15533); ?at Webberville (7601); near Deatsville (764, 14125): 2 miles northwest of Deatsville (14128); 2<sup>1</sup>/<sub>1</sub> miles north by west of Deatsville (16146);  $31_1$  miles southeast of Manor (16142); 31/2 miles east of Manor (14158, 15534); 31,4 miles east by north of Manor (13861, holotype and 13 unfigured paratypes); 2 2 5 miles southeast of Manor (18196); 4 miles south of Manor (Tex. Bu. 2399); 5 miles west by north of Elgin (14162); branch 614 miles southwest of Currie (14139, 1 figured paratype);  $4\frac{1}{2}$  miles northeast of Roane (12921).

Range.---Rare in Corsicana marl and common in Kemp clay of Navarro group.

## CRASSATELLA VADOSA CHATFIELDENSIS Stephenson, n.var.

## Pl. 29, figs. 10, 11

This subspecies is represented by one large, well preserved shell from near Chatfield, but younger and imperfectly preserved specimens from several other localities are also referred to it. Compared with the typical *C. vadosa* Morton, it is larger, proportionately higher, is plumper anteriorly, and the umbones are more prominent and a little farther removed from the anterior extremity; the umbonal ridge is less angular, and the posterodorsal slope not so steep.

Dimensions of the holotype: Length 56 mm., height 46 mm., thickness 31.5 mm.

Holotype.- U.S.N.M. no. 76547.

Distribution in Texas. --Navarro group, Nacatoch sand: 3 5 to 4/5 mile northeast of Chatfield (14117, type loc.); near Kaufman (761); 3 miles north of Sulphur Bluff (5322);  $1\frac{1}{2}$  miles west of Commerce (5323).

## CRASSATELLA VADOSA BEXARENSIS Stephenson, n.var.

## Pl. 29, figs. 1-5

Great numbers of the shells of this subspecies occur in a good state of preservation, in concretions in gullies which enter Cibolo Creek from the Bexar County side. 11/2 miles west of Zuehl, Guadalupe County. They exhibit great individual variation in outline, but compared with the typical form of the species they are all flatter, have less prominent and less angular umbonal ridges, and in general the beaks are somewhat more distantly removed from the anterior extremity. This subspecies is flatter than the subspecies chatfieldensis, and is more elongated and less inflated than *manorensis*. Compared with the eastern Gulf subspecies it is flatter and much less pointed posteriorly than ripleyana and is a little more inflated and in general less elongated than wadei.

Dimensions of the holotype, an adult right valve of about average outline: Length 53 mm., height 43 mm., convexity 15 mm. The right valve shown in plate 29. figure 4, which represents an extreme development of the height with respect to the length, is 57 mm. long and 50 mm. high. The left valve shown in plate 29, figure 1, which represents an extreme development of length with respect to height, is 49.5 mm. long, and 38 mm. high.

*Types.* Holotype, U.S.N.M. no. 76548; 3 figured paratypes, U.S.N.M. no. 76549; 23 selected unfigured paratypes, U.S.N.M. no. 76550.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7085, 7720; 7721, type lot); branch 6½ miles southwest of Currie (17377); road 3½ miles north-northwest of Bazette (17375); 3½ miles north-northwest of Bazette (17376).

# CRASSATELLA VADOSA CEDARENSIS Stephenson, n.var.

## Pl. 27, fig. 12

This variety is represented by four specimens from three localities. The holotype is not full grown but is well preserved. Compared with the typical *C*. *vadosa* the holotype is proportionately flatter, higher, and shorter, and is more conspicuously arched on the posterodorsal margin. It is higher and more arched on the posterodorsal margin than any of the varieties of *vadosa* here recognized.

Dimensions of the holotype: Length 32.6 mm., height 28.2 mm., convexity 8 mm.

*Types.*—Holotype, U.S.N.M. no. 76551; 1 paratype, U.S.N.M. no. 76552.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles due north of Corbet (16170, type loc.); ?from 5 miles northwest of Terrell (14104); 71/10 miles northeast of Cooper (14083).

## CRASSATELLA QUINLANENSIS Stephenson, n.sp.

## Pl. 27, figs. 9 11; pl. 28

Shell relatively small, depressed convex, elongate, subtrigonal, equivalve, inequilateral, narrowing to a subpoint posteriorly. Umbonal ridge weakly developed, rounded on the crest. Beaks nonprominent, flattish, slightly incurved, nearly direct, slightly separated, situated about 0.3 the length of the shell from the anterior extremity. Hinge of right valve with two cardinal teeth, a posterior prominent one in front of the resilifer extending obliquely downward and forward, and a weak anterior one almost marginal; the two are separated by a narrow deep socket; along the posterior flank of the posterior cardinal, closely bordering the resilifer, is a shallow socket for the reception of the posterior cardinal of the left valve; the resilifer is wide, triangular, broadly excavated, and extends to the inner margin of the hinge plate; a short, weak groove bordering the anterodorsal margin receives the sharp anterodorsal margin of the left valve; the posterodorsal margin bordering the escutcheon is a straight, sharp carina. Hinge of left valve with a prominent, thin, nearly vertical posterior cardinal in front of the resilifer, and a long, prominent, oblique anterior cardinal; between the cardinals is a deep socket of moderate width, and in front of the anterior cardinal is a narrow, shallow socket; the anterodorsal margin is a prominent sharp

carina, and bordering the posterodorsal margin is a long, narrow groove which receives the sharp posterodorsal carina of the right valve; the inner edge of this groove forms a weakly developed lateral tooth. Except on the surfaces facing the resilifer the sides of the cardinal teeth are scored approximately at right angles to the plane of contact of the two valves. Adductor scars of medium size, subovate in outline, the anterior one elongated nearly vertically, and the posterior one nearly horizontal. Inner margin finely crenulated. Lunule excavated, distinctly outlined; escutcheon excavated, sharply outlined, extending a little less than halfway to the terminus of the shell. The anterior margin is rather sharply rounded; ventral margin broadly rounded; posterior extremity subpointed; posterodorsal margin long, nearly straight, gently descending. Surface marked by medium to fine growth lines and undulations. On a young, uncorroded individual (pl. 27, fig. 11) numerous concentric ridges are strongly developed in the umbonal region.

Dimensions of the holotype, a right valve: Length 38 mm., height 22 mm., convexity 6.5 mm.

This species is a close analogue of *Crassatella pteropsis* Conrad<sup>219</sup> (not *C. pteropsis* Gabb), from the Ripley formation, Tippah County, Mississippi. The Texas species differs in that it is less pointed posteriorly, has a less clearly marked umbonal ridge, lacks a broad radial sulcus in front of the umbonal ridge, and is more plumply filled out in the region of the posterodorsal slope.

*Types.*—Holotype, U.S.N.M. no. 76553; 1 figured paratype, U.S.N.M. no. 76554; 13 unfigured paratypes, U.S.N.M. no. 76555; 20 +- paratypes, U.S.N.M. no. 76556 (on large slab, pl. 28, fig. 4).

Distribution in Texas.—Navarro group, Nacatoch sand: 1<sup>4</sup>/<sub>5</sub> miles northeast of Quinlan (16162, 16171, type lots).

# Unidentified specimens of CRASSATELLA

Poorly preserved shells and internal and external molds of *Crassatella* in the collections are mentioned below.

<sup>&</sup>lt;sup>219</sup>Conrad, T. A., Acad, Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 279, pl. 46, fig. 9.

An indeterminate internal mold of a small specimen of Crassatella was found in the Corsicana marl in a road ditch 1.8 miles N. 20° W. of Tona siding, in Hunt County (15545). U.S.N.M. no. 76557.

In two collections from the same formation in the left bank of San Marcos River, 1/2 mile below Martindale, Caldwell County (7621, 15527), are several specimens of a small Crassatella (a), about as long as high, subtrigonal in outline, and depressed convex; the anterior margin is sharply rounded, the ventral margin broadly rounded, and the posterior margin obtusely subangular below and subtruncated above: the surface is ornamented with rather coarse, somewhat irregularly developed concentric lines. coarsest toward the margin. The umbonal ridge is weakly developed. One specimen from collection 7621 figured (pl. 29, fig. 13). U.S.N.M. no. 76553; unfigured specimen (15527), U.S.N.M. no. 76559.

Another small species of Crassatella (b) from the same locality (7621, 15527)is represented by 6 poorly preserved specimens, 4 left and 2 right valves (pl. 29, fig. 12); it is an elongated, ventricose, rather coarsely sculptured species with a strongly developed, subangular umbonal ridge, bordered in front by a broad, shallow radial sulcation, and with a squarely truncated, nearly vertical terminal margin. The dimensions of the figured left valve are: Length about 10 mm., height 8 mm., convexity about 2 mm. One specimen from collection 15527 figured (pl. 29, fig. 12). U.S.N.M. no. 76561; unfigured specimens, U.S.N.M. nos. 76560, 76562.

Specifically indeterminable molds of Crassatella were obtained from the Corsicana marl at the lower crossing of Medina River at Castroville, Medina County (7796, U.S.N.M. no. 76563); on the Castroville road, 6 miles east of Castroville in Bexar County (15502.U.S.N.M. no. 76564); at pit of Standard Fuller's Earth Co., 4/5 mile north of Castroville road, about 14 miles west of San Antonio, Bexar County (15520,U.S.N.M. no. 76565): and at a depth of 1045 feet in well of Witherspoon Oil Company, Redus No. 1, G. A. Harper 92acre Survey, Medina County (13844, U.S.N.M. no. 76566). These probably belong to C. vadosa Morton or one or more of its varieties.

An internal mold of a rather small left valve of Crassatella, with a film of shell material still adhering, was found in the Kemp clay in a bluff on a small branch entering York Creek, 4 miles southeast of Zorn. Guadalupe County (10877). The specimen is flattish, is high in proportion to its length, has a weak umbonal ridge, and the posterodorsal margin is high and rounds broadly into the subtruncated posterior margin. U.S.N.M. no. 76567.

## Genus UDDENIA Stephenson, n.gen.

- 1875. Crassatellites Conrad (interpreted as a young individual), Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 6, pl. 1, fig. 25.
  1885. Gouldia Whitfield, U.S.Geol. Survey Mon., Contact Co
- vol. 9, p. 125, pl. 18, figs. 1-3. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 125, pl. 18, figs. 1-3, 1886.)
- 1905. Eriphyla Johnson, Acad. Nat. Sci. Phila-
- delphia Proc., vol. 57, p. 14. 1907. Eriphyla Weller, Geol. Surrey New Jersey, Paleontology, vol. 4, p. 550, pl. 60, figs. 48.
- 1923. Crassatellites ? Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 274, pl. 67, figs. 10-16. Type species.—Gouldia conradi Whitfield. (Types
- in Acad. Nat. Sci. Philadelphia.)

This tiny member of the Crassatellidae has heretofore been referred by different authors to Crassatellites, Gouldia, and Eriphyla (of the Astartidae), though it obviously forms a group different from any of these genera. It is apparently nearest to Crassatella, from which it differs in its diminutive size, its shorter and higher outline, its straight, long, steeply descending dorsal margins, its relatively long, narrow lateral teeth and sockets. and the high position of its adductor scars. The hinge of the left valve, as shown by specimens identified as Uddenia conradi (Whitfield), from Snow Hill, North Carolina, includes: An obscurely developed anterior cardinal tooth attached to the upper end of the long, marginal, anterior pseudolateral tooth; a profound, trigonal socket; a cardinal tooth below the beak, which is weak above, but which expands prominently below and becomes elongated backward along the lower margin of the

hinge plate; a rather deep, small cartilage pit back of the upper end of the cardinal tooth just described; a long, narrow, marginal, anterior pseudolateral tooth which fits into claspers on the right valve; and a pair of long, posterior lateral claspers which include a thin, prominent marginal carina above and a thin tooth below, separated by a deep, narrow socket.

The right valve presents: A prominent cardinal tooth which is thin above, becoming thick below in adults, and which fits into the deep socket in the left valve; back of this cardinal tooth a broad, triangular cartilage pit along the forward side of which is an open slit; the margin of the pit below overhangs a more deeply inset bench into which fits the prominent, elongated cardinal tooth of the left valve; in front of the cardinal tooth a narrow, oblique socket; a pair of elongated, anterior lateral claspers for the accommodation of the anterior marginal lateral of the left valve; a narrow, marginal, posterior pseudolateral which fits into the posterior lateral claspers of the left valve. The pallial line is simple and the adductor scars are small and high in the shell. The long lateral dentition extends past the adductors both front and rear.

The genus is named in honor of the late Dr. J. A. Udden, of Austin, Texas.

# UDDENIA TEXANA Stephenson, n.sp.

# Pl. 26, figs. 1-3

Shell small, trigonal in outline, depressed-convex, equivalve, slightly inequilateral. Beaks small, incurved, approximate, nearly direct. Greatest inflation central, above the midheight. There is a mere suggestion of an umbonal ridge, between which and the postcrodorsal margin is a shallow radial sulcus extending to the posterior margin. Lunule long, narrow, sharply outlined, moderately excavated. Escutcheon long, narrow, more sharply outlined, and more deeply excavated than the lunule. The dorsal margins descend in nearly straight lines from the beak at an angle to each other of about 95 degrees; the ventral margin is evenly and broadly rounded ascending steeply both toward the front and rear;

posterior margin truncated below the midheight. Surface marked by fine, rather sharp, closely spaced incremental lines.

Dimensions: Length 3.9 mm., height 3.7 mm., thickness about 1.8 mm.

The species is somewhat more plump, is shorter and more trigonal in outline, and is more finely and more regularly sculptured than *Uddenia conradi* (Whitfield), the type species of the genus.

Type.—Holotype, U.S.N.M. no. 76568.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518).

## UDDENIA sp.

Fragmentary material from the Kemp clay exposed on Colorado River at Webberville, Travis County (7601), furnishes the basis for the following description:

Shell small, trigonal in outline, moderately ventricose. The beak is small. slightly prominent, narrow, incurved, and nearly direct. The hinge appears to be essentially like that of typical shells of the genus from Snow Hill, North Carolina. The other internal features are also like the typical specimens. The inner surface is beautifully polished. The anteroand posterodorsal margins are straight and descend with moderate steepness from the beak. The anterior, ventral and posterior margins present a nearly uniform curvature, with a mere suggestion of a posterior truncation. The surface is nearly smooth with the exception of several small concentric wrinkles on the umbone. The largest shell is about 3 mm. long; a young incomplete right valve measures: Length 1.2 + mm., height about 1 + mm., convexity about 0.25 mm. The material probably represents an undescribed species that is smoother, relatively shorter, and much less distinctly truncated than other described species. U.S.N.M. no. 76569.

#### UDDENIA sp.

One poorly preserved left valve of Uddenia, from the Corsicana marl on San Marcos River,  $\frac{1}{2}$  mile below Martindale, Caldwell County (7621), is more elongated than U. texana and exhibits sharp, regular, concentric sculpture (pl. 26, fig. 4.) It is also more coarsely sculptured than U. conradi (Whitfield). U.S.N.M. no. 76570.

#### Genus SCAMBULA Conrad

- 1869. Scambula Conrad, Am. Jour. Conch., vol. 5, p. 48, pl. 9, figs. 7, 8.
- 1872. Scambula Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 51, pl. 1, fig. 2.
- 1885. Scambula perplana Conrad. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 121. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 121, 1886.) Discusses the genus under the species heading.
- Type species. Scambula perplana Conrad, from the Woodbury clay, Haddonfield, New Jersey.

Although this genus differs considerably in form and proportions from *Crassatella*, it appears to be more closely allied to that genus than to the Gouldiidac in which Stewart<sup>220</sup> places it. Its form is compressed, it has a broadly concave posterodorsal margin, and the submerged ligament occupies a long, narrow, curved resilifer instead of a broad, triangular one.

Conrad's original description of the genus is as follows: "Hinge with two approximate teeth in right valve, the posterior one direct and ending at the apex; a long anterior double tooth parallel with the straight cardinal line; anterior muscular impression small, rounded."

Gabh<sup>221</sup> compared the types of Scambula Conrad with those of Anthonya Gabb, and considered the former as synonymous with the latter. He says, "On comparing my types of Anthonya cultriformis, with those of Mr. Conrad's Scambula perplana, it proves that they are generically identical, the hinges agreeing perfectly. There is only one difference, and that of minor importance; my shell, which is very long, is slightly twisted, while Mr. Conrad's, which is much shorter, is all on one plane."

Gabb's genus was found in the Chico, a California formation as old as the Turonian or the Cenomanian, and his genus therefore occupied a considerably lower stratigraphic position than Conrad's genus from the Woodbury clay, which belongs well up in the Senonian. I therefore hesitate to treat these geographically and stratigraphically widely separated forms as generically identical without having had an opportunity to compare the types. Stewart<sup>222</sup> regards *Scambula* as of subgeneric rank under *Anthonya*, but he states that the hinge of the latter is not well known.

Wade's<sup>223</sup> collection from Coon Creek, Tennessee, contains two left valves, which he referred to Scambula perplana Conrad; both of the hinges are well preserved, and show two well developed, long, slightly curved, nearly vertical cardinal teeth, separated by a deep socket whose sides are striated normal to the plane of juncture of the two valves; the anterior cardinal is thicker than the posterior one, and is also crenulated on its anterior side. Back of the slender, posterior cardinal is a long, deeply excavated, slightly curved resilifer which is a little wider than the socket just described. A long, thick posterior lateral tooth extends in a broad curve concave outward, from the beak past the resilifer, along the inner margin of the hinge plate, nearly to the rear end of the posterior adductor scar; this lateral is separated from a long, narrow, marginal carina by a long, narrow, deep channel, the tooth and the carina forming a pair of claspers. There is also a slightly thicker marginal carina extending from the beak nearly to the front end of the anterior adductor scar.

The types of Scambula perplana Conrad in the Academy of Natural Sciences of Philadelphia include 5 well preserved shells, 3 left and 2 right valves. The hinge of the left valve agrees closely with those of the left valves from Coon Creek, Tennessee; the right valve has a resilifer opposite that of the left valve. a pair of long anterior claspers for the reception of the marginal carina of the left valve, and a long, thin posterior marginal carina fits into the claspers of the left valve.

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<sup>&</sup>lt;sup>229</sup>Stewart, Ralph, Acad. Nat. Sci. Philadelphia Special Pub. No. 3, p. 149, 1930.

<sup>&</sup>lt;sup>201</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 26, p. 311, 1876.

<sup>222</sup>Stewart, Ralph, op. cit., pp. 148-149.

<sup>&</sup>lt;sup>223</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 82, pl. 25, figs. 11, 12, 15, 16, 1926.

Tertiary shells which Dall<sup>224</sup> referred to Scambula, and treated as a section under Crassatellites, cannot properly be so classified. In this connection Woodring<sup>225</sup> says: "The name Scambula was proposed by Conrad for an Upper Cretaceous species, S. perplana Conrad, from New Jersey. This species has also been found in Upper Cretaceous deposits in Georgia and Tennessee. It is very small, unusually flat, has a different hinge, and in general fea-The name tures resembles Crassinella. Scambula can be used only for this peculiar Upper Cretaceous shell. The difference between the Bowden species, which belong to the group that has been called Scambula, and the type of Crassatellites, hardly warrants a new section name.'

## SCAMBULA PERPLANA Conrad

#### Pl. 26, figs. 11, 12

- 1869. Scambula perplana Conrad, Am. Jour. Conch., vol. 5, p. 48, pl. 9, figs. 7, 8.
- 1872. Scambula perplana Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 51, pl. 1, fig. 2.
- 1885. Scambula perplana Conrad. Whitfield, U. S.Geol. Survey Mon., vol. 9, p. 123, pl. 18, figs. 8–10. (Geol. Survey New Jersey, Palcontology, vol. 1, p. 123, pl. 18, figs. 8–10, 1886.)
- 1905. Crassatellites (Scambula) perplana (Conrad). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 14.
- 1907. Scambula perplana Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 562, pl. 61, figs. 13, 14.
- 1926. Scambula perplana Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 82, pl. 25, figs. 11, 12, 15, 16.

This genus is represented in the Corsicana marl by several imperfect specimens embedded in marl, with the shell substance partly dissolved away, only a film remaining; the hinge of a left valve is fairly well shown on one specimen, and appears to be identical with that of the types in the Academy of Natural Sciences of Philadelphia and with perfect shells described by Bruce Wade from Coon Creek, Tennessee. Shell small, thin, elongate, equivalve, inequilateral, almost flat.

Beak flat, angular and prominent vertiopisthogyrate. cally, slightly situated about two-fifths the length of the shell from the anterior extremity. Anterodorsal margin nearly straight, but slightly arched near the beak, moderately inclined; anterior extremity subrectangular; ventral margin broadly convex, straightening out a little posteriorly; posterior margin truncated, slightly inclined forward toward the upper margin; posterodorsal margin rather strongly concave, especially toward the beak. The surface is smooth except for fine incremental lines which become a little coarser toward the antero- and posterodorsal margins, and apparently also toward the beak.

Dimensions of the specimen shown in plate 26, figure 12: Length 14 mm., height 9.7 mm.

No other species of *Scambula* has been recorded from the American Cretaceous.

Types.—Three left valves and two right valves in the Academy of Natural Sciences of Philadelphia, from the Woodbury clay, Haddonfield, New Jersey. Two plesiotypes from Texas, U.S.N.M. nos. 76571, 76572.

Distribution in Texas.—Navarro group, Corsicana marl: 1/2 mile below Martindale (7621, 15527, 1 specimen figured from each lot).

Outside distribution.--Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Owl Creek formation.

Chattahoochee region (Alabama and Georgia): Upper part of Ripley formation.

New Jersey: Woodbury clay and Wenonah sand.

Range.—Corsicana marl of the Navarro group of Texas, and the zones of Exogyra ponderosa and E. costata in the Atlantic and eastern Gulf Coastal Plain.

# Superfamily CHAMACEA

#### Family MONOPLEURIDAE

# Genus TITANOSARCOLITES Trechmann

Type species. - Caprinula gigantea Whitheld. 226

The genus *Titanosarcolites* Trechmann<sup>227</sup> was erected to include those large,

<sup>&</sup>lt;sup>221</sup>Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, pp. 1467-1475, 1903.

<sup>&</sup>lt;sup>225</sup>Woodring, W. P., Carnegie Inst. Washington Pub. 366, p. 94, 1925,

<sup>&</sup>lt;sup>224</sup>Whitfield, R. P., Bull, Amer, Mus, Nat, History, vol. 9, art. 12, pp. 194-196, pls. 18-22, 1897.

<sup>&</sup>lt;sup>227</sup>Trechmann, C. T., Geol, Mag., vol. 61, pp. 397-400, pl. 23, figs. 1, 2; text fig. 1, 1924. See also Cox, L. R., Geol. Assoc. London Proc., vol. 44, pp. 379-388, 1933.

thick-shelled, subequivalve rudistids, each valve of which is traversed by a comparatively small longitudinal septate body cavity and each valve of which has a thick outer shell layer traversed by a series of relatively large tubes of irregular size and distribution and circular, oval, and irregular cross section: the tubular laver is developed around the anteroventral side. The two valves are curved in one plane with the tips turned toward each other. This large cumbersome bivalve is interpreted not to have been attached at the beak of either valve but to have lain recumbent on the sea bottom on the anteroventral side.

A detailed description of the genus, with especial reference to Cuban material, is given by Mac Gillavry.<sup>228</sup>

Both Douville<sup>229</sup> and Mac Gillavry assign to the genus a monopleurid rather than a caprid or radiolitid ancestry, a conclusion based on the arrangement of the cardinal apparatus. Mac Gillavry points out the relation of this apparatus to that of such genera as *Antillocaprina*, *Trechmannella*, *Hippurites*, and *Rousselia*, to all of which he ascribes a monopleurid origin.

Neither the cardinal apparatus nor the dentition are preserved in *Titanosarcolites* oddsensis, and its reference to this genus is based on the similarity of such of its features as the longitudinal septate cavity, the longitudinal canals, and the series of large longitudinal tubes in the outer part of the shell on the anteroventral side. That this Texas shell is specifically different from *T. giganteus* is indicated by the smaller size of the septate cavity, the more sharply defined perimeter of this cavity, the much larger size of the longitudinal canals, and the larger average size of the longitudinal tubes.

In addition to the Texas specimens herein described, fragmentary material that may belong to *Titanosarcolites* has been recorded from the Upper Cretaceous of the United States under the names Ichthyosarcolites Desmarest and Caprinella D'Orbigny. However, none of these specimens has shown in the parts preserved any evidence of the presence of the thick outer shell layer traversed by large longitudinal tubes, such as characterizes Titanosarcolites.

Tuomey<sup>230</sup> described three species of so-called *Ichthyosarcolites* from Noxubee County, Mississippi, which may have been representatives of *Titanosarcolites*, but he did not illustrate his material, his descriptions are inadequate, and his types are lost. In the collection of the National Museum is a cast of the internal septate cavity of a *Titanosarcolites?* (U.S.N.M. no. 12689) from Alabama, which F. B. Meek identified as belonging to "*Ichthyosarcolites cornutus*," one of the three species described by Tuomey.

Hall and Meek<sup>231</sup> described one valve of rudistid shell from Sage n Creek. Nebraska, from the upper part of division No. 4 ( -= upper part of Pierre shale), under the name Caprinella coraloidea: it may be a Titanosarcolites. The description and figures indicate a short conical. somewhat spirally twisted shell about 2.5 inches long, having an internal cavity divided into chambers by lamellae or septa convex toward the apex. spaced at intervals of 1 to 4 millimeters; the chambers are filled with matrix or secondary calcite. The shell is composed of numerous fourto six-sided longitudinal canals whose hollow interiors are interrupted at irregular intervals by thin transverse laminae. According to J. B. Reeside, Jr.,232 shell fragments of this character have subsequently been found at several localities in the Pierre shale. Wade<sup>223</sup> identified a small fragment from Coon Creek, Mc-Nairy County, Tennessee, as belonging questionably to Hall and Meek's species.

232Oral communication.

<sup>&</sup>lt;sup>228</sup>Mac Gillavry, Henry James, Geology of the Province of Camaguay, Cuba, with revisional studies in rudist paleontology: Dissertation, Univ. Utrecht, 1937, pp. 85-92, pl. 2, figs. 1-7, 10, 11; pl. 3, fig. 3; pl. 9, fig. 1, 1937.

<sup>&</sup>lt;sup>223</sup>Douville, H., Soc. géol. France Bull., 1e ser., tome 26, pp. 131-133, pl. 8, fig. 5, 1927.

<sup>&</sup>lt;sup>230</sup>Tuomey, M., Acad. Nat. Sei. Philadelphia Proc., vol. 7, p. 172, 1854.

<sup>&</sup>lt;sup>23</sup> Hall, James, and Meek, F. B., Amer. Acad. Arts Sci. Mem., n. ser., vol. 5, pp. 380-381, pl. 1, figs. 3a-f, 1856.

<sup>&</sup>lt;sup>2231</sup>Wade, Bruce, U. S. Gool, Survey Prof. Paper 137, p. 82, pl. 25, figs. 13, 14, 1925,

#### TITANOSARCOLITES ODDSENSIS Stephenson

# Pl. 30; pl. 31; pl. 32, fig. 1

## 1938. Titanosarcolites oddsensis Stephenson, U.S. Geol. Survey Prof. Paper 193-A, p. 3, pl. 1; pl. 2; pl. 3, fig. 1.

The holotype, a left valve, is incomplete at both ends, and the outer surface is badly damaged and largely destroyed by corrosion. Scattered about over the surface are the incomplete attached portions of small irregular oysters of undetermined species.

The adult shell is large, very thick, conular, rather strongly curved, traversed longitudinally by a proportionately small acentric tubular septate body cavity. The poorly preserved outer surface of the shell appears to be longitudinally ribbed, the ribs probably being of only moderate The body cavity is markedly strength. acentric in position as shown by the cross sections: it lies 10 to 20 mm. within the shell a little to one side of the plane of maximum curvature of the cone. The side of the cavity has been partly crushed in mechanically, the pressure having been applied from the thinnest side of the surrounding shell; as a result the thin septa have been broken and the fragments segregated in parts of the cavity (see pl. 32, fig. 1). Before the crushing took place the cavity was probably subovate in cross section and had a maximum diameter of about 32 millimeters.

The maximum measurable thickness of the shell surrounding the septate cavity is 109 millimeters. Radially outward from the cavity the shell is divisible into three layers or bands of unequal thickness. The inner layer is 1 millimeter or less in thickness and forms a well-defined lining or boundary to the cavity; it is lamellar in structure, the lamellae lying parallel to the inner surface of the cavity; the septa, which are also lamellate, protrude inward across the cavity from this layer, and are concave toward the larger end of the shell. The intermediate laver has a maximum measured thickness of about 52 mm. and is composed of two kinds of canals. The main body of the layer is made up of longitudinal four- to six-sided thin-walled, chambered canals

measuring in cross section as much as 2.5 mm. and showing no serial arrangement in The transverse laminae any direction. dividing these canals into chambers are irregularly spaced, the spaces ranging from 0.5 to 2.5 mm.; the laminae are concave toward the larger end of the shell. As shown in the polished cross section of the shell a subordinate part of the intermediate layer is composed of tabular or "stretched" canals, which are subdivided into rectangular spaces by much thinner longitudinal walls. transverse These tabular canals are arranged in three separate longitudinal groups whose cross sections are seen in the illustrations; a large, sharply outlined group, clongated lensshaped in cross section, lies to the right of the septate cavity, the lower end almost touching the inner shell-layer, and the other end lying upward to the right of and obliquely away from the septate cavity; a second smaller more irregularly shaped group lies above and well away from the first group; a third group, seen only in the smaller cross section, is badly crushed, but at the smaller broken end of the shell itself this group appears as a large, broad, well-defined patch similar to, but less elongated than, the first group described. These groups of tabular canals mark the areas of muscular attachment during the successive stages of shell growth; the large crushed area to the left of the septate cavity in plate 3, figure 1, is interpreted to mark the position of the posterior myophore (mp) and the one to the right the anterior myophore (ma).

The outside shell layer has a maximum measured thickness of 79 millimeters, and the cross section cut near the large incomplete end shows that the thickness of this layer does not fall below 50 mm. in an incompletely preserved band extending around the anteroventral side of the shell. This layer is traversed longitudinally by many tubular cavities ranging in cross section from less than 2 mm. to a measured maximum of 39 mm. The cavities have a heterogeneous arrangement and range in cross section from subcircular to ovate; some are irregular. The cavities are filled with fine brown calcareous silt matrix. They are separated from each

other by proportionately thin walls of shell substance, the better preserved parts of which are seen to be canaliculate like the intermediate shell layer already described. However, the structure has been partly destroyed or obscured apparently by the recrystallization of the calcite, and much of the layer is stained with limonite and therefore appears dark in the photographs. Each cavity is lined with a calcitic layer generally less than a quarter of a millimeter thick. The dental apparatus is not preserved in the holotype, and there is no indication of the position of the ligament.

The greatest dimension of the incomplete holotype, measured in the longitudinal direction, is about 250 mm.; the minimum and maximum dimensions of the largest cross section are respectively 152 and 208 mm.; the smaller broken end of the specimen has minimum and maximum diameters of approximately 104 and 112 mm. A smaller mechanically flattened specimen, incomplete at both ends, from the type locality, probably belongs to the same species and is listed as a paratype. It is 140 mm. long; in its crushed condition it increases from about 75 mm. in maximum diameter at the small end to 92 mm. at the large end. The shell structure has been destroyed by recrystallization of the calcite. Two fragments from a concretion in the same formation at another locality in Falls County probably belong to this species.

*Types.*—Holotype, U.S.N.M. no. 75979; 1 paratype, U.S.N.M. no. 75980.

Distribution in Texas.—Navarro group, upper part of Kemp clay: Limonitestained calcium carbonate concretions in a field north of the McClanahan-Odds road on the southwestward-facing slope of Big Creek valley, 1 mile west by south of Odds (Limestone County), in Falls County (17373, type loc.); questionably in a field on the westward-facing slope of Big Creek valley 1.3 miles southcast of Parsons Bridge and 3 miles southwest of Stranger, Falls County (17372).

# Unidentified specimens of TITANOSARCOLITES?

Specimens of *Titanosarcolites*? too incomplete for specific identification have been found at three localities in the Navarro group, as indicated below. In addition one small fragment was found in the upper part of the Taylor marl on State Highway 34, 5<sup>3</sup>/<sub>4</sub> miles northeast of Ennis, Ellis County (17378). U.S.N.M. no. 76574.

The most complete of the Navarro specimens was obtained in the Nacatoch sand on Postoak Creek at the north edge of Corsicana, Navarro County (518, U.S.N.M. no. 20903). (See pl. 32, figs. This specimen indicates a short, 2-4.)expanding, curved, rapidly strongly slightly spiral shell. Except near the apex only the part of the shell on the inner side of the curve is preserved; it is proportionately very thick and is composed of longitudinal prismatic canals of varying sizes. of which most are four- to sixsided but a few of the smaller ones may be circular or oval in cross section. The hollow interior of each of the canals is interrupted at irregular intervals by thin transverse uncurved laminae, the laminae in one canal bearing no uniform relation in position to those in adjoining canals; the canals in one group, shown just to the left of the internal cavity in plate 32, figure 3, are smaller than the others. A part of the external surface on the inner curve of the shell is nearly smooth but exhibits fine radial striations and six or seven light-colored radial lines above the beak, spaced at intervals of 2 to 4 The septa that divide the inner mm. cavity of the shell into chambers are not preserved, having apparently been lost before fossilization. This cavity ends apically in a bluntly rounded bottom, corresponding rather closely in shape to the inner cavity shown in Hall and Meek's illustrations of Caprinella coraloidea (op. cit., pp. 380-381, pl. 1, figs. 3a-c). The specimen cannot be satisfactorily identified with the latter species. Dimensions: Length, measured from the beak along the curve of the internal cavity to the outer margin, about 70 mm.; maximum thickness of shell, about 28 mm.

One large imperfect shell fragment from the Nacatoch sand, found on the Dallas highway 3/5 mile west of Kaufman, Kaufman County (14098, U.S.N.M. no. 75981), is made up of polygonal prismatic

canals like those of Titanosarcolites, except that the transverse septa in the longitudinal canals are not curved. (See pl. 33, fig. 10.) The shell is very thick and the canals, though of irregular size, are in general larger than those of the Corsicana specimen. The hollow canals are set off at longitudinal intervals of 0.5 to 2 mm. by thin transverse laminae, and the intervening spaces are filled with secondary calcite. The external tubular layer such as characterizes Titanosarcolites, if originally present, is wanting in the specimen as preserved. Dimensions: Greatest diameter, 106 mm.; maximum thickness of shell, 65 mm.

A small elongated, curved shell fragment was found in the Kemp clay in a creek bank on the east side of a road  $3\frac{1}{2}$  miles north of Powell and 10 miles northeast of Corsicana, Navarro County (9556). The fragment is composed of irregular polygonal canals in which at longitudinal intervals of 0.5 to 1.5 mm. are thin, transverse, uncurved laminae. The structure is similar to that of *Titanosarcolites*. U.S.N.M. no. 76573.

## Superfamily RUDISTACEA

## Family RADIOLITIDAE

## Genus SAUVAGESIA Bayle

## Type species .-- Sphaerulites lusitanicus Bayle.

One species only, Sphaerulites lusitanicus Bayle, was mentioned in connection with the original description of this genus,<sup>234</sup> and that species must therefore be accepted as genotype by monotypy. Later attempts by M. Choffat and others to shift the genotype to *Radiolites nicaisei* Coquand seem clearly to be in violation of the rules. The acceptance of *Sauvagesia* as a valid genus depends on whether *Sphaerulites lusitanicus* Bayle is or is not a true *Radiolites*. Even granting the validity of *Sauvagesia* there is still a question as to the correctness of referring the Texas species to it.

#### SAUVAGESIA? HILLI Stephenson, n.sp.

# Pl. 33, fig. 1; pl. 34, fig. 9; pl. 35, fig. 9; pl. 36, fig. 9

Lower valve large, thick-walled, elongated, tapering, gently curved, broadly ovate in cross section. Main shell composed of strongly undulating cellular growth laminae which lie roughly normal to the length of the shell; the cell pattern is of medium coarseness, but the cells are exceedingly variable, ranging in size from very small to 1.5 mm. in diameter, and in form from 4- to 8-sided. The inner shell layer as preserved is less than a millimeter thick, is finely striated longitudinally within and is composed of longitudinal cells running parallel to the inner surface. Ligamental ridge thin, prominent, standing fully 7 mm. out from the inner surface, and expanding on the crest to a flange about 3 mm. wide; the part of the ridge between the inner surface and the flange is about 1 mm. thick. The external surface of the shell is badly corroded so that the thin external or cortical layer is partly or wholly destroyed except on the sides and bottoms of some of the intercostal depressions. The shell is coarsely ornamented with 11 strong ribs of very unequal size. As most of the intercostal spaces and their steeply sloping sides are similarly ornamented with small riblets there is difficulty in determining the position of the siphonal bands. The anterior siphonal band (E) is probably the deep, moderately wide longitudinal depression which cuts the outer surface directly opposite the ligamental ridge; the bottom of this depression is rounded or U-shaped below near the small end, but becomes less rounded and more nearly V-shaped from below upward. The second depression to the right of the anterior band (E), (pl. 35. fig. 9), may be the posterior siphonal band (S); it is similar to the anterior band (E), but is not quite so deep, and is round to sub-V-shaped on the bottom. The two strong ribs between the supposed siphonal bands are badly corroded on their crests; they are separated by a broad sub-V-shaped depression shallower than the siphonal bands, and slightly acentric in cross section. The 9 other main

<sup>&</sup>lt;sup>233</sup>Douvillé, H., Bull. Soc. Géol. de France, 3d ser., tome 14, p. 398, 1886. (Genus credited to Bayle.)

ribs may be briefly described from left to right as follows: (1) A narrow, high rib followed by a narrow, deep V-shaped depression; (2) a broad, moderately high rib, steep on the left side, much less steep on the right, rendered bifid by a shallow, narrow crestal depression which lies a little to the left of the center; (3) beyond the next interspace is a broad, prominent, but badly corroded rib, steeper on the left than the right, and followed by a narrow V-shaped depression; (4) a narrow rib less prominent than the preceding ones, followed by a narrow sub-V-shaped depression; (5) a broad, badly corroded rib, a little steeper on the left than on the right side, followed by a deep, moderately wide depression with a somewhat rounded bottom; (6) a narrow rib with equally steep sides, followed by a narrow, deep depression with rounded bottom; (7) a broad, strong, equally steep-sided rib, rendered trifid by 2 shallow, narrow crestal depressions, and followed by a broad depression, acentric in cross section, with gentlest slope on the right; (8) a broad, prominent bifid rib with steepest slope on the left, followed by a narrow V-shaped depression; (9) a prominent rib with equally steep sides, followed by the anterior siphonal band (E).

The species is represented only by one lower valve which is incomplete at the small end; the large end appears to be complete except for severe corrosion which has destroyed the impressions of the radial vessels.

Dimensions, as preserved: Maximum length 144 mm., diameter at small end 62 mm., longest diameter at large end 103 mm., shortest diameter 85 mm., longest diameter of opening at large end 56 mm., shortest diameter 40 mm. The flattening of the latter opening on the side opposite the ligamental ridge may be due in part to mechanical crushing.

The family Radiolitidae is represented in the material at hand from the Navarro group, only by poorly preserved and fragmentary specimens of *Durania* from the Neylandville marl at one locality in Navarro County, and by the present species of *Sauvagesia?* from the Corsicana marl near San Antonio. The family appears therefore to be rare in the group.

The Salado Creek species bears a general resemblance to *Sauvagesia? acutocostata* Adkins<sup>205</sup> from the upper part of the Austin chalk in Travis County, Texas, but it has fewer and coarser ribs.

Sauvagesia? coloradensis Stephenson<sup>236</sup> from the upper part of the Mendez shale in the southern part of the State of Tamaulipas, Mexico, is also a similar species, but it differs markedly in the appearance of its siphonal bands, which are broader and much shallower than those on S? hilli.

Holotype.-U.S.N.M. no. 76575. Named in honor of Dr. Robert T. Hill, eminent pioncer geologist of Texas.

Distribution in Texas.—Navarro group, Corsicana marl: Salado Creek, upstream from Highway 90, Bexar County (16671).

# Genus DURANIA Douvillé DURANIA? sp.

# Pl. 37, fig. 13; pl. 38, fig. 7

The material includes imperfect and fragmentary specimens representing 4 or 5 individuals, collected from one soft, calcium carbonate concretion in the Neylandville marl in a gully in a field, 1.6 miles east-southeast of Black Hills school, 3½ miles west-northwest of Corsicana, Navarro County (16166). U.S.N.M. no. 76576.

The most complete specimen is a badly corroded lower valve of which only the thick outer shell layer is preserved. The inner cavity is broadly ovate in cross section and tapers very gradually downward; there is no evidence of a ligamental ridge. The anterior siphonal channel (E) is deep and sub-V-shaped in cross section, and cuts through the shell to within 3 or 4 mm. of the inner surface: the narrow bottom of this channel (4 to 10 mm. wide) has been completely broken away; each of the steep sides of the channel is ornamented with 4 or 5 low, longitudinal ribs of irregular width

<sup>&</sup>lt;sup>235</sup>Adkins, W. S., Univ. Texas Bull, 3001, p. 99, pl. 7, figs. 3, 4, 1930.

<sup>&</sup>lt;sup>236</sup>Stephenson, L. W., U. S. Nat. Mus. Proc., vol. 61, art. 1, p. 11, pls. 12-14, 1922.

and spacing. The posterior siphonal channel (S) is not as deep as the anterior one, and cuts through to within 8 or 9 mm. of the inner surface; it is U-shaped in cross section and is separated from the anterior channel by a prominent ridge whose sides round-crested and crest are ornamented with more or less irregular, low. round-topped longitudinal ribs. The rest of the surface is largely destroyed by corrosion, but wherever preserved on the different fragments it exhibits irregular longitudinal undulations covered with secondary, irregular, roundcrested ribs like those on the sides of the siphonal grooves.

The growth layers are thin and closely packed and the cells are small. Internal surfaces of the shell exposed by breaks parallel to the growth layers exhibit rather widely spaced radial vessels which may fork once or twice in their course from the inner to the outer surface of the shell.

Dimensions of the shell shown in plate 37, figure 13: Greatest preserved length 134 mm., greatest preserved diameter 108 num., diameter of internal cavity at large end 54 mm., at small end about 38 mm. Maximum thickness of shell about 34 mm.

## Superfamily LUCINACEA

## Family LUCINIDAE

#### Genus LUCINA Bruguière

## LUCINA PARVILINEATA Shumard

## Pl. 33, figs. 2 6

1861. Lucina parvilineata Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 204.

1928. Lucina(?) parvilineata Shumard, Adkins, Univ. Texas Bull. 2838, p. 149.

Shell of moderate size, subcircular to broadly subovate in outline. a little longer than high. equivalve, slightly inequilateral, depressed convex. Shell wall thin. Beaks small and low, approximate, incurved, prosogyrate, situated slightly back of the midlength. Umbonal ridge very faint: posterodorsal slope slightly excavated. Hinge not uncovered in the available material, but partly broken margins indicate a rather strong lateral dentition. Internal features of shell not uncovered. The edges of the shell form a nearly regular curve, a little broader, however, on the ventral margin than on the extremities, and the anterodorsal margin is a little excavated just in front of the beak. The surface is nearly smooth, but exhibits fine growth lines and irregularly spaced, concentric depressions marking resting stages; on the younger stages of some shells are fine, irregularly spaced, concentric ridges; fine, rather faint, radiating lines, differing in strength on different individuals, are present on both the antero- and posterodorsal slopes.

Dimensions of the neotype: Length 15 mm., height 13 mm., thickness 5 mm. The largest shells in the collections are about 22 mm. long. The shell measured by Shumard was 0.74 inch in length, which would be nearly 19 mm.

Although Shumard's type specimen is not known to have been preserved, his description of the species is adequate to permit of a satisfactory identification of material from the type locality near Corsicana. His statement that the beak is directed backward indicates that he mistook the posterior for the anterior part of the shell. This species is not apt to be confused with any other described species from the Coastal Plain.

Types.—Shumard's type specimen from near Corsicana has apparently been lost. The nearly perfect shell shown in plate 33, figures 2, 3 (U.S.N.M. no. 76577), has been selected as neotype; 1 typical specimen figured, U.S.N.M. no. 76578; 1 typical specimen figured, U.S.N.M. no. 76579; 10 unfigured typical specimens, U.S.N.M. no. 20943.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles south of Ben Hur (15543).

Navarro group, Nacatoch sand: Vicinity of Corsicana (763, includes neotype and 1 figured example); north edge of Corsicana (518, 1 example figured); road 5 miles south-southwest of Corsicana (7573); vicinity of Chatfield (762); loose pieces of rock in street at Chatfield (7568); 2 miles north of Corsicana (9553); 3 miles northeast of Corsicana (9545); vicinity of Kaufman (761).

*Range*.—The species ranges from the Neylandville marl upward into the Nacatoch sand of the Navarro group.

## LUCINA MATTIFORMIS Stephenson, n.sp.

# Pl. 33, fig. 7

Shell of moderate size, broadly subovate in outline, longer than high, equivalve, slightly inequilateral, depressed convex. Shell wall of medium thickness. Beaks small and nonprominent, incurved, approximate, slightly prosogyrate, situated near the midlength of the shell. Anterodorsal slope slightly excavated; posterodorsal slope marked by a shallow depression broadening from the beak toward the posterior margin. Hinge not uncovered in the available material. Internal features of shell not uncovered. The anterior, ventral, and lower posterior margins form a nearly regular curve a little broader on the lower edge. The posterior margin is slightly truncated. The anterodorsal margin is short, horizontal and nearly straight, and the posterodorsal margin is long, inclined and nearly straight except toward the beak where it is slightly arched. The surface exhibits closely spaced, thin, sharp, concentric ridges which are imperfectly preserved because of their frailness, and between every two of these ridges are two or more fine, more or less obscure incremental lines. The concentric ridges become a little crowded on the dorsal slopes. There are no radiating ribs.

Dimensions of the holotype, a left valve: Length about 20 mm., height 18.5 mm., convexity 4 mm. The largest specimen in the collection is about 22 mm. long.

This species is not apt to be confused with any described species from the Upper Cretaceous formations of the Coastal Plain. Its sculpture is very much finer than that of *Lucina glebula* Conrad, from the Snow Hill member of the Black Creek formation, North Carolina.

Types. - Holotype, U.S.N.M. no. 76580; 2 unfigured paratypes, U.S.N.M. no. 76581.

Distribution in Texas.—Navarro group, Nacatoch sand: 1½ miles west of Campbell (12925); 14% miles northeast of Quinlan (16162); field 3/5 mile west of Kaufman (14103, type loc.); road 3/5 mile west of Kaufman (14098); vicinity of Kaufman (761); 2<sup>1</sup>/<sub>2</sub> miles north of Corsicana (14114); road 5 miles southsouthwest of Corsicana (7573); vicinity of Corsicana (763); 4 miles north of Corsicana (17366).

#### LUCINA LINEARIA Stephenson, n.sp.

## Pl. 33, figs. 8, 9

Shell small, subcircular in outline, slightly longer than high, of medium convexity, equivalve, slightly inequilateral. Shell wall thin. Beaks small, flattish, slightly incurved, prosogyrate, situated about midway of the length. Anterior slope flattened a little toward the margin; posterodorsal slope marked by a shallow depression which broadens toward the posterior margin. Hinge of left valve with two strong cardinal teeth separated by a deep socket; anterior cardinal vertical, short, thick below, thinning above, slightly bifid; posterior cardinal longer, a little oblique, and relatively thin; socket deep, narrow, flaring a little inwardly. Anterior claspers distant, short, the inner one longer and stronger than the outer one which is very short and weak, the two separated by a rather deep and relatively wide socket: posterior claspers more distant and a little longer than the anterior ones, the outer strong one separated from the inner weak one by a deep socket of medium width. Lunule rather wide, profound, about 1.5 mm. long; escutcheon narrow, deep, about 2.5 mm. long. Ligamental groove long, narrow and moderately deep. Adductor scars small, situated slightly above the midheight; anterior scar elongated, the lower end diverging inward away from the pallial line; posterior scar subovate. Pallial line simple. Inner margin of shell faintly and finely crenulated. Anterior and ventral margins forming a nearly regular curve, the latter a little the broadest; posterior margin subtruncated nearly vertically. Anterodorsal margin excavated; posterodorsal margin long, inclined, and slightly arched. The surface is ornamented with numerous, very thin, sharp, concentric lamellae, well developed all over the surface, but becoming a little more widely spaced toward the margin; where well preserved these lamellae stand out prominently, but they are very fragile, and have nearly all been partly broken away: they are most prominent on the posterodorsal slope and become weaker toward the anterior margin.

Dimensions of the holotype, a left valve: Length 5.4 mm., height 4.8 mm., convexity 1.3 mm.

This species is not quite as large as Lucina parva Stephenson from the Snow Hill member of the Black Creck formation in North Carolina, and its lamellae are more regular, more prominent and more closely spaced. Compared with Lucina ripleyana Wade, it is larger and its lamellae are more prominent, thinner and more widely spaced. No other described species from the Cretaceous of the Coastal Plain is apt to be confused with it.

Types.—Holotype, U.S.N.M. no. 76582: 1 figured paratype, U.S.N.M. no. 76583; 2 unfigured paratypes, U.S.N.M. no. 76584.

Distribution in Texas.—Navarro group, Corsicana marl: ?5 miles southwest of Quinlan (15546).

Navarro group, Kemp clay: Webberville (7601, type loc.).

## LUCINA CHATFIELDANA Stephenson, n.sp.

# Pl. 34, figs. 4, 5

Shell small, subquadrate in outline, equivalve, slightly inequilateral, depressed convex. Umbonal ridge distinct, extending to the lower posterior subangulation: greatest inflation above the midheight at about the midlength; posterior slope moderately steep. Beaks centrally located, small, slightly prominent, incurved, slightly prosogyrate, approximate. Hinge and internal features not uncovered. Anterodorsal margin nearly straight, slightly inclined; anterior margin subtruncated, rather sharply rounded below, meeting the dorsal margin above at a broad subobtuse angle; ventral margin broadly rounded; posterior margin subtruncated, with a very broad subobtuse angle below, and rounding into the nearly straight, slightly inclined posterodorsal margin above. Lunule indistinctly outlined. The surface is smooth with the exception of fine growth lines, and slight, irregular growth undulations.

Dimensions of the holotype, a left valve: Length 9.5 mm., height 9 mm., convexity about 2.5 mm. Dimensions of a small nearly perfect shell with both valves attached: Length 5.7 mm., height 5 mm., thickness 2.3 mm.

The form of this shell suggests that it belongs in the family Lucinidae, but the hinge has not been seen, and the generic relationships of the shell must be regarded as only tentatively established until the hinge characters have been determined.

*Types.* Holotype, U.S.N.M. no. 76585; 1 figured paratype, U.S.N.M. no. 76586; 6 unfigured paratypes, U.S.N.M. no. 76587.

Distribution in Texas. -Navarro group, Nacatoch sand: Field south of Chatfield (7569, type loc.); 3/5 to 4/5 mile northeast of Chatfield (14117); ?vicinity of Kaufman (761).

## LUCINA SEMINALIS Stephenson, n.sp.

## Pl. 34, figs. 1, 2

Shell small, subcircular in outline, of medium convexity, equivalve, subequilateral. Shell wall of medium thickness. Beaks moderately prominent, incurved, approximate, prosogyrate, situated centrally. Greatest inflation at the midlength, above the midheight, from which point the surface rounds down regularly to the anterior, ventral, and posterior margins. Hinge and other internal features not uncovered. Lunule short, broad, and sharply outlined. Escutcheon wanting. Ligament deeply inset. The regularity of outline is modified by the noticeably excavated anterodorsal margin, and by a slightly fuller curve on the anterior margin than on the posterior. Surface covered with low growth ridges of medium strength numbering about 5 to the millimeter; these are regularly spaced except as modified on the earlier stages by shallow, concentric depressions that mark resting slages.

Dimensions of the imperfect holotype, the only available specimen: Length 5.5 mm., height 5.6 mm., thickness 3.4 mm. This species is not likely to be confused with any previously described species.

Holotype.-U.S.N.M. no. 76588.

Distribution in Texas.--Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

## LUCINA OLEODORSUM Stephenson, n.sp.

## Pl. 34, fig. 3

Shell small, subcircular in outline, depressed convex, subequilateral. Maximum inflation at the midlength well above the midheight. The regularity of surface curvature is modified by a slight radial flattening extending from the beak with increasing width to the lower anterior margin; the anterodorsal slope is also slightly flattened. Beak slightly prominent, incurved, prosogyrate, situated centrally. Lunule short, moderately wide, deeply and sharply impressed. Ligament deeply inset, attached to a narrow, well developed nymph. Dentition feeble, poorly preserved, but apparently there are two small, short, obscure cardinal teeth in the right valve: anterior lateral of right valve distant, short, nonprominent, separated from the outer margin by a short, shallow socket not well preserved in the holotype; posterior lateral wanting. Other internal features not uncovered. The regularity of marginal outline is modified by a short inclined truncation on the lower anterodorsal margin; the lower anterior margin becomes a little more sharply rounded as it passes into the ventral margin; the lower posterior margin is also a little more sharply rounded where it rounds into the ventral margin; the posterodorsal margin is broadly arched. Surface covered with regularly spaced, concentric lines, the interspaces widening a little toward the outer margin; these lines number 3 to 6 to the millimeter; at irregular intervals are stronger concentric depressions marking resting stages. Numerous faint, radial lines may be seen under a lens.

Dimensions of the holotype, a right valve: Length 6.7 mm., height 6.6 mm., convexity 2 mm.

Compared with *Lucina seminalis* this species is a little larger, proportionately less inflated and less regular in marginal outline.

*Type.*—Holotype, a right valve, the only available specimen, U.S.N.M. no. 76589.

Distribution in Texas.—Navarro group, Nacatoch sand:  $\frac{1}{2}$  mile northwest of Oil Ridge School, 4 miles north of Corsicana (17366).

#### Unidentified specimens of LUCINA

Poorly preserved specimens of Lucina that cannot be specifically identified have been found at the following localities in the Navarro group. In the Nacatoch sand in the northward-facing slope of Sulphur Creek valley, in the northwestern corner of Franklin County (12931, U.S.N.M. no. 76590); on Rock Branch on Walton lease of Houston Oil Co.,  $\frac{1}{2}$  mile north of Corsicana-Chatfield road, 3 miles northeast of Corsicana (9545, U.S.N.M. no. 76591); in the Corsicana marl, in a branch below public road,  $2\frac{1}{2}$  miles north of Tona siding, 5 miles southwest of Quinlan, Hunt County (15546, U.S.N.M. no. The specimens at the latter 76592). place belong to a small, smooth, depressedconvex, subcircular species of Lucina; these are internal molds with a trace of shell substance adhering and are more or less compressed and distorted by mechanical pressure.

## Family UNICARDIIDAE

# Genus UNICARDIUM D'Orbigny UNICARDIUM? sp.

Pl. 34, figs. 6, 7

One internal mold of a right valve, with a few fragments of thin shell adhering, apparently belonging to the genus Unicardium, was found in the Corsicana marl in a bluff on the left side of Guadalupe River, 1 3/10 miles above McQueeney, Guadalupe County (15524). U.S.N.M. no. 76593.

The shell is of moderate size, subtrigonal in outline, a little longer than high, strongly convex, inequilateral, probably equivalve; greatest ventricosity well above the midheight at about the midlength; anterodorsal slope steep, excavated, subangular above; posterodorsal slope rounding down steeply to the margin. Beaks prominent, strongly incurved, prosogyrate, situated at about the midlength. Hinge and internal features not preserved. Anterior margin sharply rounded at about the midheight; ventral margin broadly rounded; posterior margin broadly rounded; posterodorsal margin broadly arched, descending steeply. The adhering shell fragments indicate a surface with small, sharp, closely spaced, concentric ridges; the surface of the internal molds shows very faint, radial lines on the anterior part of the shell.

This specimen is too imperfect for specific identification, but appears to differ in outline and surface features from both Unicardium concentricum (Conrad)<sup>237</sup> from the Ripley formation at Eufaula, Alabama, and from Unicardium neusense Stephenson from the Snow Hill member of the Black Creek formation at Whiteley Creek Landing, Neuse River, North Carolina.<sup>238</sup>

#### Superfamily LEPTONACEA

#### Family GALEOMMATIDAE

## Genus SCINTILLA Deshayes

The one available individual, which is tentatively placed in this family, is questionably referred to *Scintilla* solely on the basis of its superficial resemblance in form to the members of that group. The hinge and other internal features are not uncovered, and are therefore not available for determining the family and generic relationships of the specimen. The heretofore known range of the family is from the Eocene to the Recent.

## SCINTILLA? RAMONI Stephenson, n.sp.

#### Pl. 34, fig. 8

Shell of moderate size, elongated, compressed, most inflated posteriorly, equivalve, inequilateral. Beaks small, low, scarcely projecting, situated about 0.3 the length of the shell from the anterior extremity. Hinge and internal features not uncovered. Anterodorsal margin curving down steeply and broadly; anterior margin subtruncated, sharply rounded below; ventral margin long and nearly straight centrally, curving upward at each end; posterior margin sharply rounded much below the midheight; posterodorsal margin passing in a long, broad arch from the extremity upward to the beak. Surface marked by rather coarse, concentric growth lines and undulations.

Dimensions: Length 20 mm., height 12.6 mm., thickness about 5 mm.

*Holotype.*—U.S.N.M. no. 76594. Named for Capt. Domingo Ramón, an early Texas explorer and founder of missions.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### Superfamily CARDIACEA

#### Family CARDUDAE

#### Genus CARDIUM Linné

The representatives of the genus Cardium in the Navarro group of Texas, are referrable to at least four subgenera, Pachycardium Conrad, Granocardium Gabb, Ethmocardium White, and Trachycardium Mörch. Pachycardium is represented by numerous well preserved individuals of one species, and by one internal mold which is specifically indeterminate; five or more species are assignable to Granocardium; one species belongs to Ethmocardium; and Trachycardium is represented by one determined species and by several specifically indeterminate lots of poorly preserved specimens.

## Subgenus PACHYCARDIUM Conrad

1869. Pachycardium Conrad, Am. Jour. Conch., vol. 5, p. 96.

Type species .-- Cardium spillmani Conrad.

This subgenus is characterized by its large size, thick shell, elongation in the direction of the height, and nearly smooth surface, with only faintly developed radial sculpture on the umbonal area. Three closely related species of the subgenus, including the new species described below, have been differentiated in the American Upper Cretaceous.

<sup>&</sup>lt;sup>237</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., n. ser., vol. 4, p. 280, pl. 46, fig. 4, 1860.

<sup>&</sup>lt;sup>208</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, p. 278, pl. 69, figs. 1-3, 1923.

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## CARDIUM (PACHYCARDIUM) WADEI Stephenson, n.sp.

## Pl. 38, figs. 1, 2; pl. 39, figs. 4-6

Shell large, thick, subovate in outline, elongated in the direction of the height, moderately convex. Beaks large, prominent, strongly incurved, approximate, slightly prosogyrate, situated a little in advance of the midlength. Umbonal ridge broadly rounded. A broad, shallow sulcus extends from the umbone to the ventral margin just in front of the umbonal ridge; this sulcus is caused by a pronounced thickening of the shell on the anterior slope, and is not reflected on the inner surface of the shell. The anterior slope rounds down broadly, becoming steep toward the dorsal margin; the posterior slope is steep and high. The hinge plate is broad and heavy. In the right valve a prominent posterior cardinal tooth is oblique backward, and is separated from a small, short anterior cardinal by a deep triangular socket; back of the posterior cardinal is a relatively shallow, narrow oblique socket. The inner one of the pair of anterior claspers is short and thick and is supported by a buttress-like thickening of the shell back of it; the outer clasper is small and short and is separated from the inner one by a deep. wide socket. The posterior claspers are smaller and shorter than the anterior ones, the inner one being strong and well developed, and the outer one very small and obscure; the socket is moderately wide and deep. The walls of both the sockets are obliquely striated on the sides. In the left valve the anterior cardinal tooth is large, thick and short and is separated from an obscure, narrow, oblique, posterior cardinal by a deep, triangular socket. The anterior lateral is prominent and short and exhibits concave depressions on the sides. The posterior lateral is smaller and shorter than the anterior one, but is modcrately prominent and distinct; it has a pronounced concavity on the inner side. The ligamental groove is narrow and deep and is bordered by a strong nymph.

The adductor scars are high in the shell, the posterior one being the larger; a small retractor muscle scar is situated on the thickened, slightly overhanging,

buttress-like portion of the shell just above the anterior adductor scar; a broad radial ridge borders the inner side of the posterior adductor scar. The pallial line is simple and is rather far in from the border. The inner posterior margin is strongly crenulated from the shoulder of the shell above down to the middle of the ventral margin; the rest of the margin is smooth. The dorsal margin of the shell is strongly arched; the anterior margin is subtruncated above, becoming broadly rounded below; ventral margin sharply rounded; posterior margin nearly straight. The surface presents fine incremental lines and irregularly spaced concentric depressions which mark resting stages; these depressions become pronounced on the anterior slope and less so on the steep posterior slope, and give to the shell a strong rugged appearance. Five or six faint radiating costae appear on the umbonal ridge, and faint radiating lines can be made out on the posterior slope.

Dimensions of the holotype, a right valve: Length 69 mm., height 96 mm., convexity 35 mm. The largest shells in the collection attain a height of 116 mm.

Compared with Cardium (Pachycardium) spillmani Conrad, this species is not so elongated in the direction of the height, and is less ventricose; it also differs in the pronounced thickening of the shell on the anterior slope, and in the more rugged aspect of its growth features. The species shows a close relationship to Cardium (Pachycardium) stantoni Wade, from the Cook Creek tongue of the Ripley formation of Tennessee, but differs in that it is a much thicker, heavier and more rugged shell, is less elongated in the direction of the height, and has a much heavier and more elongated hinge.

*Types.* — Holotype, a right valve, U.S.N.M. no. 76595; 2 figured paratypes, U.S.N.M. no. 76596; 5 selected unfigured paratypes, U.S.N.M. no. 76597. Named in honor of Dr. Bruce Wade.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518); vicinity of Corsicana (763, type loc.); 2<sup>1</sup>/<sub>2</sub> miles north of Corsicana (14114); vicinity of Chatfield (762); <sup>3</sup>/<sub>4</sub> mile east of Chatfield (7571); road 2 miles southwest of Kaufman (7546); road <sup>3</sup>/<sub>5</sub> mile west of Kaufman (7545, 14098); vicinity of Kaufman (761).

## CARDIUM (PACHYCARDIUM) sp.

Internal molds of shells of this subgenus were found near Cooper, in the Neylandville marl, as follows: Cut of Texas Midland Railroad, 1/2 mile north of Cooper, Delta County (14062, U.S.N.M. no. 76598); 2/5 mile north of Cooper (14063. U.S.N.M. no. 76599). Inasmuch as the surface features, on which the identification of these shells chiefly depends, are not reflected in the molds, it is scarcely possible to refer them to definite species.

## Subgenus ETHMOCARDIUM White

- 1880. Ethmocardium White, U.S.Nat. Mus. Proc., vol. 2, pt. 2, p. 291. 1900. Ethmocardium White. Dall, Wagner Free
- Inst. Sci. Trans., vol. 3, pt. 5, p. 1074. Type species.—*Cardium speciosum* Meek and Hayden. (Specific name preoccupied; renamed C. (Ethmocardium) whitei Dall.)

This subgenus is characterized by lines of deep pits on the internal pallial area, and these lines correspond to the intercostal channels of the external surface. The internal pits extend through the shell wall or are covered outwardly only by a thin film of shell which, in some cases, may have been destroyed in fossilization; at any rate the pits appear externally as rows of perforations between the costae of most specimens.

#### CARDIUM (ETHMOCARDIUM) WELLERI Stephenson, n.sp.

#### Pl. 34, figs. 13-17

1907. Cardium wenonah Weller (in part), Geol. Survey New Jersey, Paleontology, vol. 4, p. 576, pl. 63, figs. 10-13 (not figs. 14-16).

Shell small for the genus, broadly subovate in outline, slightly elongated in the direction of the umbonal ridge, moderately ventricose. Beaks only moderately prominent, strongly incurved, approximate, prosogyrate, situated a little in advance of the midlength. Umbonal ridge broadly rounded below, becoming more sharply rounded to subangular toward the beak. Anterior slope moderately steep, flattening out a little toward the anterior

margin and becoming slightly excavated toward the anterodorsal margin; posterior slope steep, becoming a little excavated toward the margin. Although many individuals in the collection have separated from the hard concretionary matrix in such a way as to show the external features perfectly, the hinges are not well exposed in any of them. The hinge plate appears to be rather narrow, and the dentition normal. As seen on internal molds the anterior adductor scar is small. subovate, and situated high in the shell; the posterior scar is larger, more elongate, and extends much lower in the The inner surface of the shell shell. within the pallial line exhibits radial rows of pits corresponding in position to the intercostal channels of the exterior, the pits numbering 1 to 3 to the millimeter; these pits were filled with matrix and appear on the internal mold as rows of nodes; many of the pits penetrate the shell and appear on the exterior as rows of perforations in the intercostal channels. The pits do not become conspicuously developed until the adult stage is reached and may appear to be wanting on the younger stages. Serrations on the margin of the shell mark the ends of the costae. Dorsal margin of shell arched; anterior and ventral margins broadly and evenly rounded; posterior margin subangular below, very broadly rounded above, meeting the dorsal margin in a very broad, subobtuse angle. The surface is ornamented with about 32 distinct spineless ribs; laterally these are squarish to broadly rounded on their crests, and are separated by slightly narrower interspaces with squarish bottoms; on the anterior slope the ribs become narrower and the interspaces wider; on the posterior slope the ribs are low, triangular in cross section, and show a tendency to become bifid on their crests. The internal pits appear as rows of perforations in the intercostal channels as already explained.

Dimensions of the holotype, a complete right valve: Length 14.2 min., height 15 mm., convexity 5.5 mm. The largest shell measured is about 16 mm. long. The shows considerable individual species variation in form and outline and the paratype shown in plate 34, figures 14, 15, is an extreme in plumpness and in abbreviation in the direction of the height. The dimensions of this paratype are: Length 13.5 mm., height 14.2 mm., thickness 11 mm.

Weller identified this species as *Car*dium wenonah Weller, and figured three specimens from near Corsicana. Although the New Jersey species exhibits a superficial resemblance in outline and in the number and character of the ribs, the types from the Wenonah sand near Marlboro do not seem to possess the characteristic internal pits, and this, together with the fact that they occupy a stratigraphically lower position, seems to justify separating them from the Texas species.

The only other reported occurrence of the subgenus *Ethmocardium* in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain is in the San Miguel formation (upper Taylor age), in Maverick and adjacent counties, Texas, but *C. (Ethmocardium) whitei* Dall, the type species of the subgenus, is common in the Montana group (Upper Cretaceous) of the Western Interior.

*Types.*—Holotype, U.S.N.M. no. 76600; 1 figured paratype, U.S.N.M. no. 76601; 2 figured paratypes, U.S.N.M. no. 76602a, b; about 24 selected unfigured paratypes, U.S.N.M. no. 76603.

Distribution in Texas.-Navarro group, Nacatoch sand: North edge of Corsicana (518); vicinity of Corsicana (763, type loc.); road 5 miles south-southwest of Corsicana (7573); ?2 miles north of Corsicana (9557); 3 miles northeast of Corsicana (9545); 4 miles north of Corsicana (17366); vicinity of Chatfield (762); loose pieces of rock in street at (7568); south of Chatfield Chatfield (7569); field 3/5 mile west of Kaufman (14103); vicinity of Kaufman (761); field 2 miles south by west of Kaufman (7547); road 2 miles south by west of Kaufman (7546); ?14/5 miles northeast of Quinlan 16162).

#### Subgenus GRANOCARDIUM Gabb

Type species.— Cardium carolinum d'Orbigny (Pal. France, Crétacé, vol. 3, p. 29, pl. 245, figs. 1, 2, 1843), designated by Ralph Stewart (Acad. Nat. Sci. Philadelphia Special Pub. No. 3, p. 261, 1930). Gabb described the subgenus Granocardium in 1869 (Geol. Survey California, Paleontology, vol. 2, p. 266, 1869). The following year Conrad described the subgenus Criocardium, based on Cardium (Criocardium) dumosum Conrad, from the Woodbury clay at Haddonfield, New Jersey, which appears to belong to the same subgeneric group as Granocardium Gabb (Am. Jour. Conch., vol. 6, p. 75, 1870).

The subgenus is characterized by numerous smooth ribs, with rows of spines In Conrad's type in the interspaces. species, dumosum, the spines in every third interspace are much larger than those in the other interspaces, but the number of rows of small spines between the rows of large ones varies from one to three in dif-In d'Orbigny's species ferent species. carolinum the number of rows of small spines between the rows of large ones appears to be one or two on different parts of the same shell, as rather poorly represented in the original figures. The spines range in different species from circular in cross section to strongly compressed parallel to the costac. The subgenus is represented in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain by at least 5 described species, and by several undescribed species.

The subgenus is represented in the Cretaceous of Europe by several species among which are *carolinum* (d'Orbigny), *productum* (Sowerby), and *moutoniaum* (d'Orbigny), from the Cenomanian of France; *proboscideum* (J. Sowerby), from the upper Albian? of England; and *productum* (J. Sowerby) from the lower part of the Upper Cretaceous of France and the Aachen district, Germany.

# CARDIUM (GRANOCARDIUM) DELTANUM Stephenson, n.sp.

## Pl. 35, figs. 1-4

The description is based on external and internal molds only. Shell of moderate size, broadly subovate in outline, slightly oblique, a little higher than long, moderately ventricose, shell wall rather thin. Beaks prominent, strongly incurved, approximate, slightly prosogyrate, situated

about midway of the length. Umbonal ridge broadly rounded; anterior slope rounding down broadly, and moderately steep; posterior slope steep and high. The hinge is not well exposed on the available material. The adductor scars are not well preserved, but they are situated high in the shell and the posterior one is the larger of the two. Pallial line simple. Margins crenulated, the notches corresponding to the intercostal channels. The dorsal margin is only slightly arched; the anterior and ventral margins are regularly rounded; the posterior margin is broadly subangular below, becoming very broadly convex to nearly straight above. The surface is ornamented with 60 to 62 small, low, smooth ribs with rows of spines in the interspaces. On the main part of the shell the ribs are squarish with a faintly impressed fine line along the crest of each, and are a little wider than the interspaces; on both the anterior and dorsal slopes the ribs become larger and tend to become triangular in cross section. Rows of moderately compressed spines occupy all the intercostal channels. On the main part of the shell in front of the umbonal ridge the spines in every fourth channel are much larger and more widely spaced than in the intermediate channels; on the umbonal ridge and on the posterior slope the spines in every other or in every third channel are larger. The spines in one row on the umbonal ridge are much larger than any of the others, and of the other large spines those on the anterior and posterior slopes are the larger. The height of the spines can not be ascertained as the modelling material can not be forced to the bottom of the perforations representing the spines in the molds. The small spines appear to be low and are little more than compressed nodes; they are spaced a millimeter to a little more than a millimeter apart; the larger spines are spaced 2 to 4 mm. apart, and the highest of them probably rise 2 mm. above their bases.

Dimensions of the holotype: Length 24 mm., height 26 mm., thickness about 18 mm.

This species differs from *Cardium* (*Granocardium*) dumosum (Conrad)

chiefly in having three instead of two rows of the smaller intercostal spines between the rows of larger spines, over the main part of the shell. The species differs from *C ar d i u m (Granocardium) alabamense* (Gabb) in this same feature, and also in having slightly coarser ribbing. On *Cardium uniforme* Weller the spines are nearly uniform in size in all the rows, and the ribbing is a little coarser than in the Texas species. In all the other described species the sculpture is much coarser than in the Texas species.

Types. -Holotype, U.S.N.M. no. 76604: the material includes the internal and parts of the external molds of both valves of one individual, preserved in four pieces of rock. Paratypes, unfigured, 2 fragments, U.S.N.M. no. 76605.

Distribution in Texas.—Navarro group, Neylandville marl: ½ mile north of Cooper, Delta County (14062, type loc.); ?2½ miles northeast of Royce City (16157).

## CARDIUM (GRANOCARDIUM) ROSSAE Stephenson, n.sp.

# Pl. 36, figs. 1, 2

Shell of medium size, broadly subovate in outline, slightly oblique, higher than long, strongly inflated, shell wall thick: umbonal ridge broadly rounded; dorsal slopes steep and high. Beaks prominent, strongly incurved, approximate, slightly prosogyrate, situated centrally. Umbonal ridge broadly rounded, most strongly humped above the midheight. Dorsal slopes steep. Hinge not clearly exposed. Adductor scars of medium size, situated high in the shell, the posterior one the larger. Margins finely crenulated, the notches corresponding to the intercostal Surface covered with 70 or more spaces. low, rounded or subangular radial ribs with rows of spine scars in the interspaces; the spines are broken and gone. The spines are in two orders of size, one very tiny, the other relatively large. Over most of the surface the distribution of the spine rows is such that two adjacent rows of small spines intervene between single rows of large spines; however, on the upper posterior slope just back of the crest of the umbonal ridge several of the large and small spine rows succeed each alternately. The smaller spine other scars tend to become obscure toward the outer margins. The cross sections of the large spine scars are elongated in the direction of the ribs and number about 4 in a radial distance of 5 mm.; the small spine scars appear to be nearly circular in cross section and number anywhere from 8 to 17 in a radial distance of 5 mm. The ribs tend to become obscure and difficult to count toward the dorsal margins, and a small area bordering each dorsal margin is ribless.

Dimensions of the holotype, a right valve: Length 22.3 mm., height 38 mm., convexity 15 mm. The largest paratype is mechanically distorted but measures approximately: Length 40 -mm., height 44 +mm.

This species is more clongated in the direction of the height than is *Cardium* (*Granocardium*) deltanum, the ribs are more numerous and closely spaced, and the number of spines, both large and small, in the same radial distance is much greater. The species differs from the more typical species of *Granocardium* in the low, rounded contour of the ribs, and in the obscurity of the smaller spines toward the margins of the shell.

*Types.*—Holotype, U.S.N.M. no. 76606; 4 unfigured paratypes, U.S.N.M. no. 76607. Named in honor of Miss Gene Ross of The University of Texas, who collected the holotype.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, paratypes; Tex. Bu. 17300, holotype); 3½ miles west-northwest of Corsicana (16166).

## CARDIUM (GRANOCARDIUM) BOWENAE Stephenson, n.sp.

# Pl. 34, figs. 10-12

Shell large, thick, subcliptical in outline, elongated in the direction of the height, strongly ventricose. Beaks high, prominent, strongly incurved, nearly direct, but very slightly prosogyrate, approximate, situated centrally. The anterior and posterior slopes are very steep, and the central part rounds broadly over from slope to slope, with only a slight differentiation of the umbonal ridge, and a faint obliquity in the direction of that ridge. Hinge not well exposed. Adductor scars situated high in the shell, the posterior one larger than the anterior one. Margin serrated, the notches corresponding to the intercostal channels. Dorsal margin slightly arched with subangular shoulders; anterior margin subtruncated above, broadly rounded below; ventral margin rather sharply rounded, posterior margin long and very broadly rounded to The surface is ornanearly straight. mented with not less than 50 small, narrow radial costae, smooth except for an impressed line along the crest. In all of the interspaces are rows of moderately compressed spines, the prevailing arrangement on the central and anterior part of the shell being 2 rows of small spines between rows of much larger spines; on the holotype, about midway of the anterior slope two of the rows of larger spines have only one intermediate row of small spines: on the posterior slope the prevailing arrangement is one row of smaller spines between two rows of larger spines, but two of the rows of large spines a little above the middle have two intermediate rows of smaller spines. The small spines are fairly uniform in size over the whole shell, but the large spines become considerably larger about midway of both the anterior and posterior slopes.

Dimensions of the holotype, a left valve: Length 19.5 mm., height 28 mm., convexity 12.5 mm. The larger specimens in the collections are incomplete but they probably exceed 40 mm. in height.

Although this species is closely related to *Cardium (Granocardium) dumosum* (Conrad), it is much more ventricose, is more clongated in the direction of the height, and is markedly more coarsely sculptured. *C. (Granocardium) kümmeli* (Weller) is less ventricose, and less clongated in the direction of the height. The Texas species is not likely to be confused with any other described species of *Cardium* in the Coastal Plain.

*Holotype.*—U.S.N.M. no. 76608. Named in honor of Miss Nell L. Bowen, Clerk of the Section of Coastal Plain Investigations, United States Geological Survey. Distribution in Texas.—Navarro group, Nacatoch sand: Road 3 '5 mile west of Kaufman (12923, type loc.); vicinity of Kaufman (761); 2 miles southwest of Kaufman (7546); field 2 miles southwest of Kaufman (7547); 6 miles southeast of Cooper (12929); northwestern corner of Franklin County (12931).

Outside distribution.---Arkansas: Questionably in the Nacatoch sand.

*Range*.---Nacatoch sand of the Navarro group in Texas and questionably in the Nacatoch sand of Arkansas.

# CARDIUM (GRANOCARDIUM) THOLI Stephenson, n.sp.

## Pl. 36, fig. 3

Shell large, thick, and dome-like, broadly subovate in outline, a little higher than long, rather strongly convex, slightly oblique in the umbonal direction. Beaks broad and prominent, strongly incurved, approximate, slightly prosogyrate, situated centrally. Umbonal ridge broadly rounded. Most prominent inflation about midway of the length and a little above the midheight. From the center the surface rounds down broadly to the anterior margin: the posterior slope is steep above, becoming broadly rounded below. Hinge not well exposed. but hinge plate obviously rather heavy. Adductor scars rather small, strongly impressed, situated above the midheight; anterior scar subtrigonal; posterior scar subovate, more elongated and larger than the anterior Margin serrated, the notches corone. responding to the intercostal spaces. Pallial line simple. Dorsal margin only slightly arched, with squarish shoulders; anterior and ventral margins regularly rounded; posterior margin subtruncated to nearly straight. Surface ornamented with 50 or 52 smooth ribs, with interspaces a little wider than the ribs. Each of the interspaces is occupied by a row of spines, and over the well preserved portions of the surface of the main part of the shell of the holotype and of one other specimen, every third row is larger than the others; on the slopes the order may be either two rows of small spines between single rows of large ones, or alternate large and small One ferruginous fragment of a rows.

mold of the main surface of the shell, in a collection from near Kaufman, shows in succession from front to rear, three, three, two, three, and four rows of small spines between the rows of large ones; this may be a different species, or it may indicate that this species is variable in the arrangement of its spines. The spines are circular to slightly compressed in cross section and stand up to a maximum of 2 mm. or more above the surface.

Approximate dimensions of the holotype, a right valve: Length 53 mm., height 61 mm., convexity 24 mm.

This species is larger, more ventricose. coarsely sculptured and more than Cardium (Granocardium) dumosum (Con-С. rad). (Granocardium) tippanum (Conrad) is much more elongated in the direction of the height, has only one row of small spines between the rows of large ones, and the spines are in general more circular in cross section. C. (Granocardium) bowenae is smaller, more elongated in the direction of the height, and is proportionately more ventricose. C. (Granocardium) kümmeli is a similar but more coarsely sculptured species.

*Types.*—Holotype, U.S.N.M. no. 76609; 1 unfigured paratype, U.S.N.M. no. 76610.

Distribution in Texas.—Navarro group, Nacatoch sand: Field south of road 5 miles northeast of McClanahan (17371); vicinity of Chatfield (762, type loc.); 1/2 mile east of Chatfield (7570); vicinity of Kaufman (761).

Outside distribution.—Arkansas: Questionably in the Nacatoch sand.

Range.---Nacatoch sand of the Navarro group in Texas, and questionably in the Nacatoch sand in Arkansas.

## CARDIUM (GRANOCARDIUM) TIPPANUM (Conrad)

#### Pl. 37, figs. 9-12

- 1858. Cardium tippanum Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 326, pl. 34, fig. 8b.
- 1864. Cardium (Acanthocardia) tippanum Conrad. Meek, Check list of the invertebrate fossils of North America, Cretaceous and Jurassic, p. 12.
- ceous and Jurassic, p. 12.
  ?1876. Cardium (Granocardium) tippanum Conrad. Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 310.

The description is based on well preserved shells from Owl Creek, 2½ miles portheast of Ripley, Tippah County, Mississippi, the type locality of the species. The available Texas material consists of poorly preserved specimens from two localities, questionably referred to the species.

Shell large, thick, subovate in outline, elongated in the direction of the height, strongly convex, the greatest inflation being midway of the length and well above the midheight, equivalve, slightly inequilateral; antero- and posterodorsal slopes steep. Beaks prominent, strongly incurved, slightly prosogyrate, approximate, situated about at the midlength. Hinge of right valve, as shown by specimens from the type locality, with one prominent, pointed cardinal tooth below and a little back of the beak, with a deep, curved-conical socket in front; a short, narrow, shallow, nearly horizontal socket lies just above the cardinal tooth and a weak protuberance or tooth stands just above the deep socket; anterior and posterior claspers short, the inner or lower ones of each pair moderately prominent, the outer ones weak, the two of each pair separated by a short, deep lateral socket. Hinge of left valve with a similar prominent cardinal tooth standing in front of a deep socket; above the cardinal is a shallow socket which receives the protuberance above the socket of the right valve, and above the socket is a weak horizontal tooth which fits into the corresponding socket above the cardinal of the right valve; short, prominent anterior and posterior lateral teeth are each bounded above and below by short sockets for the reception of the claspers of the right valve. Ligamental groove external, short and deep.

Inner margin crenulated, each notch marking the terminus of an intercostal space. Adductor scars small, high, the anterior one smaller than the posterior. Pallial line simple. Anterodorsal and anterior margins broadly and regularly rounded; ventral margin sharply rounded; posterior margin subtruncate or only very broadly rounded. The ornamentation normally includes 55 to 57 narrow, sharp, low

radiating ribs with every alternate interspace occupied by a row of strong, coarse spines, and the remaining interspaces by rows of fine, nonprominent spines; many of the coarser spines are broken away but enough are preserved to show that they are irregular in size and spacing, and that their maximum height is 3.5 or 4 mm.; these spines range from circular in cross section to slightly flattened, with the long axis in the direction of the height, and are spaced 0.5 to 2 mm. apart, and tend to become coarser away from the beak and on the dorsal slopes; the smaller spines are closely spaced and are also slightly flattened; on some individuals the small spines become obsolete on the posterodorsal slope; on the posterodorsal slopes of most specimens the regular alternation of large and small spine-rows is broken by the occurrence of one or more pairs of small spine-rows between the larger ones, but this is a variable feature.

Dimensions of the neotype, a right valve: Length 41 mm., height 56 mm., convexity 23.5 mm.

On one of the available Texas specimens, a large internal mold of a left valve with a film of shell remaining in places, the spines have been largely corroded away, but enough is preserved to show an apparent essential identity in surface characters; the form also appears to be identical.

Compared with Cardium (Granocardium) dumosum (Conrad), the type species of the subgenus, and the most nearly related species, C. (G.) tippanum, is more elongated in the direction of the height, exhibits normally one instead of two rows of small spines between the rows of large ones, and is much more coarsely ornamented.

Types.—The holotype is not listed among the types in the Academy of Natural Sciences of Philadelphia and is probably lost. The type is from the Owl Creek formation on Owl Creek,  $2\frac{1}{2}$  miles northeast of Ripley, Tippah County, Mississippi. Figured neotype, U.S.N.M. no. 76611, from the type locality. Other typical examples (topotypes), U.S.N.M. nos. 76612 and 76613, also from the type locality. Plesiotype from Texas, U.S.N.M. no. 76614.

Distribution in Texas.—Navarro group, Corsicana marl: ?6 miles east of Castroville (16156, figured); ?near Castroville (7665).

Outside distribution.—Mississippi: Owl Creek formation and Prairie Bluff chalk.

Chattahoochee rcgion (Alabama-Georgia): Questionably in the Providence sand.

Range.—Upper part of Exogyra costata zone in the Gulf region.

## Unidentified specimens of CARDIUM (GRANOCARDIUM)

A large, strongly inflated internal mold of this subgenus, accompanied by a portion of the external mold and another smaller internal mold (16170,U.S.N.M. no. 76643), was obtained from the Neylandville marl in the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County. The sculpture is of the same type as that on Cardium (Granocardium) deltanum but is somewhat finer and more densely crowded; the mold indicates a shell proportionately a little more elongated in the direction of the height (pl. 38, figs. 3, 4).

In the same formation on the Dallas road,  $2\frac{1}{2}$  miles northeast of Royce City, in Collin County (13834), was obtained an imperfect external mold of *Granocar*dium having the same type of spinose sculpture as *C. (G.) alabamense*, but considerably coarser. U.S.N.M. no. 76616.

Single unidentified specimens of the subgenus were found in the Nacatoch sand in Hunt County on the W. N. Guthrie place, 1½ miles west of Campbell (12925, U.S.N.M. no. 76617), and 1½ miles west of Commerce (5323, U.S.N.M. no. 76618).

In 6 lots from the Nacatoch sand in Navarro County the form of the shells of this subgenus is well shown in internal molds, but the character of the ornamentation is not adequately revealed. In one lot the shell is present, but the spinose surface is so firmly embedded in hard sandstone matrix that it cannot be uncovered. These localities are: Public road  $\frac{3}{5}$  to  $\frac{4}{5}$  mile northeast of Chatfield (7572, U.S.N.M. no. 76619; 14117, U.S.N.M. no. 76620); near Chatfield (762, U.S.N.M. no. 21084); field south of Chatfield (7569, U.S.N.M. no. 76621); 2½ miles north of Corsicana (14114, U.S.N.M. no. 76622); road 5 miles southsouthwest of Corsicana (7573, U.S.N.M. no. 76623). One internal mold from near Kaufman, Kaufman County (761, U.S.N.M. no. 76624), appears to be like the preceding.

Poorly preserved specimens of *Cardium* (Granocardium) having the general form of Cardium (Granocardium) dumosum (Conrad)<sup>239</sup> have been found in the Corsicana marl at the localities described below, but the ribs and spines are not well enough preserved to permit accurate identification and description. Five internal molds with a film of shell material still adhering to two of them have been found near the old Frieze well of the Morgan Oil Company, 2<sup>3</sup>/<sub>5</sub> miles north by east of Malta, Bowie County (5310, U.S.N.M. no. 76625; 12934, U.S.N.M. no. 76626: 16159, U.S.N.M. no. 76627). The ribbing, as poorly shown on the molds, is of about the same degree of fineness as that on C. (Granocardium) dumosum (Conrad), but the size of the spines and the distribution of the rows of large and small spines, can not be clearly made out on all of them. Two internal molds, probably of the same species, were collected in a public road, 11/4 miles south by east of Oak Grove, Bowie County (16160, U.S.N.M. no. 76628). Six internal molds of Cardium (Granocardium), one also showing the mold of part of the external ornamentation, were obtained in a small branch on the Wm. H. Moore Survey, 100 yards south of the Missouri, Kansas & Texas R.R., 1/4 mile east of the west line of the Survey, about 5 miles east by north of Greenville, Hunt County (12924, U.S.N.M. no. 76629). These specimens are very much like C. (Granocardium) dumosum Conrad, in that between most of the rows of large spines there are two rows of small ones, but on the specimen showing sculpture three rows of small spines were noted between two rows of the large ones, near the middle of the shell.

<sup>&</sup>lt;sup>239</sup>Conrad, T. A., Amer. Jour. Conch., vol. 6, p. 75, 1871.

Variations of this kind are not uncommon in this subgenus as shown by large suites of well preserved shells from the Ripley formation of Mississippi.

Several imperfect specimens of *Cardium* (*Granocardium*) from the Corsicana marl on Guadalupe River, 1 3/10 miles above McQueeney, Guadalupe County (7637, U.S.N.M. no. 76630; 15524, U.S.N.M. no. 76631), exhibit a similar type of ribbing to *C.* (*Granocardium*) dumosum (Conrad); as rather obscurely seen, the arrangement of the spines is variable, either two or three rows of small spines occurring between the rows of large ones. The shells are also more elongated in the direction of the height, and are more ventricose, than is true of *dumosum*.

#### Subgenus TRACHYCARDIUM Mörch

1853. Trachycardium Mörch, Catalogus Conchyliorum, quae reliquit D. Alphonso et Gadea Comes de Yoldi, Fasc. 2, p. 34. Type species.—Cardium isocardia Linné.

The subgenus, Trachycardium Mörch, differs from the typical *Cardium* in the absence of spines on the ribs, but the ribs, and in some species the intercostal channels, are imbricate or granulose; the strength of the granulosity differs markedly, however, on different species. In the Navarro group the subgenus appears to be represented by moderately well preserved shells of one species from three localities and by imperfect specimens from several other localities. There can be no question that these Cretaccous shells possess characters which ally them closely to the type species, Cardium isocardia Linné, a Recent species from Florida and adjacent seas, but slight differences in the hinge features, together with the fact that they are separated by a vast lapse of time, warrant caution in placing the Cretaceous species in the same subgeneric group with the Recent ones. The lineal relationships of the group should be given much more thorough study than they have yet received.

## CARDIUM (TRACHYCARDIUM) EUFAULENSE HUNTANUM Stephenson, n.var.

## Pl. 36, fig. 4

Shell of moderate size and thickness, broadly subovate in outline in the vertical direction, slightly oblique toward the lower posterior extremity, moderately Beaks moderately prominent, convex. strongly incurved, prosogyrate, approximate, situated slightly in advance of the Umbonal midlength. ridge broadly rounded becoming subangular near the beak. Central inflation broadly rounded and only slightly greater than that of the umbonal ridge; anterior slope rounding down broadly to the margin; posterior slope moderately steep above, becoming less so below. Hinge not exposed in the available material. Ligamental groove short, narrow, and deep. Adductor scars situated high in the shell, but rather obscure in the available material. Margin of the shell crenulated; along the ventral margin the notches correspond to the ribs, but toward the front and rear the notches shift in such a manner that on the anterior and posterior margins they are at the ends of the intercostal chan-Dorsal margin gently arched; nels. anterior and ventral margins regularly rounded; posterior margin subangular below, becoming broadly convex to nearly straight above, meeting the dorsal margin at a broad subobtuse angle. Surface ornamented with 37 or 38 well defined radiating ribs which, as preserved, appear to be broadly rounded over the crest, and wider than the interspaces. Fine growth ridges give to both the ribs and interspaces a granulated appearance, and this is strongest on the anterior and posterior slopes.

Dimensions of the holotype, a left valve: Length 24 mm., height 27.5 mm., convexity 10 mm.

Compared with the typical Cardium (Trachycardium) eufaulense Conrad, this species is less elongated in the direction of the height, the ribs are lower and broader, and the interspaces narrower; the number of ribs is about the same. There are several varietal forms of Conrad's species, in the Upper Cretaccous deposits of the Coastal Plain, which have not been critically studied and described; they are generally referred to C. eufaulense and regarded as individual variations of that species.

*Types.*—Holotype, U.S.N.M. no. 76632; 6 unfigured paratypes, U.S.N.M. no. 76633.

Distribution in Texas.—Navarro group, Nacatoch sand: 1½ miles west of Campbell, Hunt County (12925, type loc.); 1½ miles northeast of Quinlan (16162, 16171); vicinity of Kaufman (761).

## Unidentified specimens of CARDIUM (TRACHYCARDIUM)

Poorly preserved specimens of *Cardium* (*Trachycardium*) have been found in the Nacatoch sand in Navarro County at the following localities:  $\frac{1}{4}$  mile north of Rock Branch,  $\frac{3}{4}$  mile north of the Corsicana-Chatfield road, 3 miles northcast of Corsicana (9560, U.S.N.M. no. 76634); a small branch at the north end of the M. R. and M. J. Thompson property, 1 mile west of the Corsicana-Chatfield road, 2 miles north of Corsicana (9554, U.S.N.M. no. 76635; 9555, U.S.N.M. no. 76636).

Several phosphatic internal molds of *Cardium (Trachycardium?)* from the Corsicana marl, in a road ditch in the westward-facing slope of Lynne Creek valley, 3 7/10 miles southwest of Campbell, Hunt County (15547), are too incompletely preserved for even subgeneric identification. U.S.N.M. no. 76637.

Imperfect specimens of the subgenus from the Kemp clay have been collected at several localities as follows: North corner of the John A. Thompson estate, 1500 feet east of the west line of the Wm. Fisher Survey, about  $3\frac{1}{2}$  miles northwest of Bazette, 4 miles northeast of Roane, Navarro County (12922, U.S.N.M. no. 76638); branch  $\frac{1}{2}$  mile south of McLeod school,  $6\frac{1}{2}$  miles southwest of Currie, Navarro County (14139, U.S.N.M. no. 76639); a gully north of Garfield, Travis County (7603, U.S.N.M. no. 76641).

Several internal and external molds of a moderately large species of *Cardium (Trachycardium)* were collected from the Kemp clay in a roadside gully  $\frac{1}{2}$  miles west of Elm Creek School,  $4\frac{1}{2}$  miles northwest of Lockhart, Caldwell County (15528, U.S.N.M. no. 76640; 16151, U.S.N.M. no. 76642). The approximate dimensions of the internal mold of a right valve are: Length about 27 mm., height about 33 mm., convexity 12.5 mm. The ribs number 42 or more. The species is similar to *C. (T.) eufaulense* Conrad but attains a larger size, and has a more prominent umbonal ridge, squarer, more prominent shoulders, and a few more ribs. With better material it might appropriately be named a variety of Conrad's species, but for the present it seems best to leave it as specifically unidentified.

## Genus BREVICARDIUM Stephenson, n.gen.

# Type species.—Brevicardium fragile Stephenson, n.sp.

Brevicardium appears to be related to Nemocardium Meek<sup>240</sup> (type species, Cardium semiasperum Deshayes),<sup>241</sup> which was assigned by its author to subgeneric rank under Cardium. Characters in common between the two genera are: Similarity of form, fine radial lining over the main surface of the shell, stronger radial ribbing on the posterodorsal slope, fine crenulations on the margin, and similarity of hinge characters. Perhaps the most essential difference between the two genera pertains to the position of the spines which, on Brevicardium, occupy the channels between the ribs, whereas in Nemocardium they stand upon the crests of the ribs. Although the development of these spines is variable, even on the individuals of the type species of Brevicardium, and they appear to be wanting on the Texas species, B. tenue, the fact that when present they are between and not on the ribs probably indicates a fundamental generic difference. The position of the spines between the ribs relates Brevicardium to Granocardium. On B. fragile there is a conspicuous development of sinuous, concentric ridges which are independent of the growth lines, but these curious ridges seem to be entirely wanting on B. tenue and also on B. parahillanum (Wade),<sup>242</sup> another species of the group. Protocardia salinaensis Meek. from the Mentor formation of Kansas, which Wade mentioned as resembling perahillanum, lacks the radiating lines

<sup>&</sup>lt;sup>240</sup>Meek, F. B., Kept, U. S. Geol, Survey Terr., vol. 9, p. 167, 1876.

<sup>&</sup>lt;sup>241</sup>Deshayes, G. P., Animaux sans vertèbres Bassin Paris, vol. 1, p. 573, pl. 55, figs. 1, 2, 1860.

<sup>&</sup>lt;sup>212</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 87, pl. 27, fig. 1, 1926.

over the main disc, and is a true Protocardia. Protocardia hillana<sup>243</sup> Sowerby, from the Upper Greensand of England, also mentioned by Wade, is the genotype of Protocardia; it lacks the fine radial lining over the main shell. Cardium subhillanum Leymerie,<sup>244</sup> from the Cretaceous of France, possesses the radial lining, and may belong to Brevicardium.

The American representatives of *Brevicardium*, of which five species are known, are all small, none exceeding 8 mm. in length, and in this respect are in contrast to *Nemocardium* which may reach a length of over 50 mm. The three species resemble each other in form and outline.

## BREVICARDIUM FRAGILE Stephenson, n.sp.

# Pl. 36, figs. 5-8

This species is based on three well preserved left valves from the Owl Creek formation at the classic locality on Owl Creek, 21/2 miles northeast of Ripley, Tippah County, Mississippi. Shell small, thin, fragile, subcircular in outline, modcrately inflated, slightly inequilateral. Beaks moderately prominent, strongly incurved, slightly prosogyrate, approximate, situated slightly in advance of the midlength. Umbonal ridge weakly developed, the surface of the disc forming a wide subobtuse angle with the moderately steep, slightly excavated, posterodorsal slope; anterodorsal slope steep, excavated. The maximum inflation is at about the midlength, above the midheight. Hinge of left valve rather thin and frail, with a moderately prominent cardinal tooth a little in advance of the beak, and a deep socket behind it directly below the beak; posterior cardinal weak, situated above the socket and just back of the beak; a relatively strong anterior lateral is separated from the outer margin by a moderately deep socket; posterior lateral wanting. Adductor scars large, the posterior one slightly the larger. Inner margin of shell finely crenulated. Lunule small, short,

excavated, sharply outlined. Dorsal margin broadly arched; anterior margin rounded with a slight tendency to subtruncation; ventral margin broadly rounded; posterior margin subtruncated, slightly inclined forward, rounding into the dorsal margin.

The surface of the main disc is covered with fine, radial lines; these separate very low, weak ribs which scarcely override the concentric ribs; the posterodorsal slope and a band in front of the umbonal ridge about 1.5 mm. wide, as measured on the margin, are covered with radial ribs which are stronger than those on the rest of the disc; these ribs, however, lose their relative coarseness toward the dorsal margin and pass into a nearly smooth area at the margin; scattered low tubercles or spines occur in some of the interspaces on the posterodorsal slope and on the similarly ornamented part of the disc in front of the umbonal ridge; the development of these spines is variable on different individuals. The surface of the main disc is further ornamented with moderately strong, relatively broad, concentric ribs which in places are sinuous in their trend, and are developed independently of the growth lines; these sinuosities are most marked on the anterior slope where there is a marked tendency for the ribs to descend toward the margin and to unite with similar ribs of a later stage which are more nearly parallel to the margin; the ribs are separated by narrower interspaces in the bottoms of which are small pits marking the intersections of the radial lines. The concentric ribs become weak posteriorly before reaching the umbonal ridge, but are easily traceable across the posterodorsal slope: over the posterior part of the shell the pits marking the intersection of the concentric and radial interspaces are conspicuously developed, and produce a decided cancellated sculpture; these pits which externally look like perforations, do not penetrate to the interior of the shell and may be the scars of spines broken away at some period of the shell's growth.

The Texas specimens, which are questionably referred to this species, are

<sup>&</sup>lt;sup>243</sup>Woods, Henry, A monograph of the Cretaceous Lamellibranchia of England, vol. 2, p. 197, pl. 31, figs. 6a-e, pl. 32, figs. 1-6, 1908.

<sup>&</sup>lt;sup>244</sup>D'Orbigny, Alcide. Paléontologie francaise, vol. 3, p. 19, pl. 239, figs. 7, 8, 1844.

mechanically flattened, and are poorly preserved, the shell material being largely corroded away, but enough remains on one specimen to show the presence of sinuous concentric ribs; one fragment of an external mold shows rows of spine scars on the posterodorsal slope.

Dimensions of the holotype: Length 5.8 mm., height about 5.8 mm., convexity 2.5 mm. Length of the largest paratype 7 mm.

The coarser sculpture, the sinuous concentric ribs, and the spines on the posterior part of the shell, sharply distinguish this species from *Brevicardium tenue* which, however, has about the same size and form. *Brevicardium parahillanum* (Wade) from Coon Creek, Tennessee, has finer radial sculpture over the main disc, stronger ribs on the posterodorsal slope, and lacks the cancellated sculpture on this slope; it exhibits, however, a few small spines in two or three of the interspaces.

Types.—Holotype, U.S.N.M. no. 76644; from the Owl Creek formation on Owl Creek,  $2\frac{1}{2}$  miles northcast of Ripley, Tippah County, Mississippi (707): three paratypes from the same locality, U.S.N.M. no. 20701; four questionable examples from Texas, U.S.N.M. no. 76645; 1 questionable example from Texas, U.S.N.M. no. 76646.

Distribution in Texas.--Navarro group, Corsicana marl:  $?\frac{1}{2}$  mile below Martindale (7621);  $?2\frac{4}{5}$  miles east of Cooledge (13832).

Outside distribution.—Mississippi: Owl Creek formation at Owl Creek, Tippah County (type locality).

*Range.*—Known only from the type locality and questionably from the Corsicana marl of the Navarro group at two localities in Texas.

# BREVICARDIUM TENUE Stephenson, n.sp.

# Pl. 35, fig. 5

In size, outline and form, this species resembles *B. fragile*, but it differs markedly in ornamentation. Over the main disc are fine radiating lines crossed by fine, subdued, concentric ribs which show no sign of sinuosity. Coarser radial ribs cover the umbonal ridge and the upper part of the posterodorsal slope; the lower part of this slope in an area having a maximum width of about 1 mm. is smooth. No spines or spine scars can be seen on the shell, which has a finely cancellated appearance due to the crossing of the concentric ribs. The posterior ribbing is much finer than in *B. parahillanum* (Wade).

Dimensions of the holotype, a right valve which is incomplete in the posteroventral portion: Length 6.2 mm., height 6 mm., convexity 2.3 mm.

Types.—Holotype, U.S.N.M. no. 76647; 7 unfigured paratypes, U.S.N.M. no. 76648.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, type lot; 17365);  $2\frac{1}{2}$ miles northeast of Royce City (16157).

# BREVICARDIUM GUADALUPENSE Stephenson, n.sp.

Pl. 35, figs. 7, 8

This species is based on one slightly crushed individual with the two valves attached. In size and general form the shell is very much like the two species already described. The ribbing is fine all over the shell and although the ribs are slightly coarser on the posterior slope there is apparently no sharp line of demarcation between the ribbing on this slope and that on the main part of the shell. The posterior half of the shell exhibits faint indication of spine scars between the ribs, and 2 to 4 rows of smaller spines intervene between rows of larger spines. A few small spines are still preserved near the posterior margin. The incremental lines are very faintly developed.

Dimensions: Length 7.7 mm., height 7.5 mm., thickness 4 + mm.

Of the two species already described, this species is nearest to *B. tenue*. It differs, however, in the possession of easily recognizable spine scars and a few unbroken spines, in the noticeably coarser ribbing, and in the lack of a sharp line of demarcation between the ribs on the main part of the shell and those on the posterior slope.

Holotype.-U.S.N.M. no. 76649.

Distribution in Texas.—Navarro group, Kemp clay: 2 miles south-southeast of Schumansville (16668).

## BREVICARDIUM MARCOSENSE Stephenson, n.sp.

# Pl. 35, fig. 6

Shell small, broadly subovate in outline, moderately convex, with a broadly rounded plump aspect; umbonal ridge broadly rounded: anterodorsal slope steep, slightly excavated in front of the beak; posterodoral slope steep with a broad shallow radial depression extending from the beak to the posterior extremity. Beaks moderately prominent, strongly incurved. direct, approximate, nearly situated slightly in advance of the midlength. Hinge and internal features not uncov-Dorsal margin broadly arched, ered. curving broadly down in front; anterior margin regularly rounded, slightly sharper than a semicircle; ventral margin broadly rounded: posterior margin sharply rounded below, subtruncated above, the truncation inclined somewhat forward. rounding into the dorsal margin. Surface sculptured by numerous, closely spaced, radiating ribs which are a little coarser on the umbonal area, with narrower interspaces, and by about equally strong concentric ridges which tend to be wider than the interspaces; the radiating and concentric sculpture produce a finely punctate surface. As the shell substance is partly removed, leaving only a thin film on the internal mold, the actual surface is not completely preserved.

Dimensions of the holotype, a left valve: Length 6 mm., height 4.7 mm., convexity about 1.5 mm.

The greater elongation of the shell and the finer surface sculpture serve to distinguish this species from B. fragile, the most nearly related Navarro species.

Types.—Holotype, U.S.N.M. no. 76650; 1 unfigured paratype, U.S.N.M. no. 76651.

Distribution in Texas.—Navarro formation, Corsicana marl: 1/2 mile below Martindale (15527).

## BREVICARDIUM sp.

One internal mold with fragments of shell adhering, from the Nacatoch sand

near Chatfield, Navarro County (762), appears to belong to *Brevicardium*; it exhibits fine radial lining and fine marginal crenulations. U.S.N.M. no. 76652.

# Superfamily ISOCARDIACEA

# Family ISOCARDIIDAE

Genus ISOCARDIA Lamarck

## ISOCARDIA BULBOSA Stephenson, n.sp.

# Pl. 37, figs. 4, 5

Shell broadly subovate in outline, a little longer than high, strongly convex. Shell wall very thin. A weak, shallow, radial sulcus extends from the beak to the middle of the posterior margin. Beaks prominent, strongly incurved, slightly separated, moderately prosogyrate, situated about two-fifths the length of the shell from the anterior extremity. The anterior part of the shell is strongly bulbous, descending steeply to the anterior margin, and more gently to the posterior margin. Dorsal margin arched: anterior margin sharply rounded; ventral margin broadly rounded; posterior margin rather sharply rounded below, slightly subtruncated above: posterodorsal margin broadly rounded and much longer than the anterodorsal margin. Lunule and escutcheon wanting; the anterodorsal slope is very steep to slightly overhanging. The surface is nearly smooth with the exception of very fine concentric lines which are a little stronger on the dorsal slopes, and very faint radial lines, best seen in the umbonal region, which are spaced about three to the millimeter and are formed of closely spaced pores visible only under a magnifying glass. The hinge and internal features are not exposed, and the generic identification is made on the basis of the general form, and the characteristic forward twist of the beaks.

Dimensions of the holotype, an internal mold with shell attached over more than half of the surface: Length 11.6 mm., height 11 mm., thickness 8.5 mm.

This species is less elongated, more bulbose, and has a more direct beak than *Isocardia hendersoni*. It has a near ally in *Isocardia cliffwoodensis* Weller from the Cliffwood clay, New Jersey. The
Texas species is, however, higher in the posterior part, has a more broadly rounded posterior margin, and the inflated part of the shell lacks the posterodorsal humping that seems to characterize the Cliffwood species.

*Types.*- Holotype, U.S.N.M. no. 76653; 5 unfigured paratypes, U.S.N.M. no. 76654.

Distribution in Texas. -Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); road 5 miles southsouthwest of Corsicana (7573); 4 miles north of Corsicana (17366).

# ISOCARDIA HENDERSONI Stephenson, n.sp.

# Pl. 37, figs. 7, 8

Shell of moderate size, subtrigonal in outline, somewhat elongated, strongly convex, inequilateral, slightly inequivalve, the right valve the more ventricose, shell wall very thin. Beaks prominent, strongly incurved, strongly prosogyrate, curved slightly away from each other at the tips, situated one-fifth the length of the shell from the anterior extremity. The greatest inflation is a little above the midheight and in advance of the midlength, and the surface descends steeply toward the front and more gently toward the rear. Hinge not uncovered. Adductor scars obscure, but apparently of moderate size and situated low in the shell. Other internal features obscure. Anterodorsal margin short. steep; anterior margin sharply rounded; ventral margin broadly rounded; posterior margin sharply rounded much below the midheight; posterodorsal margin long, broadly arched. Surface marked only by fine incremental lines. Lunule and escutcheon wanting.

Dimensions of the holotype: Length 15 mm., height 12.1 mm., thickness 10 mm., maximum length about 17 mm.

The species is less bulbose, more elongated, more pointed posteriorly and has a more strongly prosogyrate beak than *I. bulbosa*; it lacks the faint radiating lines of that species. It is less bulbose, and less strongly humped on the posterodorsal area, than *I. cliffwoodensis* Weller. The specimens referred to this species exhibit some variation in the proportion of length to height.

*Types.*—Holotype, U.S.N.M. no. 76655; 6 unfigured paratypes, U.S.N.M. no. 76656. Named for the Hon. James P. Henderson, first governor of Texas, 1846-1847.

Distribution in Texas. Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.): north edge of Corsicana (518): 2½ miles north of Corsicana (14114): vicinity of Kaufman (761); road 3/5 mile west of Kaufman (14098); 1½ miles northeast of Quinlan (16162).

# ISOCARDIA IRELANDI Stephenson, n.sp.

# Pl. 37, fig. 6

This species is very much like *I. bulbosa* in form, but is more elongated, not quite so bulbose, and the maximum inflation appears to be a little more toward the rear; the lining produced by fine radiating rows of pores appears to be wanting. The shell material is not well preserved on any of the examples, but there is impressed on the internal mold of the holotype, a faint cancellated sculpture resulting from the crossing of exceedingly weak radial lining with the concentric growth lines.

Types. --Holotype, U.S.N.M. no. 76657; 8 unfigured paratypes, U.S.N.M. no. 76658. Named for the Hon. John Ireland, Governor of Texas, 1883–1887.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, type lot; 17365); 3½ miles west-northwest of Corsicana (16166); 2½ miles northeast of Royce City (16157).

## ISOCARDIA SHUMARDI Stephenson, n.sp.

### Pl. 37, figs. 1-3

Shell large, strongly ventricose with greatest inflation well toward the front, broadly subtrigonal in outline; shell wall thin and fragile; a sinuous subangular umbonal ridge extends to the lower posterior extremity, and between this and the posterodorsal margin is a broad, shallow, sinuous, radiating excavation extending to the posterior truncation; the anterodorsal slope rounds down steeply to the front, and is deeply excavated toward the Beaks prominent, strongly inbeak. curved, approximate, strongly prosogyrate on the tip, situated about one-third the length of the shell from the anterior extremity. The ligamental groove is external, short (5 or 6 mm.), opisthodetic, and appears as a mere slit. Hinge not uncovered. Muscle scars and pallial line not apparent on the internal mold. Jnternal mold smooth except toward the ventral margin where faint radiating lines appear. In the uncrushed right valve the anterior margin is regularly rounded except for a faint subtruncation; this margin rounds regularly into the dorsal margin above: ventral margin broadly and regularly rounded; posterior margin subangular at the extremity which is much below the midheight, broadly truncated and sloping forward above the extremity, rounding into the posterodorsal margin which is rather long and gently convex. Surface smooth with the exception of fine incremental lines which are a little coarser on the posterodorsal slope.

Dimensions of the holotype, a somewhat crushed left valve: Length 34 mm., height, 25 mm., convexity about 11 mm. The paratype, a right valve, is 37 mm. long, 32 +mm. high, and has a convexity of about 12 mm.

Two large species of Isocardia in the Upper Cretaceous of the Atlantic Coastal Plain are similar to this species. Isocardia truncata Stephenson,245 which was originally described under the name Trapezium truncatum Stephenson, is comparable in size to the Texas species, but is proportionately higher, more inflated, and has a much sharper umbonal ridge. Isocardia tintonensis Weller from the Tinton sand member of the Red Bank sand, of New Jersey, is not so long, and the beak is nearer the center. In none of these species is the hinge uncovered, and the generic relations have therefore not been finally established.

Types.—Holotype, U.S.N.M. no. 20905; 1 figured paratype, U.S.N.M. no. 76659; 4 unfigured paratypes, U.S.N.M. no. 76660. Named for Dr. B. F. Shumard who, in 1861, described 20 or more new species of Navarro fossils from Navarro County.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, loc. of holotype); 2½ miles north of Corsicana (14114); 3½ miles due north of Corsicana (16168, loc. of. 1 figured paratype).

# Superfamily VENERACEA

# Family VENERIDAE, sensu lato

In a paper published in 1936 Frizzell<sup>246</sup> offers a preliminary reclassification of the veneracean pelecypods. He raises the family Veneridae to the superfamily rank, the Veneracea, and gives an incomplete list of families that should be included therein. He also gives an extensive list of genera, subgenera and sections that have been referred by different authors to the Veneracea as restricted by him, indicating by capital letters those that he regards as acceptable. He does not assign the genera to their respective families. Because of the incomplete stage of development of this classification its adoption in the present paper has not seemed practicable.

# Genus APHRODINA Conrad

### APHRODINA TIPPANA Conrad

Pl. 39, figs. 1-3; pl. 40, figs. 5, 6

- 1858. Meretrix tippana Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 326, pl. 34, fig. 18.
- 1864. Dione tippana (Conrad). Meek, Check List of the Invertebrate Fossils of North America, Cretaceous and Jurassic: Smithsonian Misc. Coll., vol. 7, no. 177, p. 13.
- 1869. Aphrodina tippana Conrad, Amer. Jour. Conch., vol. 4, p. 246, pl. 18, fig. 5.
- 1905. Aphrodina tippana Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 16.
- 1907. Meretrix tippana Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 607, pl. 68, figs. 1, 2 (probably not fig. 3).
- 1916. Antigona (Aphrodina) tippana (Conrad). Gardner, Maryland Geol. Survey, Upper

<sup>240</sup>Frizzell, Don L., Preliminary reclassification of Veneracean pelecypods: Bull, du Musée royal d'Histoire naturelle de Belgique, Tome 12, No. 34, 84 pp., 1936.

<sup>&</sup>lt;sup>215</sup>Stephenson, L. W., North Carolina Geol, and Econ. Survey, vol. 5, pt. 1, p. 267, pl. 74, figs. 2-5, 1923.

Cretaccous (2 vols.), p. 681, pl. 40, figs. 3. 4.

- 1923. Aphrodina tippana Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 314, pl. 79, figs. 1-6.
- 1926. Aphrodina tippana Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 89, pl. 28, figs. 5-7.

Shell of moderate size and convexity, subovate in outline, longer than high. Beaks prominent, incurved, approximate, prosogyrate, situated about 0.3 the length of the shell from the anterior extremity. Umbonal ridge scarcely differentiated, very broadly rounded. Shell most inflated centrally, rounding down broadly in every direction. The hinge plate becomes rather broad and heavy in large adults. In the left valve there is a long, narrow, oblique, slightly arched posterior cardinal paralleling the nymph from which it is separated by a narrow, shallow channel; this is followed by an elongated, deeply impressed, trigonal socket; the middle cardinal is short, oblique toward the rear, thick below and wedging to an edge above; a deep trigonal socket separates the middle from the anterior cardinal which is thick and slightly bifid on its inward-facing edge, and wedges to a thin edge toward the beak; a narrow, socket lies in front of the anterior cardinal; the anterior lateral is moderately long, heavy posteriorly, thinning toward the front, and roughly corrugated all over. In the right valve the posterior cardinal is oblique, moderately long, bifid, and slightly arched; it is separated posteriorly from a long, prominent, arched nymph by a curved socket which widens inwardly; a trigonal socket separates the posterior cardinal from the middle cardinal which is thick at the base and thin on the crown; a deep trigonal socket separates the middle cardinal from the anterior cardinal which is subequal in size and form to the middle cardinal; the anterior lateral of the left valve fits into a rugose socket with slightly raised edges, in the right valve. The ligamental groove is long, deep, and broadly arched, and is bordered below by a rather strong, narrow nymph. The anterior and posterior adductor scars are subovate and subequal, and are situated a little above the midheight; just back of

the upper end of the anterior adductor scar is an elongated, rather weakly impressed retractor scar. The pallial sinus is moderately profound, bluntly rounded anteriorly, and directed toward the anterior lateral tooth. Inner margin smooth. Anterodorsal margin markedly excavated; anterior margin rather sharply rounded; ventral margin broadly and regularly rounded; posterior margin sharply rounded: posterodorsal margin broadly arched, with a slight humping back of the umbo. The suface is smooth with the exception of rather vigorous concentric growth lines. The lunule is moderately excavated and is sharply outlined by a thin, impressed line. There is no well defined escutcheon.

Dimensions of the average-sized right valve shown in plate 39, figure 2: Length 51 mm., height 41 mm., convexity 14.5 mm. The largest shell in the collection is 61 mm. long.

This species exhibits slight variations in form and outline in any suite of specimens from a given locality. It is possible that with large suites of specimens for comparison small but constant differences might be found between the shells from Texas and those from the type locality of the species at Owl Creek in Tippah County, Mississippi, but no differences sufficiently marked to be of practical value in separating them have as yet been detected. Some slight differences in dentition have been noted, but not enough hinges have been uncovered to determine whether or not these are individual variations.

Types.—The holotype is a rather small right valve in the Academy of Natural Sciences of Philadelphia. This shell was found in the Owl Creek formation at the classic locality on Owl Creek 2½ miles northeast of Ripley, Tippah County, Mississippi. Four plesiotypes from Texas, U.S.N.M. no. 76661.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, 4 specimens figured); road 2 miles southwest of Kaufman (14099); 14/5 miles northeast of Quinlan (16162); ?from northwest corner of Franklin County (12931).

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Navarro group, Corsicana marl: about 5 miles east by north of Greenville (12924).

Navarro group, Kemp clay: ?from  $4\frac{1}{2}$  miles northwest of Lockhart (15528).

*Outside distribution.*—Arkansas: Nacatoch sand.

Tennessee: Coon Creek toogue of Ripley formation.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Ripley formation (upper part) and Providence sand.

North Carolina: Peedee formation (upper part).

Maryland: Monmouth formation.

Range. -Nacatoch sand, Corsicana marl, and Kemp clay of the Navarro group, and beds of equivalent age in the Atlantic and Gulf Coastal Plain.

### APHRODINA? NAVARROANA Stephenson, n.sp.

#### Pl. 38, figs. 5, 6

The description is based on one left valve, the only representative of the species in the collections.

Shell small, moderately thick, depressed convex, subovate in outline, inequilateral; greatest inflation a little in advance of the midlength and well above the midheight, from which point the surface rounds down regularly to the anterior and ventral margins; the anterodorsal slope is steep and the shell flattens out a little back of an obscurely developed umbonal ridge. Beaks moderately prominent, incurved, prosogyrate, approximate, situated about two-fifths the length of the shell from the anterior extremity. The hinge of the left valve has 3 cardinal teeth, the anterior one weak, thin, and low, the middle one prominent, thin, rather long and oblique, and the posterior one very long, very oblique, nonprominent and closely paralleling the nymph; deep sockets separate the cardinals, and there is a deep, open socket in front of the anterior cardinal; anterior lateral strongly developed, apparently smooth, and of moderate length; as preserved there is no evidence of a posterior lateral but the edge of the shell partly broken away. is Ligamental groove rather long and of moderate depth.

Lunule sunken, sharply outlined; escutchcon wanting. Internal features not uncov-Anterodorsal margin concave; ered. anterior margin sharply rounded; ventral margin broadly rounded; posterior margin subtruncated; postero-dorsal margin inclined, broadly arched. Surface covered with numerous low, flat-topped concentric ribs separated by sharply incised lines; these ribs tend to become broader toward the ventral margin, but there is considerable irregularity in their width; near the margin they number about 4 to the millimeter. There is no trace of radial sculpture.

Dimensions: Length 10 mm., height 8.5 mm., convexity about 2.5 mm.

A complete right valve from Coon Creek, McNairy County, Tennessee, identified by Wade<sup>247</sup> as Meretrix eufaulensis (Conrad), has broader concentric ribs, and is a different species, though its reference to Conrad's species is doubtfully correct. It appears to be generically the same as the Texas species, however, and its hinge and internal characters appropriately may be noted here. The three cardinal teeth are all rather thin; the anterior one is prominent, the middle one short and subdued, and the posterior one long and oblique; none is bifid; deep sockets separate the cardinals and there is a shallower socket in front of the anterior cardinal; the lateral dentition includes a deep socket with weak claspers for the receipt of the anterior lateral of the left valve, and a distant, long, rather deep posterior lateral socket, bordered below by a strong clasper, and above by the margin of the shell. The lunule is sharply outlined with an impressed line, but there is no escutcheon. The pallial line is of moderate width and depth, ascends steeply, and is rounded on the anterior end.

The type of Meretrix eufaulensis (Conrad) (== Callista eufaulensis Conrad) from Eufaula, Alabama, is lost. The New Jersey shells which have been referred to Conrad's species<sup>248</sup> may belong to the

<sup>&</sup>lt;sup>247</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 89, pl. 28, figs. 3, 4, 1926.

<sup>&</sup>lt;sup>215</sup>Weller, Stuart, New Jersey Geol. Survey, Paleontology, vol. 4, p. 609, pl, 68, figs. 8-10, 1907.

same genus, but it is doubtful if they are correctly identified specifically. Wade<sup>249</sup> suggested a resemblance between this species and *Callista (Dosiniopsis) deweyi* Meek and Hayden,<sup>250</sup> but even the generic identity of the two species is doubtful; the latter has a more orbicular outline, a different type of surface sculpture, and an angular instead of a rounded pallial sinus.

# Holotype .---- U.S.N.M. no. 76662.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

### Genus CYPRIMERIA Conrad

### Type species .- Cytherea excavata Morton.

Cyprimera excavata (Morton) is recorded as having come from Cretaceous marl at Arneytown, New Jersey.<sup>251</sup> According to Weller<sup>252</sup> the type came from the Navesink marl at Arneytown. This town is located on the Red Bank sand, but the Navesink is exposed within a mile to the northwest.

# CYPRIMERIA DEPRESSA Conrad

#### Pl. 40, fig. 3

- 1860. Dosinia depressa Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 278, pl. 46, fig. 6.
- ?1860. Sanguinolaria cretacensis Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 277, pl. 46, fig. 11.
- ?1861. Dosinia haddonfieldensis Lea, Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 149.
- ?1867. Cyprimeria cretacensis Conrad, Am. Jour. Conch., vol. 3, p. 9.
- 1869. Cyprimeria cretacea Conrad, Am. Jour. Conch., vol. 5, p. 98, pl. 9, fig. 12.
- 1875. Cyprimeria depressa Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C Kerr), App. A, p. 9.
- 1885. Cyprimeria depressa Conrad. Whitfield, U.S.Gcol. Survey Mon., vol. 9, p. 156, pl. 22, figs. 11, 12, 13(?). (Geol. Survey New Jersey, Paleontology, vol. 1, p. 156, pl. 22, figs. 11, 12, 13(?), 1886.)
  1905. Cyprimeria depressa Conrad. Johnson,
- 1905. Cyprimeria depressa Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 16.

<sup>252</sup>Weller, Stuart, Geol, Survey New Jersey, Paleontology, vol. 4, pp. 602-604, 1907.

- 1916. Cyprimeria depressa Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 687, pl. 40, figs. 8-10.
- 1923. Cyprimeria depressa Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 307, pl. 74, figs. 6–13.
- 1926. Cyprimeria depressa Conrad. Stephenson, Geol. Survey Alabama Special Rept. No. 14, p. 250, pl. 92, fig. 12. (Figure only.)
- 14, p. 250, pl. 92, fig. 12. (Figure only.)
  1929. Cyprimeria depressa Conrad. Dane, Arkansas Geol. Survey Bull. 1, p. 150, pl. 27, fig. 11. (Figure only.)

Shell small, subovate in outline, longer than high, but varying greatly in the proportion of length to height in different individuals, depressed convex, inequivalve, both valves bent slightly to the left posteriorly. Beaks small, flattish, rising slightly above the hinge area, prosogyrate, approximate, somewhat variable in position, but in general about 2/5 the length of the shell from the anterior extremity. Umbonal ridge wanting on left valve, faintly discernible on right valve. Owing to the twist of the shell the right valve is slightly swollen posteriorly, and the left valve is correspondingly excavated. The hinge of the left valve is set with three cardinal teeth as follows: A narrow, oblique, slightly curved posterior cardinal tooth, back of a deeply excavated moderately wide socket; a broad bifid middle cardinal, the posterior element of which is narrow and is separated from the broad, forward-sloping element by a narrow, sharply excavated channel or subsocket; a long, narrow, oblique, prominent anterior cardinal, bordered on either side by deep, narrow channels. The hinge of the right valve also carries three cardinal teeth as follows: A long, narrow, oblique, sharply bifid posterior cardinal with a deep, narrow socket behind it, and a broad socket in front of it, which is deep posteriorly and slopes up anteriorly; the middle cardinal is broad, oblique forward, has a high, sharp ridge anteriorly, and slopes toward the rear; in front of the middle cardinal is a deep, narrow socket which is considerably overhung by the short, narrow anterior cardinal. Lateral teeth are wanting. The ligamental groove is relatively short, narrow, and deep, and the nymph is narrow and sharp. There is a small lunule set off by a faintly impressed line; back of the beaks

<sup>&</sup>lt;sup>249</sup>Op. cit., p. 89.

<sup>&</sup>lt;sup>250</sup>Meek, F. B., Rept. U. S. Geol, Survey Terr., vol. 9, p. 182, pl. 17, figs. 15a-e, 1876.

<sup>&</sup>lt;sup>251</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Proc., vol. 16, p. 212, 2 text figs., 1864. See also Morton, S. G., Synopsis of the organic remains of the Cretaceous group of the United States, p. 67, pl. 5, fig. 1, 1834.

is a long, narrow, deeply excavated depression, V-shaped in cross section, which is mechanically necessary to the opening of the two closely compressed valves. The dorsal margin is broadly arched; the anterior margin, beginning at the beak is regularly rounded, becoming just a little more sharply rounded at the anterior extremity; the ventral margin is broadly rounded; the posterior margin is more sharply rounded than the anterior, and in most specimens is more or less distinctly subtruncated.

Dimensions of the figured specimen: Length  $37 \pm$  mm., height 28 mm., convexity about 3.5 mm.

Considering the common occurrence of this species in the Coastal Plain as a whole, its distribution in Texas, as at present known, is relatively sparse, except in the San Miguel formation of the Rio Grande Valley in Maverick and Kinney counties, where it is common. The extremes in outline and form of the shells referred to this species would seem to justify splitting it into varieties, or even species, but the variations noted in specimens from one horizon, or even from one locality, are such as to induce caution in the subdivision of the group. Because of its range and individual variability, the species appears to be of little value in the close discrimination of faunal zones.

*Types.*—Holotype, Academy of Natural Sciences of Philadelphia; from the Ripley formation at Eufaula, Alabama. Plesiotype from Texas, U.S.N.M. no. 76663.

Distribution in Texas.—San Miguel formation: Northward-facing bluff of Agua de Fuera Creek valley, 5 miles southcast of Spofford, Kinney County (8262); westward-facing slope of Elm Creek valley, 1½ miles northeast of Paloma, Maverick County (8253); Imperialist Creek, 2½ miles west of Darling siding, Maverick County (8255); Imperialist Creek, 3 miles northwest of Paloma siding, Maverick County (8234); Del Rio road, 12½ miles northwest of Eagle Pass (8226).

Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (4064).

Navarro group, Nacatoch sand:  $1\frac{1}{2}$  miles west of Campbell (12925, figured);  $1\frac{4}{5}$  miles northeast of Quinlan (16162).

Navarro group, Corsicana marl: about 5 miles east by north of Greenville (12924).

Navarro group, Kemp clay:  $4\frac{1}{2}$  miles northwest of Lockhart (15528, 16151);  $3\frac{1}{5}$  miles north-northwest of Fentress (16149).

Outside distribution. — Arkansas: Brownstown marl and Nacatoch sand.

Mississippi: Ripley formation and Owl Creek formation.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Eutaw formation, Blufftown formation, Cusseta sand, Ripley formation (upper part), and Providence sand.

North Carolina: Snow Hill member of Black Creek formation and Peedee formation.

Maryland: Monmouth formation.

New Jersey: Woodbury clay.

Range.—The geographic range of this species is from the Rio Grande to New Jersey, and the geologic range is through the zones of *Exogyra ponderosa* and *E. costata*, that is, through beds corresponding in age to the Taylor marl and the Navarro group.

# CYPRIMERIA ALTA Conrad

Pl. 40, figs. 1, 2; pl. 41, figs. 1-4

- 1858. Dosinia densata Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 325, pl. 34, fig. 13. (Specific name preoccupied by Dosinia densata Conrad from New Jersey.)
- 1875. Cyprimeria alta Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 27.
- Kerr), App. A, p. 27. ?1876. Cyprimeria torta Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 308.
- 1916. Cyprimeria major Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 689, pl. 40, figs. 11, 12; pl. 41, figs. 1-4; pl. 42, fig. 1; pl. 43, fig. 1.

The Texas shells referred to this species are poorly preserved, large, and thick, and evidently lived in a highly favorable environment. They are broadly subovate in outline, moderately convex, and exhibit the slight posterior twist to the left, which characterizes the genus. Beaks small, not prominent, approximate, prosogyrate, situated about  $\frac{1}{3}$  the length of the shell from the anterior extremity.

Umbonal ridge faintly developed. The dentition on the right valve, as incompletely exposed on one right valve, shows the three cardinal teeth essentially as in typical shells from Mississippi (see pl. 41, fig. 2). On a typical Mississippi shell the anterior cardinal tooth of the right valve is thin and sharp; the middle cardinal is thick, high, steep in front, and slopes off to the socket behind it; and the posterior cardinal is distinctly bifid; behind the latter is a narrow socket which is bordered on the posterior rim by a low, narrow, roughened area. The left valve shows a single, oblique anterior cardinal tooth, thickest toward its forward end, a thick middle cardinal, steep and high posteriorly, gently inclined and slightly bifid on its forward side, and a long, narrow, oblique posterior cardinal which is closely paralleled behind by a lower, narrow, roughened area; the latter stands opposite the similar roughened area in the right valve. The ligamental groove is long, narrow and deep, and the nymph is narrow and sharp-edged. There is a small and not deeply excavated lunule outlined by a faintly depressed line, but there is no well defined escutcheon other than the V-shaped excavation which permits the opening of the valves. The anterior adductor scar is elongated, and there is a small retractor scar back of its upper end: the posterior scar is small and broadly subovate. A row of small irregular pits extends from the retractor scar of each valve back to the apex of the interior under the beak. The pallial line is simple except for a broadly obtuse subangulation where the line turns up at the rear toward the posterior adductor. Dorsal margin arched; anterior margin regularly curved, starting at the beak; ventral margin broadly curved; the posterior margin is subtruncated below the midheight, obtusely subangular at the extremity, and curves rather sharply above into the posterodorsal margin; there is a slight humping of the margin back of the umbone. The surface is marked by vigorous incremental lines which become more pronounced on the posterodoral slope.

The approximate dimensions of a large, slightly crushed, figured shell from Texas, with the two valves together are: Length 102 mm., height 91 mm., thickness 60 mm.(?). The dimensions of a typical specimen, a left valve, from Owl Creek, Mississippi, are: Length 73 mm., height 65 mm., convexity about 17 mm.

The Texas shells, though poorly pre-served, appear to agree well with the typical shells from Owl Creek, Mississippi, both in outline and form, but the former are much larger. If size is to be accepted as a determinative character in separating species, the Texas shells should not be regarded as identical with the Owl Creek shells, but if large size is determined mainly by favorable environmental conditions, as appears to be true with some mollusks, the Texas shells may be referred to the Mississippi species. For the same reason Cyprimeria major Gardner, from the Monmouth formation of Maryland, may be placed in the synonymy of C. alta Conrad, for at the same stage of growth the Maryland shells are essentially identical with typical Owl Creek specimens.

The beautifully preserved shells from the Coon Creek tongue of the Ripley formation in McNairy County, Tennessee, figured by Bruce Wade under the name *C. alta* Conrad, are more compressed, more elongated, and have a more sharply developed umbonal ridge and a more sharply outlined posterodorsal area than the typical shells from Owl Creek, Mississippi; I have on a following page renamed them *Cyprimeria coonensis*, and have referred certain Texas specimens to the new species.

The type of Cyprimeria excavata (Morton) (= Cytherea excavata Morton) in the Academy of Natural Sciences of Philadelphia is badly broken, but as preserved it appears to be less inflated and proportionately shorter and higher than C. alta and probably is a distinct species. This conclusion is supported by 3 rather poorly preserved topotypes from Arneytown, New Jersey, the type locality, in the Academy collection.

Cyprimeria densata Conrad, from New Jersey, based on a large internal mold, is one of many specific names which,

owing to the incomplete preservation of the type specimen, can safely be applied only to that specimen; the mold appears to belong to a much more elongated species than *C. alta.* 

C. alta has a fairly close analogue in C. geinitzii Müller from the greensands (Lower Senonian) of the Aachen district, Germany.<sup>253</sup>

Types.—The holotype, which should be in the Academy of Natural Sciences of Philadelphia, is not listed among the Cretaceous types there and is apparently lost. This shell was originally referred by Conrad to Dosinia densata (Conrad), but was later made the type of Cyprimeria alta by the same author. The original figure is good and shells from the type locality on Owl Creek, 21/2 miles northeast of Ripley, Tippah County, Mississippi, may be readily identified with it. The figured specimens (topotypes) shown on plate 41, figures 1-3, are from the type locality in Mississippi (U.S.N.M. nos. 76664, neotype, and 76694). One large specimen (plesiotype) from Texas, showing cracks and some distortion, is figured, U.S.N.M. no. 76665.

Distribution in Texas.—Navarro group, Corsicana marl: Near Castroville (7665); near Martindale (15526); 3 7/10 miles southwest of Campbell (15547).

Navarro group, Kemp clay: 3½ miles cast of Manor (14158, 15534); 3¼ miles southeast of Manor (16142); 2 2/5 miles southeast of Manor (18196, plesiotype); near Deatsville (764); ?2½ miles north of Malta (12934).

Outside distribution.—Mississippi: Owl Creek formation of northern Mississippi and questionably Prairie Bluff chalk of east-central Mississippi.

Chattahoochee region, Alabama: Ripley formation (variety?).

Maryland: Monmouth formation.

Range.---Upper part of the Navarro group and beds of corresponding age in the Atlantic and Gulf Coastal Plain.

# CYPRIMERIA COONENSIS Stephenson, n.sp.

### Pl. 40, fig. 4

1926. Cyprimeria alta Wade, U.S.Geol. Survey Prof. Paper 137, p. 91, pl. 29, figs. 2-4; pl. 30, figs. 1, 8.

The splendidly preserved shells from Coon Creek, McNairy County, Tennessee, described and figured by Bruce Wade under the name *Cyprimeria alta* Conrad, are more clongated and more flattened in the umbonal region than typical specimens of Conrad's species. I therefore rename them.

Incomplete specimens from the Nacatoch sand near Kaufman, Kaufman County, Texas, appear to be more like the Coon Creek shells than they are like those from Owl Creek. The right valve shown in plate 40, figure 4, appears to be essentially a duplicate of right valves from the Coon Creek locality, so far as it is preserved.

The shell is large, moderately thick, subovate in outline, depressed convex. It is 91 mm. high, but its length cannot be measured; its convexity is about 25 mm. In all of its characters except its greater compression and greater elongation, it appears to be essentially like *Cyprimeria alta* Conrad.

Types.- The cotypes, a complete shell with both valves attached, and a nearly perfect left valve, from Coon Creek, McNairy County, Tennessee, are in the United States National Museum, U.S.N.M. no. 32803. One figured example from Texas, U.S.N.M. no. 76666.

Distribution in Texas.—Navarro group, Neylandville marl: Two questionably identified internal molds from 5 miles northwest of Terrell (14104).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761, 1 specimen figured); field 3/5 mile west of Kaufman (14103); 2½ miles north of Corsicana (14114).

Outside distribution.—Arkansas: Questionably in the Nacatoch sand in a dug well at Cabot in Lonoke County.

Tennessee: Coon Creek tongue of Ripley formation.

*Range.*—The range of the species is believed to be through the Neylandville

<sup>&</sup>lt;sup>253</sup>Holzapfel, Eduard, Die Mollusken der Aachener Kreide: Palaeontographica, Band 35, p. 174, pl. 12, figs. 1 4, 1889.

marI and the Nacatoch sand of the Navarro group, and through beds of corresponding age in the Gulf Coastal Plain.

#### Genus LEGUMEN Conrad

### LEGUMEN ELLIPTICUM Conrad

# Pl. 42, figs. 13-19

- 1858. Legumen ellipticus Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 325, pl. 34, fig. 19.
- b) 1 Hindelphia Sonn, 2d Sri, von 8, p. 325, pl. 34, fig. 19.
  1858. Legumen appressus Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 325.
- 1877. Legumen planulatus (Conrad). Gabh, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 304.
- 1885. Legumen ellipticum Conrad. Whitfield, U. S.Geol. Survey Mon., vol. 9. p. 184, pl. 25, fig. 5. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 184, pl. 25, fig. 5, 1886.)
- ?1885. Legumen planulatum (Conrad). Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 184 pl. 25, figs. 3, 4(?). (Geol. Survey New Jersey, Paleontology, vol. 1, p. 184, pl. 25, figs. 3, 4(?), 1886.)
- 1905. Legumen ellipticum (Conrad). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 17.
- ?1907. Legumen planulatum (Conrad). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 612, pl. 69, questionably figs. 3, 4, probably not figs. 5-7.
- 1916. Legumen planulatum (Conrad). Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 684, pl. 40, figs. 5-7.
- 1926. Legumen planulatum (Conrad). Wade, U. S.Geol. Survey Prof. Paper 137, p. 90, pl. 29, fig. 1.

Shell thin, greatly elongated, subelliptical, inequilateral, equivalve, compressed. Beaks small, not prominent, incurved, approximate, situated about onefourth the length of the shell from the anterior extremity. There is no umbonal ridge. The shell is most inflated at about the upper third of its height, and parallel to its long axis, and slopes gently toward the anterior, ventral, and posterior margins, and more steeply toward the dorsal The dental formula is 1.101010 margin. R.010101. In the left valve the two posterior cardinal teeth are long, oblique, thin, and separated by a deep narrow socket; the anterior cardinal is short, nearly vertical beneath the beak, moderately thick and slightly bifid on its inner edge, and thins wedgelike upward; a deep, wide triangular

socket lies back of the anterior cardinal and a deep, narrower socket in front of There are no lateral teeth. In the it. right valve the posterior cardinal is long, thin, oblique and deeply bifid; it is bordered behind by a long, narrow, deep socket, and in front by a wide, triangular, deep socket; the two anterior cardinals are short, thin, nearly vertical beneath the beak, and separated by a narrow, deep The ligamental groove is long socket. and narrow and is bordered below by a thin nymph. There is neither lunule nor escutcheon. The anterior adductor scar is of moderate size, subovate and situated above the midheight; the posterior adductor is large, subovate, elongate parallel to the dorsal margin, and lies high in the shell; the pallial sinus, though distinctly developed, is not profound; it lies close below the posterior adductor, pointing forward, but falls considerably short of reaching the anterior end of the adductor. The inner margin is smooth. The margins of the shell form a greatly elongated subellipse, with a slight truncation on the lower posterior margin; on account of the great elongation both the dorsal and ventral margins are nearly straight. The surface is marked only by incremental lines, which vary somewhat in their coarseness on different parts of the shell; they show a tendency to become more sharply defined toward the ventral margin, especially its forward portion; the shell is, as a rule, smoother in the umbonal region than elsewhere.

Dimensions of the right valve shown in plate 42, figure 18: Length 44.5 mm., height 19 mm., convexity 3 mm. The species exhibits considerable variation in the proportion of length to height even among specimens from the same locality.

Legumen appressum Conrad, which was described, but not figured, immediately following the original description of *L. ellipticum* Conrad, was probably a younger individual of the latter species.

Compared with Legumen concentricum Stephenson, from the Snow Hill member of the Black Creek formation in North Carolina, the concentric sculpture of this species is much finer, and the beak is a little nearer the anterior extremity, and there can be no reasonable doubt that it is specifically distinct.

Most authors have placed this species in the synonymy of Legumen planulatum (Conrad), a species based on an internal mold from "Monmouth County, New Jersey." That specimen may have come from any one of 8 or 9 Upper Cretaceous formations between the Raritan formation at the base and the Red Bank sand at the top. Within this series there is at least one other species, L. concentricum Stephenson, the internal mold of which is practically indistinguishable from that of L. ellipticum Conrad; this fact makes it impossible to demonstrate that either of these species should be regarded as synonymous with L. planulatum (Conrad), a name which can be safely applied only to the type specimen. Both L. ellipticum and L. concentricum are based on nearly perfect type material, and proof that either one is identical with L. planulatum has not been given by any of the authors who have accepted such identity.

Types.—The holotype is in the Academy of Natural Sciences of Philadelphia. The specimens figured on plate 42, figures 13-15, are topotypes from Owl Creek, Tippah County, Mississippi (U.S.N.M. nos. 76667, 76668). Plesiotypes from Texas, U.S.N.M. nos. 76669, 76670.

Distribution in Texas.---Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (14062).

Navarro group, Nacatoch sand: Road 3 5 mile west of Kaufman (7545, 12923, 14098); field 3/5 mile west of Kaufman (14103, 2 specimens figured); vicinity of Kaufman (761); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762, 1 specimen figured); loose pieces of rock in street at Chatfield (7568); field south of Chatfield (7569); 3/4 mile east of Chatfield (7571); 3/5 to 4/5 mile northeast of Chatfield (14117); 3 miles northeast of Corsicana (9545); Watkins' place 4 miles north of Corsicana (9558); 4 miles north of Corsicana (17366); north of Rock Branch 3 miles northeast of Corsicana (9560); vicinity of Corsicana (763); north edge of Corsicana (518);  $2\frac{1}{2}$  miles north of Corsicana (14114);

road 5 miles south-southwest of Corsicana (7573); 5 miles northeast of McClanahan (17371).

Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637); 14/5 miles N. 20° W. of Tona siding (15545); 5 miles southwest of Quinlan (15546); 3 7/10 miles southwest of Campbell (15547); about 5 miles east by north of Greenville (12924); 11/1 miles south by east of Oak Grove (13568, 16160).

Outside distribution.—Mississippi: Ripley formation and Owl Creek formation.

Tennessee: Coon Creek tongue of Ripley formation.

Chattahoochee region (Alabama-Georgia): Ripley formation and Providence sand (marine facies).

Maryland: Monmouth formation.

Range.---Navarro group and beds of Navarro age in the Atlantic and Gulf Coastal Plain. Representatives of the genus Legumen, generally poorly preserved, which are closely related to this species, occur in beds of Taylor age, notably in the San Miguel formation. It may therefore be found that this species ranges downward into these older beds.

# Genus TENEA Conrad

1870. Tenea Conrad, Am. Jour. Conch., vol. 6.

Type species .-- Tenea parilis Conrad.

Conrad<sup>254</sup> in February, 1860, described the species *Mysia parilis*, which he recorded as having been sent to him by Dr. W. Spillman, from Tippah County, Mississippi. Presumably the type came from Owl Creek (Owl Creek formation), 2½ miles northeast of Ripley, where Doctor Spillman obtained most of the fossils which he submitted to Doctor Conrad.

In 1870, Conrad described the new genus *Tenea* and cited *T. parilis* Conrad  $(=Mysia \ parilis$  Conrad) as the type. *Mysia parilis* Conrad was from Tippah County, Mississippi, but the shell on which he observed the hinge features described as characteristic of the genus came from the Woodbury clay at Haddonfield, New Jersey. The description of the genus

<sup>&</sup>lt;sup>254</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 278, pl. 46, fig. 17, 1360.

is therefore based on material identified as belonging to the species Tenea parilis, and not on material from the type locality of that species. Presumably the Haddonfield material was correctly referred to Tenea parilis. Although Doctor Dall, in the second edition of Eastman's translation of Zittel's Textbook of Paleontology (p. 487, 1913), listed Tenea as a genus under Diplodontidae, he had at an earlier date, 1900, correctly included it under the Veneridae<sup>255</sup> (sensu lato).

The hinge as seen in well preserved shells from the Ripley and Owl Creek formations of Mississippi is a modification of a hinge of the Cyclorisma type.<sup>256</sup> In Tenea the posterior, oblique, bifid tooth of the right valve has become so widely and deeply bifid that it has the appearance of two separated teeth; the upper end of the anterior element of this bifid tooth has become united with the upper end of the anterior cardinal tooth, and the intermediate cardinal has dropped down to an abnormally low, nearly horizontal position, and become separated from the anterior cardinal by a deep, nearly horizontal notch. In the left valve the two anterior cardinal teeth have become united at their tops to form an inverted V-shaped double tooth, and this tooth has dropped and become separated from the margin of the shell above by a narrow, deep slit; the wide, oblique socket back of the V-shaped tooth accommodates both of the widely separated elements of the bifid tooth of the right valve; the floor of this socket is slightly raised centrally. Lateral teeth are wanting. The pallial line is serrated in front of the pallial sinus; the pallial sinus is narrow, moderately high and sharply angular above. The inner margin of the shell is smooth.

### **TENEA PARILIS Conrad**

#### Pl. 42, figs. 9-12

1860. Mysia parilis Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 278, pl. 46, fig. 16. (Called Diplodonta parilis in plate explanation, p. 298.)

- 1870. Tenea parilis Conrad, Am. Jour. Conch., vol. 6, p. 73, pl. 3, fig. 12.
- ?1875. Tenea parilis Conrad, Geol. Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 8, pl. 2. fig. 25. 1884. Mysia (Tenea) parilis (Conrad). Tryon,
- Systematic and structural conchology,
- Systematic and structural conchology, vol. 3, p. 216, pl. 119, fig. 72.
  1885. *Tenea pinguis* Conrad. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 163, pl. 22, figs. 1–3. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 163, pl. 22, figs. 1–3. 1965) 1-3, 1886.)
- ?1885. Dosinia gabbi Whitfield, U.S.Geol. Survey Mon., vol. 9, p. 161, pl. 22, figs. 4, 5, (Geol. Survey New Jersey, Paleontology, vol. 1, p. 161, pl. 22, figs. 4, 5, 1886.)
   2005. The second Laboration Acad National Compared Laboration and National Acad National Compared Sciences Acad Nationacad National Compared Sciences Acad National Compared Sciences
- 1905. Tenea parilis Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 15.
  1907. Tenea parilis Conrad. Weller, New Jersey Geol. Survey, Palcontology, vol. 4, p. 572, pl. 63, figs. 1-6.
- 1916. Tenea parilis Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 661.
- 1926. Tenea parilis Conrad. Wade, U.S.Geol. Survey Prof. Paper 137, p. 83, pl. 26, fig. 1.

Shell of medium size, subcircular to broadly subovate in outline, equivalve, inequilateral, moderately ventricose, most inflated centrally above the midheight; the species exhibits considerable individual variation in outline, ranging from a little longer than high to a little higher than long. Beaks prominent, incurved, closely approximate, prosogyrate, situated about midway of the length. Margins regularly rounded, forming almost a circle. Anterior adductor scar small, elongated, situated high up toward the dorsal margin; posterior adductor scar obscure, situated low in the shell. Pallial line serrated in front of the pallial sinus which is narrow, low down in the shell, slightly inclined forward, and rises to a sharply angular terminus centrally at about the midheight. The inner margin is simple. Surface marked only by incremental lines becoming a little coarser ventrally and showing some resting stages.

Dimensions of the left valve shown in plate 42, figure 9: Length 23 mm., height 24 mm., convexity 8 mm. Dimensions of a smaller nearly perfect shell: Length 15.5 mm., height 15 mm., thickness 8.8 mm.

The types of Lucina pinguis Conrad and Mysia gibbosa Gabb, both of which have been regarded by authors as specifically

<sup>255</sup>Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1181, 1900.

<sup>&</sup>lt;sup>250</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 3, pt. 1, pp. 316-318, pl. 80, figs. 1-5, 1923.

identical with *T. parilis*, are internal molds representing a shell more inflated and more circular in outline, and not only belong to a different species, but probably to a different genus.

Types.—Conrad's types of Mysia parilis from Tippah County, Mississippi, and *Tenea parilis*, from Haddonfield, New Jersey, are preserved in the Academy of Natural Sciences of Philadelphia. Hinges from the Owl Creek formation, Owl Creek (U.S.N.M. no. 76671) and from the Ripley formation near Dumas (U.S.N.M. no. 20752), Mississippi, are figured. Two plesiotypes from Texas, U.S.N.M. no. 76672.

Distribution in Texas. --Navarro group, Neylandville marl; 2½ miles south of Ben Hur (15543); 3½ miles west-northwest of Corsicana (16166).

Navarro group, Nacatoch sand: Vicinity of Corsicana (763); north edge of Corsicana (518, 2 specimens figured); road 5 miles south-southwest of Corsicana (7573); 2½ miles north of Corsicana (14114); 4 miles north of Corsicana (17366); 2½ miles west by south of Corsicana (17368); vicinity of Chatfield (762); 6 miles southeast of Cooper (12929).

Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924).

Navarro group, Kemp clay: ?From a well near old Garfield (1641).

Outside distribution.—Arkansas: Nacatoch sand.

Tennessee: Ripley formation (Coon Creck tongue).

Mississippi: Ripley formation and Owl Creek formation.

East-central Alabama and Chattahoochce region (Alabama-Georgia): Questionably in Blufftown formation, in upper part of Ripley formation, and in Providence sand.

Maryland: Matawan formation and Monmouth formation.

New Jersey: Woodbury clay, Navesink marl, and Red Bank sand.

Range.—Ranges through the zones of Exogyra ponderosa and Exogyra costata in the Atlantic and Gulf Coastal Plain.

# Genus CYCLORISMA Dall

In its general outline and form, and in its smooth surface the one species Cyclorisma? pumila, referred to this genus is much like Conrad's genus Tenea, although much smaller. The hinge is rather incompletely exposed on several specimens and these show that the species does not belong to Tenea. The hinge is like that of Cyclorisma Dall in that the right valve possesses one strong, bifid, posterior cardinal tooth, very oblique toward the rear, a deep wide socket in front of this tooth, and two thin anterior cardinal teeth oblique forward, and separated by a narrow, deep socket; and the left valve possesses two subequal cardinal teeth under the beak, the anterior one oblique forward, the other nearly vertical, separated by a deep socket, and one distant, weak, oblique posterior cardinal, separated from the middle cardinal by a wide, oblique socket.

The species is a pigmy alongside the previously described species of *Cyclorisma* and this fact, together with its relatively thick shell, and the possession of a faintly defined lunule which is lacking on *Cyclorisma*, throws doubt on its really belonging to that genus. However, the generic relationships of the species can not be satisfactorily determined until a more complete exposure of the hinge is obtained.

## CYCLORISMA? PUMILA Stephenson, n.sp.

# Pl. 39, figs. 7, 8

Shell small, subcircular to broadly subovate in outline, equivalve, slightly inequilateral, moderately ventricose, most inflated above the midheight. Shell wall relatively thick. Beaks prominent, incurved, closely approximate, prosogyrate, situated about midway of the length. Margins regularly curved forming almost a circle. Lunule faintly but certainly defined on some specimens. Internal features not clearly exposed on any specimen, but a faint impression of the pallial sinus on one internal mold appears to indicate that it is rather small and narrow and of only moderate depth. Inner margin smooth. Surface smooth except for fine incremental lines and irregularly spaced concentric depressions which mark resting stages in growth. The hinge described above is essentially like that of *Cyclorisma* Dall.

Dimensions of the holotype: Length 7.6 mm., height 7.6 mm., thickness 5.2 mm. Dimensions of a smaller, nearly perfect shell: Length 6.4 mm., height 6.3 mm., thickness 4.1 mm.

*Types.*—Holotype, U.S.N.M. no. 76673; 2 unfigured paratypes, U.S.N.M. no. 76674; 2 unfigured paratypes, U.S.N.M. no. 76675; 1 unfigured paratype, U.S.N.M. no. 76676; about 60 unfigured paratypes, U.S.N.M. no. 76677.

Distribution in Texas.---Navarro group, Nacatoch sand: Vicinity of Chatfield (762, holotype and 60 unfigured paratypes): loose pieces of rock in street at Chatfield (7568); Watkins' place 4 miles north of Corsicana (9558); 2 miles north of Corsicana (9554, 9555); north edge of Corsicana (518); vicinity of Corsicana (763); road 5 miles south-southwest of Corsicana (7573, loc. of 2 unfigured paratypes); road 3 5 mile west of Kaufman (7545, loc. of 1 unfigured paratype; 14098); field 3/5 mile west of Kaufman (14103, loc. of 2 unfigured paratypes); vicinity of Kaufman (761).

#### Superfamily TELLINACEA

# Family TELLINIDAE

### Genus TELLINA Linné

# TELLINA MUNDA Stephenson, n.sp.

# Pl. 42, figs. 1-5

Shell of medium size, thin, subelliptical in outline, depressed convex, inequilateral, inequivalve, bent to the right posteriorly, making the left valve appear more ventricose than the right. Beaks small, nonprominent, nearly direct, slightly incurved, approximate, situated slightly back of the midlength. Hinge not uncovered. Ligamental groove short, deep, and narrow; ligament partly preserved on one specimen. Adductor scars subequal; anterior scar subovate, posterior scar subtrigonal, elongated. Pallial sinus deep, nearly horizontal, extending beyond the mid-length. The antero- and posterodorsal margins diverge from the beak at an angle of about 140 degrees, both margins being slightly arched; anterior margin sharply rounded; ventral margin very broadly rounded; posterior margin subangular below, subtruncated above, sloping forward and rounding into the posterodorsal mar-The internal mold shows 3 faint gin. shallow depressions radiating from the beak in the umbonal area, 1 extending obliquely backward and downward, and the other 2 extending less obliquely forward and downward. The surface is polished, and exhibits delicate radiating lines, and stronger thread-like concentric depressions numbering 5 to 8 to the millimeter.

An internal mold at one locality in the Kemp clay appears to differ in no essential respect from this species, except that it is a little larger than any yet found in the Nacatoch sand.

Dimensions of holotype: Length 22 mm., height 13 mm., thickness 4.3 mm.

The members of the genus *Tellina* are difficult to classify, because of their simplicity and the slight differences in form and outline that have to be depended upon in separating species. This species is characterized by its flatness and its narrow, truncated posterior margin. It is similar to *T. gabbi* Gardner, but has finer concentric sculpture and appears to be relatively more elongated.

Types.- Holotype, U.S.N.M. no. 76678; 1 figured paratype, U.S.N.M. no. 76679; 1 figured paratype, U.S.N.M. no. 76680; 4 unfigured paratypes, U.S.N.M. no. 76681.

Distribution in Texas.—Navarro group, Nacatoch sand: 1 4/5 miles northeast of Quinlan (16162); road 3/5 mile west of Kaufman (14098); road, 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762, loc. of holotype and 5 paratypes, 1 figured); loose pieces of rock in street at Chatfield (7568); ?3/5 to 4/5 mile northeast of Chatfield (14117); 3 miles northeast of Corsicana (9545); Watkins' place 4 miles north of Corsicana (17366); road 5 miles south-southwest of Corsicana (7573, loc. of 1 figured paratype); north edge of Corsicana (518).

Navarro group, Kemp clay:  $?4\frac{1}{2}$  miles northwest of Lockhart (16151).

Range.- Ranges questionably from the Nacatoch sand upward into the Kemp clay of the Navarro group.

# TELLINA? MARCOSENSIS Stephenson, n.sp.

## Pl. 41, figs. 5, 6

Shell small, subelliptical in outline, depressed convex. Beaks not preserved but obviously low and flattish, situated a little back of the midlength. Umbonal ridge faintly developed. The dorsal margins diverge from the beak at a wide obtuse angle; anterior margin sharply rounded; ventral margin broadly rounded; posterior margin subtruncated below the midheight, rounding broadly into the posterodorsal margin above. The surface is marked by two distinct kinds of sculpture. On the anterior and central parts of the shell rather strongly impressed line-like depressions are regularly spaced about half a millimeter apart and are separated by low, broad ridges which number about 10 to half a centimeter; a little back of the midlength 3 or 4 fine lines appear in each of the interspaces between the stronger lines, and within 2 mm. back of the first appearance of the fine lines, the coarser lines disappear and give place entirely to the finer lines which mark the remainder of the surface to the terminus of the shell and number 8 or 9 to the millimeter.

Dimensions: Length 12.8 mm., height 7.5 mm., convexity about 1 mm.

The species is represented by the mold of one right valve, which clearly shows the outline, form and surface sculpture, but which does not reveal the hinge or internal characters. The species may be reasonably referred to the Tellinidae but can only be provisionally referred to *Tellina. T.? patula* is a very closely related species.

Holotype.-U.S.N.M. no. 76682.

Distribution in Texas.—Navarro group, Corsicana marl: 1/2 mile below Martindale (7621).

Range.—Known only from the type locality. However, T.? patula in the Neylandville marl and in the Nacatoch sand indicates a range of this closely related group from the Neylandville marl upward into the Corsicana marl of the Navarro group.

# TELLINA? PATULA Stephenson, n.sp.

## Pl. 41, figs. 7, 8

In form and sculpture this species appears to be essentially like that of T? marcosensis except that it is more coarsely

sculptured. Although somewhat variable the impressed concentric lines average more than half a millimeter apart so that the intervening low ridges number about 3 in a width of 2 mm. This relative coarseness is also manifested in the finer lining which characterizes the posterior part of the shell. On some specimens the coarseness of the ribbing seems to decrease a little toward the ventral margin.

Approximate dimensions of the holotype, an imperfect internal mold with fragmentary shell material adhering and with concentric lines clearly impressed: Length 11 mm., height 7 mm., convexity 1 mm.

*Types.*—Holotype, U.S.N.M. no. 76683; 1 paratype, U.S.N.M. no. 76684.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, holotype; 17365); 3 miles northeast of Drane (16164, paratype).

Navarro group, Nacatoch sand: 3/5 to 4/5 mile northeast of Chatfield (14117); ?3 miles northeast of Corsicana (9545); 4 miles north of Corsicana (17366).

*Range.*—Neylandville marl and Nacatoch sand of Navarro group.

### Unidentified specimens of TELLINA

Imperfectly preserved specimens of *Tellina*, which cannot be satisfactorily identified, have been collected from the Nacatoch sand as follows:

Near Kaufman, a small elongated species, relatively more ventricose than Tellina munda, is represented by the internal mold of a right valve (761, U.S.N.M. no. 21030), by an internal mold of an individual with both valves attached (14098, U.S.N.M. no. 76685), and by the internal mold of a right valve with some shell material attached showing rather strong concentric sculpture (7545, U.S. N.M. no. 76686). From the latter locality (7545, U.S.N.M. no. 76687) is an internal mold of a left valve with some shell adhering on the umbone, which is still more ventricose and exhibits a still stronger concentric sculpture.

In a field north of the Dallas road, 3/5 mile west of Kaufman (14103) a small left valve is represented by the interior of the shell embedded in the sandstone matrix, by the internal mold of the same specimen, and by another internal mold of about the same size; this form is clongated and appears to be less ventricose than the preceding, but more ventricose than T. *munda*. U.S.N.M. no. 76688.

In the public road at Simpson's Hill, 2 miles southwest of Kaufman (7546), was found the internal mold of a large left valve, apparently of a *Tellina*, which differs from *T. munda* in that it is more elongated, more ventricose. has a pronounced umbonal ridge, and is much more pointed posteriorly. U.S.N.M. no. 76689.

Near Kaufman (761) was also found a rather large, imperfect internal mold of a *Tellina*, with shell substance partly adhering, which is rather ventricose centrally and has narrow, sharply rounded anterior and posterior extremities. The specimen does not appear to match any described species but is too imperfect to serve as a type. U.S.N.M. no. 76690.

Imperfect specimens of Tellina have been found at two localities in the Corsicana marl as follows: In a small branch below the public road, 212 miles north of Tona siding, 5 miles southwest of Quinlan (15516, U.S.N.M. no. 76691), an elongated internal and partial external mold has the characteristic form of Tellina and measures: Length 27.5 mm., height 14 mm., thickness 5 mm.; a larger internal mold from a road ditch in the westwardfacing slope of Lynne Creek valley, 3 7/10 miles southwest of Campbell, Hunt County (15547, U.S.N.M. no. 76692), is relatively higher, rather thick, has the form of Tellina, and measures: Length 36 mm., height 24 mm., thickness 11.3 mm.

A small *Tellina*-like pelecypod represented by impressions, was obtained in the Kemp clay on Elm Creek at the crossing of the Corsicana-Angus road, 3 miles south of Corsicana, Navarro County (9550); it is characterized by rather coarse, concentric markings. U.S.N.M. no. 76693.

# Genus LINEARIA Conrad

Conrad's<sup>257</sup> original description of the genus *Linearia* is brief, somewhat inaccurate, and in part contradictory. He states in the first paragraph that there are two cardinal teeth in the left valve, the anterior one elongated, very oblique, and

the posterior one under the beak, small and bifid. In the next paragraph he states, apparently inadvertently, that he has only a right valve. The description seems to pertain to a left valve.

I have not seen a left valve from the Ripley formation at Eufaula, Alabama, the type locality, but a perfectly preserved left valve, apparently of the type species, L. metastriata Conrad. from the Providence sand (marine facies) on Chattahoochee River at the mouth of Pataula Creek, about 12 miles below Eufaula, shows the hinge features clearly. There is a long, strong, anterior cardinal extending forward and a little downward, becoming thicker anteriorly; above this tooth is a long, narrow, deep socket; below the beak is a degenerate, small, short, vertical cardinal tooth, the crest of which is very faintly divided into two nodes which are hardly distinct enough to justify describing the tooth as bifid; the small tooth is separated from the large one by a deep socket opening widely toward the interior. On one left valve from Owl Creek, Mississippi, the long anterior cardinal is slightly bifid at its distal end. There are small, distant anterior and posterior laterals on the margin of the shell. A right valve from the same locality possesses two simple, elongated cardinal teeth pointing forward and a little downward. separated by a deep, narrow socket; under the beak is a very small node-like rudimentary posterior cardinal tooth; pairs of distant, short anterior and posterior claspers accommodate the laterals of the left valve. These features have been observed also on right and left valves of L. metastriata from the Owl Creek formation of Mississippi. The rudimentary posterior cardinal of the right valve is especially well shown as a very small, narrow tooth extending backward and downward, on a well preserved shell from the lower part of the Ripley formation on Coon Creek, McNairy County, Tennessee.<sup>258</sup> There is a tendency on the larger species of the genus for the small, vestigial cardinal teeth to disappear, and the same may be said of the lateral teeth and claspers.

<sup>&</sup>lt;sup>255</sup>Conrad, T. A., Acad. Nat, Sci. Philadelphia Jour., 2d ser., vol. 1, p. 279, 1860.

<sup>&</sup>lt;sup>235</sup>Wade, Bruce, U. S. Gool, Survey Prof. Paper 137, p. 93, pl. 31, figs. 1, 2, 1926.

#### LINEARIA WIESERAE Stephenson, n.sp.

### Pl. 40, fig. 8

Shell broadly subovate in outline, inequilateral, subequivalve, depressed con-Beaks poorly preserved, but apparvex. flattish, nonprominent, ently slightly prosogyrate, situated about midway of the length. The hinge is not uncovered. The shell was temporarily peeled off of the cast of the holotype and revealed subequal, broadly subovate adductor scars situated high on the inner surface; also a relatively narrow, profound pallial sinus, rather sharply rounded anteriorly, rising somewhat and reaching beyond the midlength. The antero- and posterodorsal margins diverge from the beaks at an angle of about 130 degrees; anterior margin regularly and rather broadly rounded; ventral margin very broadly and evenly rounded; posterior margin rather sharply rounded below, subtruncated above. rounding into the nearly straight, sloping posterodorsal The surface is ornamented with margin. 33 or 34 narrow, low. but sharply defined ribs which are differently spaced on different parts of the shell: one rib closely borders the posterodorsal margin and is bordered in front by a smooth, flat interspace fully 2 mm. wide; in front of this interspace 6 ribs are crowded in a space only 4 mm. wide: from this band forward a little past the midlength the ribs are 1.5 to 2 mm. apart and are separated by flat, smooth interspaces; from the preceding forward to the edge of the anterior slope the ribs are again widely spaced, numbering only 4 or 5. Each rib supports a row of small nodes, spaced at irregular intervals of 0.5 to 2 mm. Fine concentric lines of growth cover the shell and toward the front these become a little stronger and tend to produce a finely cancellated surface.

Dimensions of the holotype, a right valve: Length 34 mm., height 27.8 mm., convexity about 5.7 mm.

The ornamentation of this species resembles that of *Linearia metastriata* Conrad, the type species of the genus, in that radiating costae cover the entire surface of the shell, but this Texas shell is much larger and more coarsely sculptured, and lacks the strong development of concentric ribs exhibited by Conrad's species. *Holotype.*--U.S.N.M. no. 76695. Named in honor of Miss Frances Wieser, Illustrator, United States Geological Survey.

Distribution in Texas.---Navarro group, Nacatoch sand: Vicinity of Corsicana (763).

#### LINEARIA PECTINIS Stephenson, n.sp.

## Pl. 40, fig. 7

Shell rather large, subelliptical, inequilateral, subequivalve, depressed convex. Umbonal ridge low, subobtusely angular, rather obscure; posterior slope steeper than the anterior one. Beaks broad, low, nonprominent, situated at about the midlength. Hinge plate narrow, with a pair of strong, rather long cardinal teeth extending forward and a little downward, separated by a deep, narrow socket. There is a mere trace of a degenerate third cardinal tooth under the beak. Lateral claspers appear to be wanting. Ligamental groove long, narrow, bordered by a narrow, well developed nymph. Internal features not uncovered. The antero- and posterodorsal margins diverge from the beak at an angle of about 145 degrees. Anterior margin rather sharply rounded, meeting the dorsal margin above at a subobtuse angle, and rounding regularly into the lower margin; ventral margin very broadly rounded, nearly straight centrally; posterior margin subtruncated, the truncation sloping upward and a little backward, subangular both above and below. Posterior slope and umbonal ridge ornamented with 12 or 14 irregularly serrated ribs, those on the ridge, and 2 or 3 bordering the dorsal margin, being the smaller; the fifth rib from the dorsal margin is the largest and appears to mark an obscure subangulation of the posterior slope. The anterior slope bears about 15 faint, closely spaced ribs, and still fainter and more closely spaced ribs can barely be seen over that part of the remainder of the surface, the shell of which is preserved. Internal molds show faint ribbing over all of the surface in front of the umbonal ridge; the posterior slope of each rib is short and steep, and the anterior slope is long and gentle; on the posterior slope of the shell there is a tendency for each rib to rise more prominently along the posterior side of its gentle anterior slope.

The shell is covered with concentric growth lines, and there is a coarse development of concentric ridges toward the ventral margin.

Dimensions of the holotype: Length 34 mm., height 22 mm., convexity about 6 mm.

This shell is not apt to be confused with any previously described species of *Linearia*.

*Types.*—Holotype, U.S.N.M. no. 76696; 2 unfigured paratypes, U.S.N.M. no. 76697.

Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637, type lot; 15524);  $\frac{1}{2}$ mile below Martindale (7621).

# LINEARIA CRIBELLI Stephenson, n.sp.

### Pl. 42, fig. 8

Shell small, subelliptical, elongate, subequilateral, subcquivalve, depressed convex. Posterior slope a little steeper than the anterior one. Beaks small, broad, nonprominent, situated about 0.55 the length of the shell from the anterior extremity. Hinge plate obscure as preserved, but obviously narrow, and it possesses the characteristic pair of long cardinal teeth extending forward and gently downward, and separated by a deep, narrow socket. Internal characters not uncovered. The dorsal margins slope from the beak at an angle of about 145 degrees; anterior margin incomplete but apparently sharply rounded a little above the midheight; ventral margin very broadly rounded; posterior margin rather sharply rounded below, weakly subtruncated above. The surface is covered with closely spaced, fine, radial ribs which are closest together centrally, a little wider apart on the anterior slope, and still wider apart on the posterior slope. On the holotype these ribs appear over most of the surface as narrow ridges on the internal mold, but fragments of shell adhering indicate that the ribs are wider than the interspaces. The radial ribs are crossed by regularly, but much more widely spaced, narrow, concentric ridges which appear to be less prominent than the ribs; on the mold the ribs and ridges cut the surface up into tiny rectangles whose long dimensions are radial.

Dimensions of the incomplete holotype, a right valve: Length 17 + mm., height 12.5 mm., convexity about 2.5 mm.

Only one specimen of this species, a right valve, is available for study, and it is scarcely adequate to serve as type. However, the type locality is accessible and there should be little difficulty in securing additional better preserved material. The nearest described ally of this species is *Linearia metastriata* Conrad, on which the concentric ridges are more prominent and more closely spaced, and the radiating ribs on the posterior and anterior slopes are apparently more prominent and more strongly noded.

Holotype .-- U.S.N.M. no. 76698.

Distribution in Texas.---Navarro group, Corsicana marl: 1/2 mile below Martindale (7621).

### LINEARIA NAVARROANA Stephenson, n.sp.

# Pl. 42, figs. 6, 7

Shell of medium size, subelliptical in outline, inequilateral, equivalve, moderately ventricose. Umbonal ridge faintly developed, broadly rounded. Greatest ventricosity above the midheight, about at the midlength. Posterior slope steeper than the anterior slope. Beaks broad, incurved, moderately prominent, apparently slightly prosogyrate, situated about two-thirds the length of the shell from the anterior extremity. Hinge not uncovered. Adductor scars moderately large, subequal. The internal mold shows 2 narrow, faint, radiating depressions on the anterodorsal slope, one a little below the margin and the other about midway of the slope. On the posterior slope a broad, shallow depression extends from the beak to the margin, just back of the umbonal ridge; this shows best on the internal mold. The dorsal margins diverge from the beaks at an angle of about 130 degrees; anterodorsal margin long, nearly straight, and slightly inclined; anterior margin sharply rounded a little below the midheight, rounding broadly into the margins above and below; ventral margin very broadly rounded; posterior margin subtruncated, the straightened part sloping upward and a little backward, subangular

below, rounding rather broadly above into the steeply inclined posterodorsal margin. The surface of the shell is smooth with the exception of fine growth lines.

Dimensions of the holotype, a right valve: Length about 20.3 mm., height 12.8 mm., convexity about 3.5 mm.

This species belongs to a group of smooth shells of the genus *Linearia*, to which Conrad<sup>259</sup> gave the subgeneric name *Liothyris*, typified by *Linearia carolinensis* Conrad from the Snow Hill member of the Black Creek formation of the Carolinas. Inasmuch as species exist which show nearly all gradations from strongly costate to smooth surfaces, with essential identity of hinge characters, the subgeneric name hardly seems necessary for the smooth species.

Linearia navarroana is similar to L. carolinensis Conrad, but is smaller, relatively more elongated, and more ventricose.

Types.—Holotype, U.S.N.M. no. 76699; 1 figured paratype, U.S.N.M. no. 76700; 1 unfigured paratype, U.S.N.M. no. 76701.

Distribution in Texas.—Navarro group, Nacatoch sand: <sup>3</sup>/<sub>4</sub> mile east of Chatfield (7571, figured paratype); <sup>1</sup>/<sub>2</sub> mile east of Chatfield (7570, holotype).

# Unidentified specimens of LINEARIA

A fragment of a left valve of Linearia, from the Nacatoch sand near Corsicana, Navarro County (518), shows the umbonal area and part of the anterior outer surface, and the cardinal portion of the hinge (pl. 41, fig. 9). The hinge shows a strongly developed, typical anterior cardinal tooth of the genus. The outer surface is ornamented with about 38 narrow, distinct ribs with wider interspaces, each rib carrying rows of irregularly developed nodes which are most strongly developed and most widely spaced on the ribs of the anterior slope; on the main part of the shell these nodes are small and closely spaced; the ribs are strongest and most widely spaced on the anterior slope, less strong and somewhat closer together on the weakly developed umbonal ridge, and fine and closely set over the remainder of the surface. The shell is closely related to *L. wieserae*, from which it appears to differ in having finer, sharper, and more closely spaced ribs. U.S.N.M. no. 20949.

Two small internal molds which may represent two species of smooth *Linearia* were found in the Nacatoch sand on Rock Branch on the Walton lease of the Houston Oil Company, <sup>1</sup>/<sub>2</sub> mile north of the Corsicana-Chatfield road, 3 miles northeast of Corsicana, Navarro County (9545). U.S.N.M. no. 76702.

A fragment of an internal mold of a *Linearia*, showing an impression of the sculpture, was found in the Corsicana marl in a branch on the Wm. H. Moore Survey, 6 miles east by north of Greenville, Hunt County (12924). The shell is small, relatively plump, and is covered with a fine, cancellated sculpture produced by uniformly spaced, radiating and concentric ribs. The sculpture resembles that of *L. metastriata* Conrad, but the shell appears to be too ventricose for that species. U.S.N.M. no. 76703.

Several imperfectly preserved specimens of a small species of *Linearia*, with a trace of the shell substance adhering, were obtained from the Corsicana marl, from the left bank of San Marcos River, 1/2 mile below Martindale, Caldwell County (15527).The sculpture consists of fine, sharp, regularly spaced, concentric lirae, numbering 5 or 6 to the millimeter, narrower than the interspaces, over the main surface, 5 or 6 radiating costae, much narrower than the interspaces, on the anterodorsal slope, and a dozen or more radiating costae, narrower than the interspaces, on the posterodorsal slope. U.S.N.M. no. 76704.

# Genus SOLYMA Conrad

Conrad,<sup>260</sup> in 1870, described the genus Solyma from near Haddonfield, New Jersey, a locality which was later correlated with the Woodbury clay, the second formation above the base of the Matawan

<sup>&</sup>lt;sup>259</sup>Conrad, T. A., Geol, Survey North Carolina Rept., vol. 1 (by W. C. Kerr), App. A, p. 9, pl. 1, figs. 20, 23, 24, 1875,

<sup>209</sup> Conrad, T. A., Amer. Jour. Conch., vol. 6, p. 75, 1870.

group. The horizon of the type locality is therefore low in the *Exogyra ponderosa* zone, corresponding in age to the lower part of the Taylor marl of Texas. The genus is based on the species *Solyma lineolatus* Conrad.

Whitfield.<sup>261</sup> in 1885, placed the genus under the family Solenidae, as did also Weller<sup>262</sup> in 1907. Gardner<sup>263</sup> in 1916, referred the genus to the Psammobiidae. The genus appears to me to be rather far removed from both the Solenidae and the Psammobiidae, and in form, internal characters, and hinge characters, to be closely related to *Tellina* and *Linearia* in the family Tellinidae.

Anatina elliptica Gabb<sup>264</sup> from Mullica Hill, New Jersey, appears to be a member of this genus.

#### SOLYMA GARDNERAE Stephenson, n.sp.

# Pl. 43, figs. 6, 7

1916. Solyma lineolata Conrad. Gardner. Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 701, pl. 36, figs. 20, 21. (In part.)

Shell thin, subovate in outline, depressed convex, inequilateral, subequivalve. Beaks nonprominent, broad, incurved, prosogyrate, approximate, situated two-fifths the length of the shell from the anterior extremity. A faint umbonal ridge extends to the lower posterior extremity; the most inflated part of the shell is above the midheight and about at the midlength. The posterior part of the shell is higher than the anterior part. The shell is bent very slightly to the left posteriorly, and is slightly gaping both anteriorly and posteriorly. The hinge is not exposed on the only two Texas specimens available for study. The type species of the genus, Solyma lineolatus Conrad, from Haddonfield, New Jersey, shows in the right valve

two nearly vertical, sharply defined cardinal teeth, convex forward in trend, separated by a deep, narrow curved socket. Lunule narrow, excavated, bordered by a sharp, slightly overhanging carina; the left side is broader than the Escutcheon long, narrow, excaright. vated, outlined by sharp, bordering edges. Ligamental groove narrow, deep, extending back more than half the length of the posterodorsal margin. Pallial sinus, as faintly discernible on the internal mold, wide, profound, broadly rounded on the inner end. The antero- and posterodorsal margins slope gently away from the beaks at a very broad, obtuse angle; anterior margin sharply rounded; ventral margin very broadly rounded, nearly straight centrally; posterior margin subtruncated, subangular both above and below. Surface marked by fine growth lines and by gentle, irregularly spaced growth undulations. No radiating sculpture appears on the outer shell surface, but the internal mold exhibits faint radiating lines.

Dimensions of the holotype: Length 27.8 mm., height 17.6 mm., thickness 9 mm.

Doctor Gardner identified the Chatfield specimen as Solyma lineolatus Conrad, and figured it as an example of that species. Although there is a close similarity in form between the Chatfield and Haddonfield shells, the former is proportionately less elongated and its beaks appear to be less prominent, and situated farther forward on the dorsal margin. In view of the difference in stratigraphic position, and the wide geographic separation of the two localities, it seems reasonable to regard the Texas shell as specifically distinct. One internal mold from the Nevlandville marl near Cooper, Delta County, is questionably referred to this species.

*Types.*—Holotype, U.S.N.M. no. 21048; 1 unfigured paratype, U.S.N.M. no. 76705. Named in honor of Dr. Julia Gardner.

Distribution in Texas.—Navarro group, Neylandville marl: ?<sup>1</sup>/<sub>2</sub> mile north of Cooper (14062).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.).

<sup>&</sup>lt;sup>251</sup>Whitfield, R. P., U. S. Gool. Survey Mon., vol. 9, p. 182, 1885.

<sup>&</sup>lt;sup>202</sup>Weller, Stuart, Geol. Survey New Jersey, Paleontology, vol. 4, p. 629, 1907.

<sup>&</sup>lt;sup>203</sup>Gardner, Julia A., Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 701, 1916.

<sup>&</sup>lt;sup>294</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 324, 1861.

### SOLYMA? PARVA Stephenson, n.sp.

# Pl. 43, figs. 18, 19

Shell small, thin, subovate in outline, moderately convex. inequilateral, equivalve. Most inflated above the midheight and a little back of the midlength; posterior slope steeper than anterior slope; posterodorsal slope steep. Beaks moderately prominent, incurved, prosogyrate, approximate, situated slightly back of the midlength. Hinge not uncovered. Adductor scars and pallial line obscure on the mold. Numerous faint radiating lines appear on the mold: they are broadly curved in trend, with the concavity toward the front. Anterodorsal margin sloping, nearly straight; anterior margin sharply rounded above the midheight; ventral margin broadly rounded, fullest anteriorly: posterior margin less sharply rounded than the anterior, rounding above into the broadly arched posterodorsal margin. Surface marked by 13 or 14 concentric, round-topped, regularly spaced ridges or undulations, which are narrower than the interspaces, and tend to smooth out toward the ventral margin.

Dimensions of the holotype, an internal mold of both valves, with a little shell material adhering in the umbonal region: Length 9.5 mm., height 6.5 mm., thickness 3.8 mm.

There are only two specimens of this species, the holotype, and the internal mold of a right valve with some shell material adhering. The generic relations cannot be determined from these specimens, but there is a suggestion of a pair of cardinal teeth below the beak on the frail, incompletely uncovered hinge of the right valve, resembling the teeth of Solvma.

Types.-Holotype, U.S.N.M. no. 76706: 1 unfigured paratype, U.S.N.M. no. 76707.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

# Superfamily SOLENACEA

#### Family SOLENIDAE

# Genus LEPTOSOLEN Conrad

# LEPTOSOLEN BIPLICATUS Conrad

# Pl. 43, figs. 4, 5

- 1858. Siliquaria biplicata Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 324, pl. 34, fig. 17.
- 1867. Leptosolen biplicata Conrad, Am. Jour. Conch., vol. 3, pp. 15, 188.
  1868. Leptosolen biplicatus Conrad. Conrad, in Cook, Geology of New Jersey, p. 727.
  1885. Leptosolen biplicata Conrad. Whitfield, U.
- S. Geol. Survey Mon., vol. 9, p. 183, pl. 25, figs. 1, 2. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 183, pl. 25, figs. 1, 2, 1886.)
- 1905. Leptosolen biplicata Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 17.
- 1907. Leptosolen biplicata Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 624, pl. 70, figs. 30, 31.
- 1916. Leptosolen biplicata Conrad. Gardner, Maryland Geol. Survey, Upper Creta-ceous (2 vols.), p. 703, pl. 42, figs. 7, 8.
- 1923. Leptosolen biplicatus Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 332, pl. 85, figs. 10–13. 1926. Leptosolen biplicata Conrad. Wade, U.S.
- Geol. Survey Prof. Paper 137, p. 94, pl. 31, figs. 4, 7.

Shell thin, greatly elongated, subrectangular in outline, inequilateral, equivalve. moderately and evenly convex from the longitude of the beak backward to the extremity, thus producing a wide open gape at the posterior extremity, compressed and less widely gaping at the anterior extremity; the greatest ventricosity is above midheight, which causes the shell to round down sharply to the dorsal margin; a low, broadly rounded swell extends from the beak to the lower anterior extremity, and is bordered on either side by a broad, shallow sulcus; there is a suggestion of a very broad, very shallow, widely flaring depression extending from the beak backward and downward to the ventral margin. Beaks small, low, nonprojecting, incurved, slightly prosogyrate, situated 0.25 to 0.28 the length of the shell from the anterior extremity. There is a slight, broad swell of the umbonal region above the level of the dorsal margin. Hinge of left valve, as seen in well preserved shells from the type locality on Owl Creek in Tippah County, Mississippi, with one paddle-like cardinal tooth which stands out prominently from the hinge line: the front side of this paddle is nearly vertical, though sloping slightly backward, and the back side is supported by a calcareous buttress or prop. Hinge of right valve with one prominent cardinal tooth similar to that in the left valve, with. however, its flat surface facing posteriorly and its supporting buttress on the front side; when the two valves are joined the flat surface of the right and left valves oppose each other. Ligamental groove narrow, deep, extending about one-third the distance to the posterior end of the hinge line. Nymph narrow and thin-edged but standing up prominently. A prominent internal rib or callosity extends from below the beak downward and slightly backward, fading out toward the ventral margin; a thin platform extends obliquely backward and upward from the dorsal end of this rib and is fused against the under side of the hinge plate, producing a deep recess under the platform at the upper end of the rib. Anterior adductor scar rather large, subtrigonal, situated just in front of the internal rib; posterior adductor small, distant, subovate. Pallial line high above the ventral margin, connecting the lower margins of the two adductor scars.

Anterodorsal margin short, broadly arched: anterior margin subtruncated, obtusely subangular above and below; ventral margin long, straight, rounding up broadly in front, and more sharply behind; posterior margin subtruncated, rounding rather evenly into the margins above and below; posterodorsal margin long, straight.

Surface divided rather sharply into two subequal areas along a line extending from the beak, backward and downward to the lower posterior extremity; in front of the separating line the surface is marked only by fine concentric growth lines which are a little more sharply defined anteriorly; back of the separating line the surface presents flatly compressed, overlapping, concentric lamellac whose edges are somewhat irregularly spaced half a millimeter to 2 mm. apart; faintly developed radial lines may be detected on the anterior portion of some individuals, especially on the radial swell which extends from the beak to the lower anterior extremity.

Dimensions of the left valve shown in plate 43, figure 4: Length 54 mm., height 19 mm., convexity about 5 mm.

The Texas representatives of this species exhibit some variation in form with a tendency toward a slightly greater height in proportion to the length than is shown by typical shells from Mississippi, but the difference does not appear to be either pronounced or constant enough to justify their specific or varietal separation. The species is of common occurrence in the Navarro group and its equivalents in the Atlantic and Gulf Coastal Plain.

Types.—Holotype, Academy of Natural Sciences of Philadelphia; from the Owl Creek formation. Topotypes are in the collections of the U.S. National Museum. U.S.N.M. no. 21170. Two plesiotypes from Texas, U.S.N.M. no. 76708.

Distribution in Texas.--Navarro group. Neylandville marl: 2½ miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103); field 2 miles southwest of Kaufman (7547); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762); field south of Chatfield (7569); 3 miles northeast of Corsicana (9545); north edge of Corsicana (518); vicinity of Corsicana (763, 2 specimens figured); road 5 miles south-southwest of Corsicana (7573).

Navarro group, Kemp elay:  $3\frac{1}{2}$  miles northwest of Bazette (12922);  $4\frac{1}{2}$  miles northwest of Lockhart (15528).

Outside distribution.—Arkansas: Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Ripley formation, and Owl Creek formation.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Eutaw formation, Blufftown formation, Cusseta sand, Ripley formation (upper part), and Providence sand. North Carolina: Snow Hill member of Black Creek formation and Peedee formation (upper part).

Maryland: Monmouth formation.

New Jersey: Magothy formation, Merchantville clay, Woodbury clay, Wenonah sand, Navesink marl, and Red Bank sand.

Range.—In Texas the species has not been found below the Navarro group, but in the Atlantic and eastern Gulf Coastal Plain the range is reported to be through the zones of *Exogyra ponderosa* and *E. costata*, that is, through the equivalents of the upper Austin chalk, the Taylor marl, and the Navarro group.

# LEPTOSOLEN? QUADRILATERUS Stephenson, n.sp.

### Pl. 43, fig. 1

Shell small, thin, greatly clongated, moderately convex, strongly inequilateral, equivalve, widely gaping posteriorly, probably slightly gaping anteriorly; anterior slope short and steep; greatest convexity a little above the midheight, from which the shell rounds over rather sharply to the posterodorsal margin, and more gently down to the ventral margin. Beaks small, nonprominent, poorly preserved in the holotype, situated about 2 nim. back of the anterior extremity. Hinge not uncovered. Internal features obscure with the exception of the strong, vertical rib, the deep impression of which on the internal mold extends downward from the beak to the ventral margin near the an-The anterior margin terior extremity. rounds regularly up to the beak, and rather sharply down into the ventral margin; ventral margin not completely preserved, but apparently nearly straight, perhaps very broadly convex; posterior margin squarely truncate, subangular above and below; the posterodorsal slope exhibits flatly compressed, finely, but irregularly spaced, sharp-edged growth lamellae.

Dimensions of the holotype, a right valve: Length 14.6 mm., height 5.9 mm., convexity about 1.5 mm.

One specimen only of this species is available. Leptosolen elongata Weller<sup>265</sup>

is a closely related species, but the Texas species appears to be more slender and more squarely truncate.

Holotype.--U.S.N.M. no. 76709.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

### LEPTOSOLEN? LINGULIFORMIS Stephenson, n.sp.

# Pl. 43, fig. 3

Shell rather small, subrectangular in outline, greatly elongated, depressed convex, strongly inequilateral, probably equivalve. Beaks small, nonprominent, slightly incurved, situated about 0.15 the length of the shell from the anterior extremity. Hinge not preserved. The imprint of a nearly vertical internal rib may be seen extending from the beak downward nearly to the ventral margin. Other internal characters not preserved. The anterior margin is rather sharply but regularly rounded; ventral margin long and nearly straight, but swelling slightly downward; posterior margin subtruncated nearly vertically, rounding sharply into the ventral margin, and less sharply into the dorsal margin above; posterodorsal margin long, broadly arched. Surface with only fine incremental lines.

Dimensions of the holotype, the imprint of a right valve: Length 19.3 mm., height about 9 mm., convexity about 1.5 mm.

This species is represented by one imprint only. Compared with *Leptosolen quadrilaterus* it is proportionately higher, the ventral and dorsal margins are not so straight, and the posterior margin is less squarely truncated.

Holotype .--- U.S.N.M. no. 76710.

Distribution in Texas.—Navarro group, Corsicana marl: 2 4/5 miles east of Cooledge (13832).

# LEPTOSOLEN? LEVIS Stephenson, n.sp.

### Pl. 43, fig. 2

Shell small, moderately clongated, moderately convex, strongly inequilateral, equivalve, apparently gaping slightly posteriorly; umbonal ridge pronounced, subangular toward the beak, becoming weaker and rounding off toward the lower posterior extremity; anterior slope steep, greatest convexity above the midheight and

<sup>&</sup>lt;sup>265</sup>Weller, Stuart, Geol, Survey New Jersey, Paleontology, vol. 4, p. 627, pl. 70, figs. 27, 28, 1907.

a little back of the umbone; posterior slope long and gentle; posterodorsal slope Beaks rather broad, strongly insteep. curved, prosogyrate, approximate, situated about one-sixth the length of the shell from the anterior extremity. Hinge not uncovered. On the internal mold the impression of a moderately strong internal rib extends from the beak downward and a little forward nearly to the ventral margin. Anterior margin rather sharply rounded at the midheight, rounding regularly upward to the beak and downward to the lower margin; ventral margin very broadly rounded, nearly straight centrally; posterior margin subangular low down toward the terminus of the ventral margin, broadly subtruncated above, inclined a little forward, meeting the margin above at a subobtuse angle; posterodorsal margin long, nearly straight anteriorly, becoming broadly arched posteriorly. Surface as shown by the mold nearly smooth, with the exception of gentle, irregular growth undulations.

Dimensions of the holotype, a right valve: Length 13.3 mm., height 6.5 mm., convexity about 2.5 mm.

The species is based on two internal molds of right valves and an internal mold of a left valve. *Leptosolen? terminalis* Weller,<sup>266</sup> from the Merchantsville clay marl, near Jamesburg, New Jersey, is a similar species but appears to be less broadly truncated posteriorly, and the posterior margin rounds much more broadly into the dorsal margin. These differences and the markedly different stratigraphic position of the Texas material justify its specific separation. The form of this species is so markedly different from the typical *Leptosolen* that its generic identity may be reasonably doubted.

Types.—Holotype, U.S.N.M. no. 76711; 1 unfigured paratype, U.S.N.M. no. 76712; 1 unfigured paratype, U.S.N.M. no. 20970.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, paratype); road 2 miles southwest of Kaufman (7546, paratype); 3/5 to 4/5 mile northeast of Chatfield (14117, holotype).

# Superfamily MACTRACEA

Family MACTRIDAE

# Genus CYMBOPHORA Gabb

### CYMBOPHORA SCABELLUM Stephenson, n.sp.

# Pl. 43, figs. 8, 9

Shell very thin, of moderate size, subtrapezoidal in outline, moderately convex, inequilateral, equivalve; umbonal ridge distinct, extending to the lower posterior extremity; anterodorsal margin steep, rounded; posterodorsal margin less steep, bending downward, slightly and broadly excavated between the umbonal ridge and the margin. Beaks moderately prominent, rather broad, incurved, slightly prosogyrate, approximate, situated about 2/5 the length of the shell from the anterior extremity. Hinge not uncovered. Ligament internal. Adductor scars only faintly impressed on the internal mold, but apparently small, subovate, situated above the midheight. Pallial line faint, but the pallial sinus, which is fairly distinct on the internal mold, is wide open behind, broadly rounded in front, extending to about midway of the length below the midheight. Anterodorsal margin descending, nearly straight in front of the beak, rounding broadly into the rather sharply rounded anterior margin; ventral margin very broadly rounded, nearly straight centrally; posterior margin subangular below, subtruncated above, inclined forward, rounding broadly into the dorsal margin; posterodorsal margin broadly somewhat arched. inclined. Surface marked by fine incremental lines which show some irregularity in strength of development; well preserved shells show regular, very fine, closely spaced, concentric ribs on the umbone.

Dimensions of the holotype, a left valve shown in Plate 43, figure 8: Length 27 mm., height 18 mm., convexity about 5.5 mm.

This shell occurs abundantly in the Nacatoch sand. It is proportionately less elongated than *Cymbophora appressa* Gabb from the Providence sand (marine facies) on Pataula Creek, Clay County, Georgia; it is also more inflated and is broader posteriorly in the direction of the height than Gabb's species.

<sup>&</sup>lt;sup>200</sup>Weller, Stuart, Geol. Survey New Jersey, Paleontology, vol. 4, p. 626, pl. 70, fig. 29, 1907.

The specimens figured by Weller<sup>267</sup> under the name Schizodesma appressa Gabb, from the Wenovah sand of New Jersey (his figs. 14–16, 20), appear to be more coarsely sculptured, and to have narrower and more prominent umbones than the Texas shells. The internal mold from the Cliffwood clay (his fig. 20) resembles the Texas shells in form except that the posterior truncation is more nearly vertical. It is doubtful if these stratigraphically lower and older shells are specifically identified with those from Texas. Of the two specimens from Texas which he figured (figs. 17, 18, and 19), one (fig. 19) is here regarded as belonging to *Cymbophora scabellum*; the other is treated as a new species, Cymbophora subtilis.

Types.—Holotype, U.S.N.M. no. 76713; 1 figured paratype, U.S.N.M. no. 76714; 1 unfigured paratype, U.S.N.M. no. 21054.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761); road 3/5 mile west of Kaufman (7515, 12923, 14098); field 3/5 mile west of Kaufman (14103, type loc.); field 2 miles southwest of Kaufman (7547); road 2 miles southwest of Kaufman (7546, 14099); vicinity of Chatfield (762); field south of Chatfield (7569); 2 miles north of Corsicana (9554); vicinity of Corsicana (763); road 5 miles south-southwest of Corsicana (7573); 2½ miles north of Corsicana (14114.)

#### CYMBOPHORA SUBTILIS Stephenson, n.sp.

#### Pl. 43, fig. 11

1907. Schizodesma appressa Gabb. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 634, pl. 71, figs. 17, 18 (not figs. 14– 16, 19 21).

Shell very thin, of moderate size, subtrigonal in outline, moderately convex, inequilateral, equivalve; umbonal ridge distinct, but not pronounced; anterodorsal margin steep, a little excavated near the margin back of the beaks; posterodorsal slope less steep, excavated slightly between the umbonal ridge and the margin. The species exhibits considerable individual variation in form and outline. Umbonal region rather narrow. Beaks prominent, incurved, slightly prosogyrate, approximate, situated slightly in advance of the midlength. Hinge not uncovered. Ligament internal. Pallial sinus low, relatively narrow, horizontal, broadly rounded in front, scarcely extending to the midlength. Anterodorsal margin slightly arched; anterior margin rather sharply rounded; ventral margin broadly rounded, becoming nearly straight posteriorly; posterior margin sharply rounded below with a suggestion of a subtruncation above, which inclines forward; posterodorsal margin gently arched. The surface presents fine, closely packed, fairly regular, concentric ridges which tend to become a little coarser toward the margins.

Dimensions of the holotype, a nearly complete internal mold with some shell material adhering: Length 20.5 mm., height 15 mm., thickness 8.5 mm.

Compared with Cymbophora scabellum, this species is shorter, has narrower, more pointed, and prominent beaks, and is more sharply pointed posteriorly. The species is similar in form to the specimens from the Wenonah sand of New Jersey, figured by Weller under the name Schizodesma appressa Gabb (his figs. 14–16, 20), but the sculpture of the Texas specimens appears to be much finer. The different individuals exhibit considerable variation in form and the longer ones are separable with difficulty from the shorter variations of Cymbophora scabellum.

The few specimens from the Neylandville marl are all smaller than the adults in the Nacatoch sand, but appear to be indistinguishable from the younger stages in that formation.

This species is more finely sculptured than the shell from Coon Creek, Tennessee, described by Wade<sup>268</sup> under the name *C. gracilis* (Meek and Hayden). The Texas species, although closely related to Meek and Hayden's species, is specifically distinct.

Types.—Holotype, U.S.N.M. no. 76715; this specimen was figured by Weller under the name Schizodesma appressa Gabb. (See synonymy.) Ten unfigured paratypes, U.S.N.M. no. 76716. One unfigured paratype selected for pallial sinus, U.S.N.M. no. 76717.

<sup>&</sup>lt;sup>207</sup>Weller, Stuart, Geel, Survey New Jersey, Paleontology, vol. 4, p. 634, figs. 14-16, 20, 1907,

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<sup>&</sup>lt;sup>208</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 98, pl. 31, fig. 8, 1926.

Distribution in Texas.--Navarro group, Neylandville marl:  $3\frac{1}{2}$  miles west-northwest of Corsicana (16166); Corsicana road,  $2\frac{1}{2}$  miles due north of Corbet (16170);  $\frac{1}{2}$  mile north of Cooper (14062).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761, loc. of holotype and 10 paratypes); road 3/5 mile west of Kaufman (7545, 12923, 14098); field 3/5 mile west of Kaufman (14103, locality of 1 paratype); road 2 miles southwest of Kaufman (7546); field 2 miles southwest of Kaufman (7547); 3 miles northeast of Corsicana (9545); north of Rock Branch, 3 miles northeast of Corsicana (9560); 2½ miles north of Corsicana (14114); vicinity of Corsicana (763); road 5 miles south-southwest of Corsicana (7573); 4 miles north of Corsicana (17366).

Navarro group, Kemp clay: ?4 miles southeast of Zorn (10877).

*Range.*—The species as recognized ranges from the Neylandville marl through the Nacatoch sand and questionably into the Kemp clay.

# CYMBOPHORA CANCELLOSA Stephenson, n.sp.

### Pl. 43, figs. 13-15

Shell of moderate size and thickness, subtrigonal in outline, moderately convex, slightly inequilateral, equivalve; umbonal ridge obscure; dorsal slopes steep, the anterior one a little excavated in front of the beak, the posterior one rounded. Beaks prominent, incurved, slightly prosogyrate, approximate, situated subcentrally. Hinge not uncovered. Under each beak is a triangular slit which extends obliquely backward to the margin. Adductor scars as impressed on internal mold, subequal, subovate, of moderate size. Pallial line obscure; pallial sinus distinctly impressed on some internal molds, narrow, ascending, sharply rounded in front, extending nearly to the midlength and midheight. Anterodorsal margin descending with moderate steepness, slightly arched; anterior margin sharply rounded at about the midheight: ventral margin broadly and evenly rounded; posterior margin a little less sharply rounded than the anterior; posterodorsal margin rather steep, broadly arched. The surface is compactly ornamented with distinct concentric ribs; toward the beaks

these ribs are quite small, are separated by mere thread-like lines, and number 8 to 12 or more to the millimeter; from the beaks outward the ribs increase regularly in size until near the margin they number only about 2 to the millimeter; with increasing distance from the beaks the interspaces widen out gradually until near the margin they are wider than the ribs, and several fine growth lines can be seen in each of them on well preserved surfaces; though the ribs are all somewhat rounded on their crests they show a tendency to become a little more angular toward the margin. The ribs cover all the surface except a narrow, radiating band on the obscure umbonal ridge, which is smooth except for growth lines and, on some specimens, 2 or 3 very obscure radiating lines. On the dorsal slopes the ribs are coarser and less numerous than they are on the main shell surface; one of these larger ribs represents 2 or 3 of the smaller ribs; the line of separation between the two types of ribbing is marked on the anterodorsal slope by an impressed, fairly distinct line, and on the posterodorsal slope by the smoother band on the umbonal ridge.

Dimensions of the holotype, a left valve which is slightly flattened and elongated by mechanical pressure: Length 25 mm., height 17.8 mm., convexity 5.5 mm.

This species has in the past been confused with *Cymbophora lintea* (Conrad). The type of Conrad's species was found in the Ripley formation at Eufaula, Alabama,<sup>260</sup> and should be preserved in the Academy of Natural Sciences of Philadelphia, but it is apparently lost. Compared with Conrad's original figure, the Texas species appears to average larger in size, is more coarsely sculptured, and lacks a radiating, shallow depression extending from the beak to the ventral margin just in front of the umbonal ridge.

Compared with *C. trigonalis* Stephenson, a closely related species from the Snow Hill member of the Black Creek formation of North Carolina, the Texas species has slightly coarser concentric sculpture, with interspaces not so deep, and the ornamentation is well developed nearly to the beak. The species is less elongated, more

<sup>&</sup>lt;sup>2020</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 273, pl. 46, fig. 17, 1860.

trigonal in outline, and more coarsely sculptured, than either *C. scabellum* or *C. subtilis*. The narrow ascending pallial sinus is also a distinguishing feature of this species.

Types.—Holotype, U.S.N.M. no. 76718; 1 figured paratype, U.S.N.M. no. 76719; 14 selected unfigured paratypes, U.S.N.M. no. 76720.

Distribution in Texas.—Navarro group, Nacatoch sand: Loose pieces of rock in street at Chatfield (7568); 2 miles north of Corsicana (8554, 9557); 2½ miles north of Corsicana (14114); vicinity of Corsicana (763, 1 paratype figured); north edge of Corsicana (518, loc. of holotype and 14 selected paratypes); road 5 miles south-southwest of Corsicana (7573).

Navarro group, Kemp clay: ?Brazos River, 2 miles above Milam County line (13776).

Range.--Nacatoch sand, questionably ranging upward into the Kemp clay, of the Navarro group.

# CYMBOPHORA BERRYI Gardner

#### Pl. 43, fig. 10

### 1916. Spisula (Cymbophora) berryi Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 708, pl. 43, figs. 2, 3.

Shell of moderate size and thickness, having a trigonal form closely similar in outline and degree of inflation to that of C. cancellosa. The species differs from C. cancellosa chiefly in its smoother surface features. It is marked on the main part of the shell by irregular growth lines, low ridges, and gentle undulations, which tend to become a little coarser toward the margin. On the dorsal slopes the concentric sculpture appears as regular ridges much coarser than the growth markings of the main part of the shell, and in the wider interspaces are fine growth lines; on the umbonal ridge is a roughened, radial, slightly impressed band set off by obscure marginal lines, having a maximum width of about 3 mm.; a distinctly impressed line or sulcus separates the sculpture of the anterodorsal slope from that of the main shell. The triangular marginal slit below the beak is sharply defined and well preserved.

Dimensions of the figured shell from Texas: Length 22 mm., height 16.4 mm., convexity 5.5 mm.

The figured specimen from Texas has been compared with the type of *C. berryi* Gardner, from the Monmouth formation at Brightseat, Prince Georges County, Maryland, and no basis can be detected for a specific separation.

*Holotype.*—The holotype is on deposit in the U.S. National Museum. Plesiotype from Texas, U.S.N.M. no. 76721.

Distribution in Texas. -Navarro group, Nacatoch sand: Vicinity of Kaufman (761, figured); northeast of Quinlan (16162).

Outside distribution.-Maryland: Monmouth formation.

Range.—Nacatoch sand of the Navarro group. Outside of Texas recorded only from the Monmouth formation (*Exogyra* costata zone) in Maryland.

### CYMBOPHORA INFLATA Stephenson, n.sp.

### Pl. 43, figs. 16, 17

Shell large, subtrigonal, rather strongly inflated, inequilateral. The shell has suffered a slight mechanical flattening in the umbonal region, but the greatest inflation appears to be a little above the midheight and slightly back of the midlength, from which point the surface rounds down regularly toward the ventral and anterior margins; the umbonal ridge is expressed by a faint subobtuse angulation where the surface of the main disk joins the posterodorsal slope; the anterodorsal slope is steep and becomes markedly excavated toward the beak; the posterodorsal slope is steep and broadly arched, and becomes slightly excavated toward the beak; it is traversed by a very faint radial ridge a few millimeters behind the umbonal ridge. The available material includes the internal and external molds of one large incomplete left valve; none of the shell substance is preserved. Beaks prominent, strongly incurved, prosogyrate, situated slightly in advance of the midlength. The hinge and internal features are not clearly exposed, but the form of the shell is such as to justify referring it to Cymbophora. Anterodorsal margin apparently very broadly arched; anterior margin sharply rounded; ventral margin broadly rounded;

posterior margin subangular below at the end of the ambonal ridge, subtruncated above this angulation, rounding above into the broadly arched posterodorsal margin. Surface nearly smooth, apparently marked only by growth lines and slight undulations, which, however, become noticeably coarser on the posterodorsal slope.

Approximate dimensions of the holotype: Length 73 mm., height 62 mm., convexity 19 mm.

Holotype.-U.S.N.M. no. 76722.

Distribution in Texas.—Navarro group, Nacatoch sand: 14/5 miles northeast of Quinlan (16162).

# CYMBOPHORA? SIMPSONENSIS Stephenson, n.sp.

### Pl. 43, fig. 12

Shell rather large, elongated, subelliptical in outline, moderately convex, inequilateral, probably equivalve; greatest inflation above the midheight, in front of the midlength. slightly back of the anterodorsal slope moderately beak: steep, rounded; umbonal ridge distinct, obtusely angular, extending to the lower end of the posterior truncation; posterodorsal slope divided into two flattish to slightly excavated radial bands expanding outwardly, by a ridge similar to the umbonal ridge. extending from the beak to the upper end of the posterior truncation. Beaks broad, incurved, strongly prosogyrate, approximate, situated about one-fourth the length of the shell from the anterior extremity. Hinge not sufficiently uncovered for description. Adductor scars obscure. Pallial sinus faint but discernible on the mold; it is wide, short, and broadly rounded in front, and is similar to that of Cymbophora scabellum, though more ascending. The anterior margin is rather sharply rounded above the midheight, and rounds up regularly to the beak; ventral margin very broadly rounded centrally, curving up regularly in front, and toward the rear turning up more abruptly and becoming subtruncated below and in front of the end of the umbonal ridge; posterior margin subtruncated with a forward inclination; posterodorsal margin long, a little inclined, broadly arched. The internal mold reflects gentle, irregular growth undulations, and fragments of the shell near the dorsal margin indicate a surface marked by fine, rather sharp growth ridges; the mold also reflects a faint radiating line extending from the beak to the front end of the posterobasal truncation.

Dimensions of the holotype, the internal mold of a left valve: Length 36 mm., height 23 mm., convexity about 8 mm.

Great longitudinal prolongation and the strongly prosogyrate character of the beaks characterize this species. In form it strongly resembles the genus *Etea*, but the pallial sinus and poorly preserved features along the dorsal margin indicate that it belongs elsewhere. It is questionably referred to *Cymbophora*. The available material is hardly adequate for specific description, but there should be little difficulty in identifying well preserved specimens of the same species from the type locality.

Several poorly preserved specimens from the type locality appear to be proportionately still more elongated and flatter than the holotype, but are tentatively referred to the species because of the known individual variation of the members of this group. Fragments of shell adhering to these specimens indicate a nearly smooth shell with fine, rather sharp growth lines.

Types.—Holotype, U.S.N. M. no. 76723; 3 unfigured paratypes, U.S.N.M. no. 76724.

Distribution in Texas.---Navarro group, Nacatoch sand: Road 2 miles southwest of Kaufman (7546, type loc.); field south of Chatfield (7569); 3-5 to 4/5 mile northeast of Chatfield (7572).

### Unidentified specimens of CYMBOPHORA

A small imperfect right valve from the Corsicana marl in a branch below the public road,  $2\frac{1}{2}$  miles north of Tona siding, in Hunt County (15546), is trigonal in form, in this respect resembling *C. cancellosa*, but the surface features are poorly preserved. U.S.N.M. no. 76725.

Specimens of *Cymbophora* have been obtained from the Kemp clay as indicated below. In the left bank of Colorado

at Webberville, Travis County River (7601, U.S.N.M. no. 76726), a badly crushed, elongated, nearly smooth shell exhibiting only fine growth lines. In a road ditch 3/5 mile west of Elm Creek School, 41/2 miles northwest of Lockhart U.S.N.M. no. 76727), three (15528,crushed, imperfect molds of a large species resembling Cymbophora inflata, but too imperfect for identification; this species is trigonal in form, apparently smooth, and is probably not less than 70 mm. long and 60 mm. high. At the same locality (16151, U.S.N.M. no. 76728), a small trigonal species resembling C. cancellosa in size, form, and outline but with surface features obliterated; at the same locality (16151, U.S.N.M. no. 76729) is a poorly preserved specimen resembling C. appressa (Gabb) in outline, but apparently more inflated.

### Superfamily MYACEA

#### Family CORBULIDAE

#### Genus CORBULA Lamarck

#### CORBULA CRASSIPLICA Gabb

#### Pl. 44, figs. 16, 17

- 1860. Corbula crassiplica Gabb, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 394, pl. 68, fig. 25.
- 1885. Corbula crassiplica Gabb. Whitfield, U.S. Geol. Survey Mon., vol. 9, p. 178, pl. 23, fig. 30.
- 1907. Corbula crassiplica Gabb. Weller, Geol. Survey New Jersey, Palcontology, vol. 4, p. 641, pl. 72, figs. 27, 28.
- 1916. Corbula crassiplica Gabb. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 713, pl. 43, figs. 6, 7.
  1926. Corbula crassiplica Gabb. Wade, U.S.Geol.
- 1926. Corbula crassiplica Gabb. Wade, U.S.Geol. Survey Prof. Paper 137, p. 96, pl. 31, figs. 9, 13.

Shell small, relatively thick, subtrigonal in outline, inequilateral, markedly inequivalve, strongly convex anteriorly, sharply compressed posteriorly. Right valve strongly humped above the midheight, a little in front of the beak, anterodorsal slope very steep to overhanging; posterodorsal slope very steep, overhanging and excavated; a sulcus separates the narrow, compressed posterior area from the main strongly ribbed surface. The left valve is much smaller and less inflated and fits well within the right valve whose margins

are strongly overlapping. Beak of right valve broad, very prominent, strongly incurved, overhanging, slightly prosogyrate, situated about 2/5 the length of the shell from the anterior extremity. Beak of left valve nonprominent, incurved, slightly prosogyrate, situated slightly in advance of the midlength; the high, prominent overhanging beak of the right valve dominates the low beak of the left valve. Hinge of right valve with one prominent upcurved tooth below the beak, behind which is a wide, profound socket for the reception of the condrophore of the left valve. In the Texas material the internal features are obscure and the hinge of the left valve was not observed.

The anterodorsal margin of the right valve is arched and rounds downward into the rather sharply rounded anterior margin; ventral margin broadly rounded becoming a little concave just back of the posterior end; posterior margin squarely truncated, the truncation making almost a right angle with the ventral margin below, and an obtuse angle with the dorsal margin above; posterodorsal margin con-The surface of the right cave upward. valve appears to be smooth for about a millimeter outward from the beak, beyond which it becomes broken into strong, round-crested, concentric ribs: near the beak these ribs are small and may be a little crowded, but as a rule they quickly become larger and are separated by deep interspaces that vary from a little narrower to much wider than the ribs; these ribs are strongly developed all over the anterior and main surface of the shell, but end abruptly at the narrow, radiating sulcus just in front of the umbonal ridge; they show a slight uproll and vary in strength and width of interspace and exhibit considerable individual variation. The slightly excavated, sinuous, posterior dorsal slope is ornamented with coarse growth lines which, toward the truncated terminus, break up into thin overlapping laminae which are generally poorly preserved or become damaged as the matrix is separated from the shell. In contrast to the right valve the left valve lacks prominent concentric ribs and is ornamented

only with coarse growth lines; it is strikingly different from the right valve and seen alone, might readily be taken for a separate species; it is set well down within the overlapping right valve. On the inner surface of the right valve between the end of the left valve and the posterior truncation is a ridge of irregular trend, approximately parallel to the truncation, with a sort of V-shaped projection toward the rear near the center.

Dimensions of the right valve shown in plate 44, figure 16: Length 6 mm., height 4.6 mm., convexity about 2.5 mm. Some of the larger individuals attain as much as 8 mm. in length.

The Texas shells have been compared with topotypes from the Coon Creek tongue of the Ripley formation, in a cut of the Southern Railway <sup>3</sup>/<sub>4</sub> mile west of Wenasoga, near the Tennessee State line, Alcorn County, Mississippi. Both the topotypes and the Texas shells exhibit considerable individual variation in the strength and spacing of their concentric ribs.

*Types.*—The type material should be in the collection of the Academy of Natural Sciences of Philadelphia, but is missing there. Plesiotypes from Texas, U.S.N.M. no. 76730.

Distribution in Texas.—Taylor marl: Small arroyo 2¼ miles south of San Marcos, 1/3 mile east of San Marcos-Staples road, Hays County (7617); Austin-Manor road, 1/5 mile east of Big Walnut Creek, Travis County (12893).

Wolfe City sand member of Taylor marl: Cotton Belt Railroad (G.C.&S.F.) east by north of Wolfe City, Hunt County, 1 mile (5325),  $1\frac{1}{2}$  miles (9710), 2 miles (9709), and  $2\frac{1}{5}$  miles (9708).

Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (4064, 5318, 7509, 14062);  $2^{1}/_{2}$  miles northeast of Royce City (16157); 1 mile east of Gastonia (7550).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761); road 3/5 mile west of Kaufman (14098, plesiotypes); field 3/5 mile west of Kaufman (14103); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762); field south of Chatfield (7569);  $\frac{3}{4}$  mile east of Chatfield (7571);  $\frac{3}{5}$  to  $\frac{4}{5}$  mile northeast of Chatfield (7572).

Navarro group, Corsicana marl: 5 miles southwest of Quinlan (15546); Onion Creek, 2½ miles west of old Garfield (14049, 14156); ½ mile below Martindale (7621, 15527); 2 miles east of Marion (Tex. Bu. 2395); well 7/20 mile south by west of St. Mary's University, Bexar County (16353, 16408).

Navarro group, Kemp clay: 4 miles south of Manor (Tex. Bu. 2399); 2 miles north-northwest of Deatsville (14128); vicinity of Webberville (Hill coll. 8): near Deatsville (764, 14125); well near old Garfield (1641).

Outside distribution.—Arkansas: Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Coffee sand and Ripley formation.

Alabama: Blufftown formation.

East-central Alabama and Chattahoochee region (Alabama-Georgia): Blufftown formation, Ripley formation, and Providence sand.

Maryland: Monmouth formation.

New Jersey: Merchantville clay, Woodbury clay, Wenonah sand, Navesink marl, and Red Bank sand.

Range.—Ranges through the zones of *Exogyra ponderosa* and *Exogyra costata* in the Atlantic and Gulf Coastal Plain.

### CORBULA WILLIARDI Wade

### Pl. 44, fig. 14

1926. Corbula williardi Wade, U.S.Geol. Survey Prof. Paper 137, p. 97, pl. 31, figs. 17, 18.

The species is represented in Texas by two right valves. These specimens, though small, are a little larger than the holotype; they are subtrigonal in outline, rather thick-shelled, and strongly ventricose; the greatest inflation is toward the front above the midheight; anterodorsal slope high, steep and slightly overhanging; umbonal ridge subangular, sinuous, bordered in front by a broad, shallow radial depression; a similar shallow radial depression occurs toward the front part of the shell; posterodorsal slope steep,

forming an excavated, sinuous, radial band, bordered below by the umbonal ridge and above by a round-crested ridge whose upper slope descends steeply to the dorsal margin. The holotype from Tennessee is only about 3.5 mm. long. Beak of right valve strongly prominent, strongly incurved, prosogyrate, situated at about the midlength. Hinge and internal features not uncovered. Posterodorsal margin slightly arched; anterior margin sharply rounded; ventral margin broadly rounded centrally, becoming slightly concave toward each extremity; posterior margin truncated vertically, slightly concave, angulated at each end of the trunposterodorsal margin slightly cation; concave. Main surface of right valve covered with strong, round-crested, concentric ribs which are wider than the moderately deep interspaces; these ribs have a maximum spacing of about 4 to the millimeter near the margin, but become progressively smaller toward the beak, practically disappearing before the tip of the beak is reached; the concentric ribs smooth out linearly as they cross the umbonal ridge, but reappear on the posterodorsal slope in smaller, more closely packed, and somewhat more irregular development. The left valve, as seen in the holotype, is smaller and less ventricose than the right valve, but is similarly sculptured.

Dimensions of the specimen shown in plate 44, figure 14: Length 4.9 mm., height 3.9 mm., convexity about 1.5 mm.

The right valve of *Corbula williardi* Wade is similar in its sculpture to that of *C. crassiplica* Gabb and to that of *C. crassiplica navarroana* Stephenson, but is smaller and much more finely marked; the strong sculpture of the left valve is in contrast to that of the smooth left valves of the species and variety named. This statement is based on the holotype, as no left valves have been found in Texas.

Corbula perbrevis Conrad, from North Carolina, is a larger, longer, and more coarsely sculptured species.

Types.—Holotype, U.S.N.M. no. 32816, from the Coon Creek tongue of the Ripley formation, Coon Creek, Dave Weeks' place, McNairy County, Tennessee. Plesiotype from Texas, U.S.N.M. no. 76731.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, 1 specimen figured);  $2\frac{1}{2}$  miles west by south of Corsicana (17368).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

Range.—Known only from the type locality in Tennessee, and from near Kaufman, Texas. The Coon Creek tongue is believed to be stratigraphically a little lower and older than the Nacatoch sand.

# CORBULA TORTA Stephenson, n.sp.

# Pl. 44, figs. 18-20

Right valve small, thick, subtrigonal in outline, strongly convex, inequilateral. The anterior part of the valve is swollen almost to overhanging at about the midheight, and the anterodorsal slope is steep and overhanging; a broad radial depression just back of the swollen portion extends to the ventral margin; the strongest inflation is midway of the length and height; at about the midheight there is a sharp change to a steeper slope which curves strongly down to the ventral margin, suggesting a senile condition; the posterior end of the valve is sharply constricted. The posterodorsal slope is steep and forms a well defined, slightly excavated, sinuous band which twists sharply as it approaches the short, truncated, posterior extremity; laterally this band joins the main surface of the shell at a subangle forming a narrow, sinuous umbonal ridge. Anterodorsal margin arched; anterior margin sharply rounded; ventral margin broadly rounded and gently sinuous; posterior margin short and truncated; posterodorsal margin broadly excavated. Beak strongly incurved, situated slightly in advance of the midlength; it is slightly crushed but appears to be weakly prosogyrate. Hinge and internal features not uncovered. As preserved the surface of the umbonal region is smooth; a little above the midheight very fine, concentric ribs appear and are followed below to the ventral margin by progressively stronger and coarser ribs which number 4 or 5 to the millimeter just above the margin; the

ribs are broadly sinuous on the anterior half of the shell; they fade out posteriorly before reaching the umbonal ridge.

Dimensions of the holotype: Length 5 mm., height 3.8 mm., convexity about 2.5 mm.

The description is based on one right valve only. The species does not appear to be closely related to any described species, but bears some resemblance to *Corbula williardi* Wade; the posterodorsal area differs, however, in that it is sharply twisted upward as it approaches the posterior extremity.

Holotype.---U.S.N.M. no. 76732.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (Tex. Bu. 17300).

### CORBULA ROCKENSIS Stephenson, n.sp.

### Pl. 44, fig. 15

Shell small, moderately thick, subtrigonal in outline, moderately clongated, inequilateral, inequivalve, strongly convex. Anterodorsal slope high and overhanging; umbonal ridge angular, sinuous; posterodorsal slope forming a steep, sinuous, slightly excavated band, bounded above by a crudely developed radial ridge with a steep, slightly excavated slope on the marginal side. The greatest inflation is toward the front and the posterior part becomes narrow and compressed. A broad, very shallow radial sulcation extends to the ventral margin just in front of the umbonal ridge. Beak of right valve broad, prominent, strongly inrolled, prosogyrate, situated about 5/8 the length of the shell from the anterior extremity. Hinge and internal features not uncovered. Anterodorsal margin long, broadly arched, slightly inclined; anterior margin sharply rounded; ventral margin broadly rounded, slightly sinuous, becoming a little concave near the rear end; posterior margin squarely truncated, angular above and below; posterodorsal margin rather strongly concave. The surface is smooth near the beak, but at a distance of 2 or 3 mm. from the beak, becomes concentrically ribbed, at first finely so, passing progressively to stronger and coarser ribs toward the margin. Very faint, fine, radial ribs can be detected in front of the umbonal ridge on the holotype, but these fade out within 2 or 3 mm. toward the front. Several left valves provisionally referred to this species are less inflated, more pointed posteriorly, and have similar concentric sculpture.

Dimensions of the holotype, a right valve: Length 8 mm., height 5.5 mm., convexity 2.5 mm.

Material from several localities identified with this species show some individual variation in outline and sculpture; some specimens are proportionately shorter than the holotype, and some are less coarsely sculptured; faint radiating costae, like those in front of the umbonal ridge on the holotype, may be detected in a similar position on several other shells, but on others radial markings appear to be want-This species is similar in form to ing. Corbula subradiata texana, on both valves of which, however, radial markings are more strongly developed, and concentric sculpture appears to be consistently finer.

Types.—Holotype, U.S.N.M. no. 76733; 1 unfigured paratype, U.S.N.M. no. 76734.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762); field south of Chatfield (7569); 3 miles northeast of Corsicana (9545, type loc.); vicinity of Corsicana (763); road 5 miles south-southwest of Corsicana (7573); 1 4/5 miles northeast of Quinlan (16162).

*Range.*—Known only from the Neylandville marl and the Nacatoch sand of the Navarro group.

### CORBULA SUBRADIATA TEXANA Stephenson, n.var.

Pl. 44, figs. 21, 22

Shell small, moderately thick, subtrigonal in outline, moderately convex, inequilateral, inequivalve; greatest inflation about midway of the length, above the midheight; anterodorsal slope steep, rounded; umbonal ridge angular, slightly sinuous; on the right valve a broad, shallow, radial depression lies just in front of the umbonal ridge and extends to the margin; posterodorsal slope of right valve forming a steep, sinuous, slightly excavated band, bordered above by the margin of the shell; same slope of left valve similar but less sinuous and less excavated. Beaks moderately prominent, incurved, slightly prosogyrate, situated a little back Hinge and internal of the midlength. features not uncovered. Anterodorsal margin broadly arched, rounding into the rather sharply rounded anterior margin; ventral margin broadly rounded, becoming nearly straight to slightly concave toward the distal end; posterior margin sharply truncated, the truncation sloping a little forward; posterodorsal margin slightly arched. Very faint, fine, rather closely spaced radiating lines formed by rows of microscopic punctations may be detected under strong magnification over most of the surface of the holotype. The lines on the forward part of the shell are finer than those farther back; the lines are obscure or wanting on the dorsal slopes. This obscure radial ornamentation is present on left valves, but the strength of the lines is variable on different individuals. The concentric sculpture of both valves is very fine, becoming smooth toward the beak.

Dimensions of the holotype, a right valve: Length 7.6 mm., height 5.2 mm., convexity about 2.5 mm.

Corbula subradiata Gardner,270 from the Monmouth formation at Brightseat, Maryland, is closely related to this Texas form, but it exhibits a less sinuous, smoother, posterodorsal area which is noticeably subdivided by a minor radial ridge, and has still finer radial lines and punctations; the latter were not mentioned in the original description. The holotype, which is on deposit in the National Museum, is badly broken. The specimens from the Brooks estate near Seat Pleasant, Maryland, represented by Gardner's figures 9-12, are more coarsely sculptured and appear to represent a different species or variety.

Types.—Holotype, U.S.N.M. no. 76735; 1 figured paratype, U.S.N.M. no. 76736; 1 unfigured paratype, U.S.N.M. no. 76737.

Distribution.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762); road 7½ to 8½ miles north by cast of Corsicana (7567); 3 miles northeast of Corsicana (9545, 1 paratype figured); vicinity of Corsicana (763); road 5 miles southsouthwest of Corsicana (7573, loc. of holotype and 1 unfigured paratype); 4 miles north of Corsicana (17366).

# CORBULA LINTEROIDEA Stephenson, n.sp.

# Pl. 44, figs. 11-13

Shell small, moderately thick, subtrigonal in outline, moderately convex, inequilateral, slightly inequivalve; a broad, slight, radial swell extends to the lower anterior extremity; umbonal ridge sharply angular. Main part of shell between the radial swell and the umbonal ridge slightly flattened, and the surface just in front of the lower end of the umbonal ridge is slightly excavated; posterodorsal slope steep, forming an excavated radial band which warps up to form a keel at the upper distal margin; on the right valve the upper margin of this band is bordered by a low carina which extends from the beak to the upper end of the posterior truncation; there is no corresponding ridge on the left valve. Left valve slightly overlapped and inclosed by the right valve. Beaks broad, flattened, incurved, prosogyrate, approximate, situated a little in advance of the midlength. The hinge of one left valve is exposed and shows a flattened chondrophore in front of which is a profound pit for the reception of the cardinal tooth of the right valve; the chondrophore is divided into two unequal parts by an impressed line or sulcus extending from the beak backward and downward to the inner margin; the posterior of the two parts is the smaller and narrower and distally supports a small node or tooth. The anterior adductor scar is imperfectly preserved; the posterior adductor is subovate and of moderate size, is situated on an upraised platform, and is bordered along its forward side by an upraised rim or carina. The pallial sinus is very shallow, consisting of a nearly vertical line concave outward. Anterodorsal margin broadly arched: anterior margin somewhat sharply rounded; ventral margin broadly rounded, becoming slightly concave near the posterior end; posterior margin sharply angular to pointed below, subtruncated above with the truncation inclined strongly forward; posterodorsal margin slightly arched. The surface is ornamented with rather sharp, somewhat irregular concentric ridges, separated by shallow, broader depressions.

<sup>&</sup>lt;sup>270</sup>Gardner, Julia, Maryland Geol, Survey, Upper Cretaceous (2 vols.), p. 718, pl. 44, figs. 13-15 (figs. 9-12), 1916.

Radial lines are faintly observable in front of the umbonal ridge on both valves in a band about 1.5 mm. wide.

Dimensions of the holotype, a shell with both valves attached: Length 6.5 mm., height about 4.7 mm., thickness 3.2 mm.

Compared with Corbula rockensis this species is less ventricose anteriorly, is less compressed posteriorly, is more finely sculptured, and is less squarely truncated posteriorly. This species contrasts with C. subradiata texana in the absence of radial ribs with the exception of the faint lines in front of the umbonal ridge, and in having a more prominent, more sharply angular umbonal ridge. The Texas species lacks the well developed radial sculpture of C. subradiata Gardner, from the Monmouth formation of Maryland, and also lacks the broad, shallow, radial sulcus which extends all the way from the beak, to the ventral margin in front of the umbonal ridge in that species. C. woodi is more coarsely sculptured and has a less prominent umbonal ridge. All of the species compared belong to a closely related group of Corbulas having radial sculpture more or less clearly developed.

*Types.*—Holotype, U.S.N.M. no. 76738; 5 unfigured paratypes, U.S.N.M. no. 76739.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); 2 miles north of Corsicana (9554): 4 miles north of Corsicana (17366).

# CORBULA WOODI Stephenson, n.sp.

# Pl. 44, figs. 6, 7

The species is represented by 2 individuals, one a young shell. Shell small, subovate in outline, moderately ventricose, inequilateral, inequivalve. The greatest inflation is about midway of the shell and a little above the midheight. The anterodorsal slope overhangs the margin somewhat, just in front of the beak. The anterior of the shell slopes forward rather gradually, and the posterior is compressed. The posterodorsal slope of the left valve is strongly excavated by a radial depression as indicated on the internal mold, while the corresponding slope of the right valve appears to be rather plump. The shell is broken away along the umbonal ridges, but an obtusely subangular, curved, somewhat sinuous ridge appears on the internal mold of the left valve. Beaks moderately prominent, the right one a little higher than the left, broad, incurved. approximate, slightly prosogyrate, situated about 0.55 the length of the shell from the anterior extremity. Hinge not uncovered. Posterior adductor scar of moderate size, subcircular, situated high in the shell. Anterodorsal margin broadly arched; anterior margin sharply rounded; ventral margin broadly rounded; posterior margin with a short, square truncation; posterodorsal margin short, slightly concave. Surface marked by rather coarse, somewhat irregular, concentric ridges, and by very faint radiating lines which can be seen on both valves.

Dimensions of the holotype: Length 9.2 mm., height 6.5 mm., thickness 4.1 mm.

Compared with *C. rockensis* the shell of this species is more regular, less humped and less ventricose posteriorly, and is not quite so coarsely sculptured; *C. subradiata texana* is more strongly humped, more finely sculptured, and has stronger radiating lines on the left valve; *C. linteroidea* is much more finely sculptured, and has a sharper, more angular umbonal ridge.

Types.—Holotype, U.S.N.M. no. 76740; 1 unfigured paratype, U.S.N.M. no. 76741. Named for the Hon. George T. Wood, Governor of Texas, 1847-1849.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, loc. of holotype); 2 miles north of Corsicana (9554, loc. of paratype).

### CORBULA INFLATA Stephenson, n.sp.

### Pl. 44, figs. 9, 10

Right valve small, thin, subtrigonal in outline, about as high as long, strongly inflated, inequilateral, protruding noticeably toward the lower anterior extremity; greatest inflation at about the midheight, a little in front of the midlength; anterodorsal slope very high and steep, overhanging, rounded; umbonal ridge sharply rounded to subangular; shell just in front of umbonal ridge full and plump above, becoming slightly excavated below; posterodorsal slope high, steep, sinuous, overhanging. Left valve very much less inflated than the right, and having a very much lower, nonprominent beak. Beak of right valve very prominent, strongly incurved, slightly prosogyrate, situated a little back of the midlength. Hinge and internal features not observed. Anterodorsal margin slightly arched; anterior margin sharply rounded below the midheight; ventral margin broadly rounded, becoming slightly concave near the posterior extremity; posterior margin with a short, squarish truncation, nearly vertical, subangular below and above; posterodorsal margin concave. In the available material the surface appears to be smooth with the exception of very fine growth lines.

Dimensions of the holotype: Length 4 mm., height 3.5 mm., convexity about 2.2 mm.

This smooth, strikingly inflated species, is unlike any species heretofore described from the Upper Cretaceous of the Atlantic and Gulf Coastal Plain.

Types.—Holotype, U.S.N.M. no. 76742; 7 paratypes, right valves, more or less imperfectly preserved, and one imperfect paratype with the two valves attached, all unfigured (U.S.N.M. no. 21018).

Distribution in Texas. -Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); road 3/5 mile west of Kaufman (14098); field 3/5 mile west of Kaufman (14103); 3/5 to 4/5 mile northeast of Chatfield (14117).

# Unidentified specimens of CORBULA

In the Neylandville marl, in a cut of the Texas Midland Railroad, half a mile north of Cooper, Delta County (14052), a calcareous concretion yielded the internal and external molds of the right valve of a small, smooth, moderately ventricose, elongated *Corbula* having a moderately distinct, angular, umbonal ridge, and a squarish posterior truncation sloping a little forward. The material is hardly adequate to serve as a type. U.S.N.M. no. 76743. In the same formation on the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170), one specimen of a poorly preserved, short, inflated *Corbula* was found in a concretion with other fossils. U.S.N.M. no. 76744.

Poorly preserved Corbulas, apparently different from any of the described species, were found in the Nacatoch sand at two localities. Near Kaufman (761, U.S.N.M. no. 21033), the internal mold of a right valve pertains to an elongated, moderately convex species with beaks a little back of the midlength, and with a compressed. narrow, squarely truncated, protruding posterior extremity (pl. 44, fig. 8); there is a suppressed sinuous umbonal ridge, and such of the surface as is preserved indicates a moderately strong concentric sculpture. On the Dallas road 3/5 mile west of Kaufman (7515, U.S.N.M. no. 76745), 3 broken left valves indicate an elongated, moderately convex, trigonal, coarsely sculptured species, with beaks well in advance of the midlength, with the umboual ridge strong and subangular, and the posterior end pointed.

An exposure of the Kemp clay in the left bank of Colorado River at Webberville, Travis County (7601), yielded one left valve of a small, short, smooth, inflated *Corbula* having a sinuous, nonprominent umbonal ridge, and a square posterior extremity; the specimen might well be the left valve of a species like *C. inflata* but in the absence of right valves, and on account of its higher stratigraphic position, its reference to that species is not justified. U.S.N.M. no. 76746.

The poorly preserved internal molds of two undetermined species of *Corbula* were obtained from the Kemp clay in a road ditch 3/5 mile west of Elm Creek School,  $4\frac{1}{2}$  miles northwest of Lockhart, Caldwell County (16151, U.S.N.M. nos. 76747, 76748). What appears to be the same species as the larger of the two preceding species was obtained in washes in a field east of the Luling-San Marcos highway,  $3\frac{1}{5}$  miles north-northwest of Fentress, Caldwell County (16149, U.S.N.M. no. 76749).

# Family SAXICAVIDAE

Genus PANOPE Menard

PANOPE SUBPLICATA Shumard

Pl. 45, figs. 3-6

1861. Panopaea subplicata Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 199.
1928. Panope subplicata (Shumard). Adkins, Univ. Texas Bull. 2838, p. 171.

Shell large, subparallelogrammatic, but variable in outline, inequilateral, equivalve, rather strongly ventricose, gaping slightly in front, gaping widely behind; the maximum inflation is above the midheight and extends from below and a little in front of the beaks backward to the extremity; anterodorsal slopes steep in front of the beaks, flattening out toward the anterior and dorsal margins; a broad, shallow to obscure sulcation extends from the beak obliquely backward and downward to the lower end of the posterior truncation. Beaks only moderately prominent, strongly incurved, approximate, slightly prosogyrate, situated about 2/5 the length of the shell from the anterior extremity. In most of the available material the anterior part of the shell is a little higher than the posterior part. The proportion of length to breadth varies markedly in different individuals, the shell just described probably being proportionately longer than the average. One left valve from near Corsicana is 75 mm. long and 45 mm. high. Hinge of right valve with one short, prominent cardinal tooth standing in front of a profound trigonal socket for the reception of the tooth of the left valve; hinge of left valve with a short, very prominent cardinal tooth, thick below, narrowing to a thin edge above; behind the cardinal tooth is a narrow oblique cleft, and in front of the tooth a deep socket for the reception of the cardinal of the right valve. Nymph short, strong, projecting, bordered by a narrow ligamental groove. Other internal features obscure in the available material. Antero- and posterodorsal margins horizontal, forming a continuous, nearly straight line; anterior margin subtruncated, slightly convex, the truncation inclined a little forward, rounding broadly into the dorsal margin above, and rather

sharply into the ventral margin below; ventral margin nearly straight, slightly sinuous or irregular; posterior margin truncated, the truncation inclining upward and backward, rounding broadly into the basal margin and rather sharply into the dorsal margin above.

The surface is covered with coarse, irregular growth lines and undulations; in a limited area toward the beak the undulations become fairly regular; the undulations are coarser where they round down from the main surface of the shell to the anterodorsal slope. One of the shells from Chatfield (pl. 45, fig. 3) shows on the well preserved part of the surface toward the beak, very faint radiating lines spaced 3 or 4 to the millimeter, each line set with tiny nodes spaced 4 or 5 to the millimeter. These are features not noted by previous authors though similar lines and nodes are present on a specimen from Coon Creek, Tennessee, figured by Wade as P. decisa Conrad, and on Gardner's type of P. monmouthensis from Brightseat, Marvland. The same features are beautifully shown on well preserved shells of the genus from the Owl Creek formation of northern Mississippi; the rows of nodes are traceable out from the beak for a distance of 15 to 20 mm., beyond which the nodes are not arranged in rows, but become scattered indiscriminately and in great numbers over the surface; they become more widely spaced toward the margin of the shell. On the types of P. decisa (internal molds) the small nodes, if originally present, are not preserved.

Dimensions of an adult shell with both valves attached (pl. 45, figs. 5, 6): Length 99 mm., height 54 mm., thickness about 39 mm.

Panope subplicata was described, but not illustrated, by Shumard, and the type material is not known to have been preserved. Two imperfect specimens have been found near Chatfield. Navarro County, the type locality of the species, one of which is designated neotype; the other specimen is the internal mold of a left valve with considerable shell material adhering about the umbo and along the dorsal margin (pl. 45, fig. 4). The type of *Panope decisa* Conrad.<sup>271</sup> compared with *P. subplicata*, has the beaks a little nearer the anterior end, and the posterior truncation is a little steeper. The specimen marked type and the 9 other specimens with it (all internal molds) are labelled as having come from Burlington County, New Jersey. Both Whitfield<sup>272</sup> and Weller<sup>273</sup> included specimens under *P. decisa* that probably do not belong to that species.

Panope elliptica Whitfield from the "Upper marl" of New Jersey, now known to be an Eocene species, lacks the pronounced anterior and posterior truncations of *P. subplicata* and *P. decisa*.

The shell referred to *Panope decisa* by Wade<sup>274</sup> is similar to the Texas species, but it is proportionately shorter and higher, is more inflated below the umbo, and is more constricted posteriorly. Well preserved shells from the Owl Creek formation in northern Mississippi are also very close to the Texas species but are proportionately higher and shorter and have more prominent umbos. The same may be said of Panope monmouthensis Garduer,275 which in addition is more inflated below the umbos. All of the species cited are more coarsely sculptured concentrically than the Texas shells.

*Types.*—Shumard's type material is probably lost. One of two imperfect specimens from near Chatfield is figured and is designated neotype, U.S.N.M. no. 76750; the other specimen is also figured. U.S.N.M. no. 21095. A more complete specimen (plesiotype) from near Corsicana is figured, U.S.N.M. no. 76751.

Distribution in Texas. Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); north edge of Corsicana (518); vicinity of Corsicana (763, 1 specimen figured); 2½ miles north of Corsicana (14114). Outside distribution.--Arkansas: Nacatoch sand.

### Family GASTROCHAENIDAE

### Genus GASTROCHAENA Spengler

The generic name Gastrochaena was introduced by Lorentz Spengler<sup>276</sup> in 1783. He included under this genus three Recent species which he named, described, and figured (plate opposite his page 182), in order as follows: G. mumia (figs. 1-7); G. cuneiformis (figs. 8–11); and G. cymbium (figs. 12–17). Spengler did not designate which of these species should be the type of his new genus. It is evident from his figures that G. mumia is generically distinct from the other two species.

In 1789 Bruguière<sup>277</sup> named the genus *Fistulana* without describing it or designating a type species. Bruguière died before his work was completed and in 1797 part of his uncompleted text, pp. 85-132, and pls. 96 to 286 of the Tableau Encyclopédique, were published under one cover; plate 167 gives good figures (figs. 17-22) of the shell and the straight tube of a species of boring mollusk such as has recently been accepted as belonging to the genus *Fistulana*.

In 1798 Cuvier<sup>278</sup> undertook to supply a type for *Fistulana* by naming *Teredo clava* Linné as the type species, but unfortunately this species, as determined by the illustrations cited by Linné<sup>279</sup> is an entirely different shell from that to which the name *Fistulana* has been generally

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<sup>&</sup>lt;sup>271</sup>Conrad. T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 2, p. 275, pl. 24, fig. 19, 1853.

<sup>&</sup>lt;sup>272</sup>Whitfield, R. P., U.S. Geol, Survey Mon., vol. 9, p. 181, pl. 24, figs. 5-8, 1885.

<sup>&</sup>lt;sup>273</sup>Weller, Stuart, Geol, Survey New Jersey, Palcontology, vol. 4, p. 646, pl. 73, figs. 3-5, 1907.

<sup>&</sup>lt;sup>271</sup>Wade, Bruce, U. S. Gool, Survey Prof. Paper 137, p. 98, pl. 32, figs. 8, 9, 1926.

<sup>&</sup>lt;sup>275</sup>Gardner, Julia, Maryland Geol, Survey, Upper Cretaceous (2 vols.), p. 722, pl. 15, figs. 4, 5, 1916.

<sup>&</sup>lt;sup>276</sup>Spengler, Lorentz, Nye Samling af det Kongelige Danske Videnskabers Selskabs Skrifter, vol. 2, p. 179, 1783.

<sup>&</sup>lt;sup>277</sup>Brugnière. Tableau Encyclopédique et Methodique, p. XII, 1789. Uncompleted text, pp. 85-132, and pls. 96-286 were published in 1797; see pl. 167, figs. 17-22.

<sup>&</sup>lt;sup>278</sup>Cuvier, G., Tableau elementaire de l'histoire naturelle, p. 432, 1798.

<sup>&</sup>lt;sup>270</sup>Linné, C., Systema naturae, Tome no. 1, pars. 6, p. 3748. 1792.

Linné does not figure the species, *Teredo clava*, but cites previously published examples of the species as follows:

Walch, Naturforscher, vol. 10, p. 38, tab. 1, figs. 9, 10, 1777.

Spengler, Naturforscher, vol. 13, p. 53, tab. 1, figs. 1-11, tab. 2, figs. 12-14, 1779.

Schroeter, Einl. in Conch., vol. 2, p. 574, tab. 6, fig. 20. The figures cited apparently do not belong to either *Gastrochaena* or *Fistulana*, as these names were subsequently used, and appear to have been correctly referred to the Teredinidae.
applied. If Cuvier's type species were to be taken seriously, *Fistulana* would pertain to shells in the family Teredinidae, for Bruguière's figures 6 to 16, on his plate 167, are reproductions of Spengler's<sup>280</sup> old figures 1 to 11, cited by Linné as examples of *Teredo clava*, and these figures indicate a *Teredo*-like shell. In other words, the type species of *Fistulana*, named by Cuvier, belongs in a different family from that of the straittubed species which was later accepted as *Fistulana*.

Lamarck,<sup>281</sup> in 1799, accepted *Teredo* clava Linné as the type of *Fistulana*, and cited Linné's original description of that species, but in 1801,<sup>282</sup> he, perhaps inadvertently, transferred the name clava from the Teredinidae to the Gastrochaenidae, for in this paper he cited as an example of *Fistulana clava*, figures 17 to 22 of Bruguière's plate 167. Some subsequent authors seem to have accepted this transfer without question, taking for granted that *Gastrochaena mumia*, Spengler and *Fistulana clava* Lamarck (not *Teredo clava* Linné) are identical.

In a volume of "Tableau Encyclopédique et Methodique," published in 1827, pages 82 to 132 of Bruguière's uncompleted paper, previously cited, are reprinted, and these pages are followed by explanations of plates 52 to 488 under the authorship of Bory de St. Vincent, whose name appears at the bottom of the last page of explanations (p. 180). In the explanation of plate 167, figures 17 to 22 are named Fistulana clava Lamarck. As already shown, the specific name *clava* can not be accepted as correctly applied to shells of this kind. The shell represented by figures 17 to 22 obviously belongs to the same generic group as Gastrochaena mumia Spengler, and it probably is that species. None of the other figures given on plate 167 under the name Fistulana, figures 6 to 16, and 23, belong to "Fistulana," that is, Gastrochaena; they appear to belong to the Teredinidae. All

except figure 23 are reproductions of the Spengler figures cited by Linné as examples of *Teredo clava*.

In Deshayes' edition of "Histoire naturelle des animaux sans vertèbres," published in 1835, page 30, Spengler's *Gastrochaena mumia* is cited as a synonym of *Fistulana clava*.

Jonas<sup>283</sup> in 1844 criticized Deshayes for not having recognized the validity of *Gastrochaena* and, though not specifically designating *G. mumia* as the type species, he clearly indicated his belief that the genus should be based on that species. Deshayes<sup>284</sup> replied with the reminder that, subsequent to the publication of the work cited above, he had in his "elementary treatise" adopted the name *Gastrochaena* in place of *Fistulana*. I have not been able to consult this latter work.

All that has just been said about *Fistulana* is of historic interest only, for the name was preoccupied by O. F. Müller,<sup>285</sup> who, in 1776, used it as a new name for *Fistularia*, which had been used in the body of the work.

In 1856, H. and A. Adams<sup>256</sup> accepted the generic name *Gastrochaena* and cited as an example, *G. mumia* Spengler. They also cited as synonyms, *Chaena* Retzius, and *Fistulana* Lamarck. This is the first definite citation of *G. mumia* as a typical example of *Gastrochaena*. They say, "The curious shell on which Spengler founded this genus is generally known under the name *Fistulana clava* Lamarck; it is the type of *Chaena* of Retzius (1788)."

In 1861, Tryon<sup>287</sup> recognized the species *Gastrochaena mumia* Spengler, and treated *Fistulana clava* (Lamarck) as a synonym of that species. In discussing *G. mumia* he says: "This is the well known type of the old genus *Fistulana*."

<sup>&</sup>lt;sup>280</sup>Spengler, Kunstverwalter, Der Naturforscher, vol. 13, pp. 53-77, tab. 1, figs. 12-14, 1779.

<sup>&</sup>lt;sup>281</sup>Lamarck, J. B., Prodrome. p. 90, 1799.

<sup>&</sup>lt;sup>252</sup>Lamarck, J. B., Système des animaux sans vertèbres, p. 129, 1801.

<sup>&</sup>lt;sup>283</sup>Jonas, J. H., Zelt, für Malac., Jahrgang 1814, pp. 135-139, 1814.

<sup>&</sup>lt;sup>264</sup>Deshayes, M. G. P., Zeit, für Malac., Jahrgang 1845, pp. 41-47, 1845.

<sup>&</sup>lt;sup>285</sup>Müller, O. F., Zool. Dan. Prodo., Add., pp. 275-282, 1776.

<sup>&</sup>lt;sup>286</sup>Adams, Henry, and Adams, Arthur, The genera of Recent Mollusca, vol. 2, pp. 334-335, 1856,

<sup>&</sup>lt;sup>257</sup>Tryon, Jr., George W., Acad. Nat. Sci. Philadelphia Proc., vol. 13, pp. 465-494 (especially pp. 470-471), 1861. (A reprint of this paper bears the page numbers 33-62.)

In 1866 Fischer<sup>288</sup> named Fistulana mumia (Spengler) as the type of Fistulana.

In 1870 Stoliczka<sup>289</sup> definitely designated *Gastrochaena mumia* Spengler as the type of *Gastrochaena*.

In 1886, Cossmann<sup>290</sup> stated that Gastrochaena clava is the first species described by Spengler under the generic name Gastrochaena, and concluded that there is therefore reason to apply the name Gastrochaena to the species with an annulated tube. He did not actually mention G. mumia, but there is an obvious implication that he regarded that name as a synonym of G. clava which to him was the type species of Gastrochaena. He treated Fistulana as a synonym of Gastrochaena.

Fischer,<sup>291</sup> in 1887, designated Gastrochaena mumia Spengler the type species of Fistulana.

*G. cuneijormis* Spengler was in 1896 designated the type of *Gastrochaena* by Bucquoy. Dantzenberg, and Dollfus,<sup>292</sup> and in 1925 Woodring<sup>293</sup> accepted this designation. Subsequently Woodring<sup>294</sup> used *Rocellaria* Blainville instead of *Gastrochaena* and cited Iredale (see paragraph below).

As a result of a brief and inadequate review of the case, Smith, in 1905,<sup>295</sup> chose to accept *Fistulana mumia* (Spengler) as valid.

The use of *Fistulana* was, in 1915, discussed by Iredale,<sup>296</sup> who insisted that the statement of H. and A. Adams (1856) quoted above, should be taken as absolutely fixing *Gastrochaena mumia* Spengler

<sup>201</sup>Fischer, Paul, Manuel de conchyliologie, pp. 1129-1130, pl. 23, fig. 16, 1887.

<sup>262</sup>Bucquoy, E., Dantzenberg, Ph., and Dollfus, G., Les mollusques marins du Roussillon, Tome 2, Pelecypodes, p. 602, 1896.

<sup>203</sup>Woodring, W. P., Carnegie Inst. Washington Pub. 366, p. 191, 1925.

<sup>294</sup>Woodring, W. P., Carnegie Inst. Washington Pub. 385, p. 22, 1928.

<sup>295</sup>Smith, F. A., Proc. Malac. Soc. London, vol. 6, p. 185, 1905.

<sup>204</sup>Iredale, Tom, Proc. Malac. Soc. London, vol. 11, pp. 296-297, 1915. as the type of *Gastrochaena*. Stoliczka's designation was overlooked by Iredale and apparently by all authors subsequent to 1870.

The shell of Gastrochaena is elongaterectangular in outline, and the animal secretes a long, straight, tapering, thin, calcareous tube which stands upright in the sand of the seabottom into which the animal bores. The tube is characterized on the exterior by rather closely spaced annulations: in the size and form of the shell, and in the shape of the tube, the Recent species, Gastrochaena mumia Spengler, is remarkedly like the Upper Cretaceous species, Gastrochaena ripleyana Stephenson, described below, and differs only in details that do not appear to be of more than specific value.

Gastrochaena is represented in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain by G. linguiformis Weller from the Merchantville clay marl of New Jersey, and G. ripleyana Stephenson, from the Ripley formation and its equivalents, of the eastern Gulf region, and from the Nacatoch sand of Texas.

The so-called Gastrochaena americana Gabh<sup>207</sup> from the Vincentown lime sand of New Jersey (Eocene), does not belong to Gastrochaena; a shell recently uncovered in a tube of this species appears to be more like the Recent species which Spengler called G. cuneiformis than it is like the generically distinct G. mumia. The present writer in 1937 made Gabb's species the genotype of the new genus Kummelia (Jour. Wash. Acad. Sci., vol. 27, no. 2, pp. 58–64, text figs. 1–8).

*Fistulana ocalana* Dall,<sup>208</sup> from the Ocala limestone of Florida, which is based on an incomplete mold of the tube, may be a *Gastrochaena*.

# GASTROCHAENA RIPLEYANA Stephenson, n.sp.

#### Pl. 46, figs. 5-14

1926. Gastrochaena americana Gabb. Wade, U.S. Geol. Survey Prof. Paper 137, p. 99, pl. 32, figs. 5–7.

Shell thin, elongate, subrectangular, equivalve, extremely inequilateral, strongly

<sup>207</sup>Gabb, Wm. M., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 393, pl. 68, fig. 20, 1860.

<sup>208</sup>Dall, Wm. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 826, pl. 35, fig. 23, 1898.

<sup>&</sup>lt;sup>285</sup>Fischer, P., Jour, Conch., vol. 14, pp. 321-335, 1886. See also Zool, Record, 1866, p. 207, pl. 12.

<sup>&</sup>lt;sup>259</sup>Stoliczka, F., Mem, Geol, Survey India, Paleontologia Indica, Cretaceous fauna of southern India, vol. 3, p. XV, 1870.

<sup>&</sup>lt;sup>209</sup>Cossmann, M., Catalogue Illustré des coquilles fossiles de l'Éocene des environs de Paris, Prem'er Fascicule, p. 9, 1886.

ventricose in front, gradually tapering wedge-like to a thin edge behind; the front end of the shell is squarely truncated almost at right angles to the longitudinal dimension; ventrally the shell is widely gaping, the opening having approximately the form of an elongated isosceles triangle, the length of the gape in the holotype being 25 nm., and the maximum width in front about 11 mm.; from the edge of the anterior truncation the main surface slopes gradually backward in a broad curve to the posterior extremity and rounds over more abruptly to the dorsal margin. Beaks small, nonprominent, slightly prosogyrate, slightly separated, situated at the anterior extremity. Hinge edentulous. Ligament long, thin, external, opisthodetic. Anterior adductor scar, as seen in a frag-ment of shell broken from the holotype and subsequently glued back in place, elongated, lying close to and parallel to the vertical anterior margin; below its lower end is another small, circular muscle scar. Pallial sinus obscure in the available material. The anterior margin is squarely truncated almost vertically, the two edges curving out a little as they meet, forming a low sharp keel; the ventral margin is long, descending posteriorly, nearly straight, slightly concave just back of the truncated front; posterior margin subtruncated nearly vertically; posterodorsal margin long, very broadly arched, descending posteriorly.

The surface is marked by concentric growth lines and ridges which vary greatly in strength on different parts of the shell; the truncated front is covered with coarse, sharp-crested ridges which descend from the upper angle of truncation downward and inward, bending up sharply and tending to fade out as they approach the inner, closed margin; on the main surface a shallow sulcus extends from the beak obliquely backward and downward to the ventral margin; in front of this sulcus the growth lines are irregular, strong, and sharp; back of the sulcus the surface is nearly smooth from the front backward to about the midlength, back of which the growth lines become sharper and more irregularly developed. On the smooth part of the surface back of and above the sulcus the magnifying glass reveals exceedingly fine, closely packed, radiating rows of tiny nodes or tubercles; at a distance of about 10 mm. from the beaks these rows of microscopic nodes break up into fine, irregular surface stippling which characterizes the surface to the posterior extremity even among the more coarsely developed growth lines.

This mollusk secrets an outer long, straight, thin, tapering tube of calcium carbonate, having a maximum measured diameter of about 18 millimeters, and an estimated maximum length of 150 millimeters or more. The tube is marked by closely spaced, regular transverse annulations; fine, irregular, longitudinal striations may be seen toward the smaller end of some of the tubes, suggesting mechanical scratching caused by the forcing of the tube upward through the sand as the animal sought to prevent the small end of the tube from becoming covered and sealed by the sediments being deposited on the sea bottom above it. The small end of the tube, as seen in one specimen, is noticeably constricted in bottle-neck fashion.

Dimensions of the holotype, a well preserved shell with valves attached: Length 29.2 mm., height at front end 6 mm., thickness 11.6 mm.

This species is based on several well preserved shells and internal molds and on numerous tubes from the Owl Creek formation, on Owl Creek, Tippah County, Mississippi.

The Texas material includes two fairly good imprints of shells in fragments of internal molds of tubes (13568), one poor imprint of a shell in a fragment of an internal mold of a tube (12927), and one well preserved internal mold of the large end of a tube representing nearly half the original length (761). This material is hardly adequate for satisfactory identification, but allowing some individual variation, the imprints of the shells agree fairly well with the typical Owl Creek shells; the imprints suggest a shell with a squarer posterior truncation, and having a more deeply impressed sulcus extending from the beak to the posteroventral margin, but until more and better specimens afford more conclusive grounds for separation, these shells and tubes may be regarded as belonging to Gastrochaena ripleyana.

*Gastrochaena whitfieldi* Weller,<sup>299</sup> from the Navesink marl (Upper Cretaccous) of New Jersey, as shown by the figured imprint of the holotype, is less squarely truncated in front, has a deeper concavity in the anteroventral margin, and is much higher posteriorly than the Owl Creek species; it appears to have constructed a very similar tube.

*Gastrochaena linguiformis* Weller,<sup>300</sup> from the Merchantville clay marl of New Jersey, is based on a poorly preserved imprint of part of a shell in a tube, which is hardly adequate to serve as a type; compared with other described species it appears to be specifically distinct, having a straighter shell with dorsal and ventral margins subparallel.

Types.—Holotype, U.S.N.M. no. 76752; 4 figured paratypes, U.S.N.M. no. 76753; 1 unfigured paratype, U.S.N.M. no. 76754. From the Owl Creck formation 2½ miles northeast of Ripley, Tippah County, Mississippi. Examples from Texas, U.S. N.M. nos. 20967, 76755.

Distribution in Texas.—Navarro group, Nacatoch sand: A tube from the vicinity of Kaufman (761, figured).

Navarro group, Corsicana marl: Castroville road, 1 1/5 miles west of Leon Creek, Bexar County (15522); 6 miles east of Castroville (16156); well 7/20 mile south by west of St. Mary's University, Bexar County (16353); 2 miles east of Marion, (Tex. Bu. 2395); 1 4/5 miles N. 20° W. of Tona siding (15545); 4 miles southwest of Quinlan (17385); 7 miles south, 3 miles east of Greenville (11250); 3 7/10 miles southwest of Campbell (15547); about 3 miles south-southwest of Campbell (12927); 11/4 miles south by east of Oak Grove (13568, 1 figured specimen; 16160).

Outside distribution.—Mississippi: Owl Creek formation and Prairie Bluff chalk.

Tennessee: Fragments of tubes reported by Bruce Wade from the Coon Creek tongue of Ripley formation.

West-central Alabama: Questionably in the Prairie Bluff chalk.

Range.—Tubes of Gastrochaena, some of them containing the imprints of the shells, occur in Texas at several localities in beds of Taylor age, including the Wolfe City sand, the Pecan Gap chalk, and the Anacacho limestone, but these specimens have not been specifically identified. A few specimens regarded as belonging to the species *G. ripleyana* occur in Texas in the Nacatoch sand and in the Corsicana marl of the Navarro group. The species occurs in the eastern Gulf region in the Owl Creek formation and in the Prairie Bluff chalk.

## Superfamily ADESMACEA

## Family PHOLADIDAE

## Genus PHOLADIDEA Goodall

# PHOLADIDEA RAGSDALENSIS Stephenson, n.sp.

# Pl. 44, figs. 4, 5

The shells on which this species is based were found as borers in the thick tubes of Hamulus? huntensis Stephenson (p. 61). Shell small, thin. reniform in the adult, equivalve, strongly gaping anteriorly in the young, the gape becoming partly closed by the callum in the adult. and less strongly gaping posteriorly. Beaks broad, strongly incurved, strongly prosogyrate, approximate, situated well in advance of the midlength in the young stage, but moving back of the midlength in the adult due to the excessive forward growth of the callum in later stages. A distinct subangulated umbonal ridge extends from the beak to the lower end of the posterior truncation. Hinge and myaphore not exposed. Posterior adductor scar large, narrow, oblique, marginal. A radiating groove on the internal mold marks the position of the internal rib; this rib reflects the position of the impressed line which divides the outer surface into anterior and posterior areas. Another radiating depression on the internal mold just in front of the posterior adductor scar marks the position of a second internal radiating rib or callosity. Posterodorsal margin keeled, long. nearly straight to broadly arched; posterior margin subtruncated; the ventral and dorsal margins vary markedly with the successive stages of growth of the callum; in the young the shell is widely gaping in front and the anterior margin leaves the dorsal margin at an acute angle, extending obliquely downward and backward in a sinuous trend, meeting the nearly straight ventral margin at a wide subobtuse angle; as the

<sup>200</sup>Weller, Stuart, Geol, Survey New Jersey, Palcontology, vol. 4, p. 618, pl. 73, figs. 10-12, 1907.

<sup>300</sup>Op. cit., p. 619.

callum develops the anterior margin is built forward, remaining widely gaping for about 2 mm., beyond which, as the senile stage is reached, the shell becomes constricted and the gape partly, but not completely, closed.

The surface is divided into two areas by an impressed line which in the adult extends from the beak obliquely downward and a little backward to the ventral margin: in front of this impressed line the fine growth lines on the main part of the shell extend obliguely forward and upward to the posterodorsal margin and these lines are paralleled by the growth lines on the callum; the growth lines on the posterior surface meet the impressed dividing line at a broad obtuse angle. The callum as fully developed on the adult produces a strong forward, somewhat swollen bulge, becoming constricted in front, which gives to the shell an appearance of abnormality. The protoplax is more or less completely broken away on the available specimens but enough remains to show that it is formed by an upward projection and outward folding of the anterodorsal margins, as in P. fragilis Stephenson.

Dimensions of the holotype: Length 7.5 mm., height 4.2 mm., thickness 3.5 mm.

Compared with *Pholadidea fragilis* Stephenson<sup>301</sup> this species is larger, has a more bulging and more strongly projecting callum, and a more sharply differentiated umbonal ridge; it is, however, closely related to that species.

*Types.*—Holotype, U.S.N.M. no. 76756; 6 unfigured paratypes, U.S.N.M. no. 76757.

Distribution in Texas.—Navarro group, Nacatoch sand: 1½ miles west of Campbell (12925).

## PHOLADIDEA sp.

Several poorly preserved specimens of *Pholadidea* were found in a concretion in the Kemp clay in a field near the old Wortham road,  $4\frac{1}{2}$  miles east-northeast of Cooledge, Limestone County (17374).

They have the general form of *P. rags-dalensis* but the best preserved specimen is larger and plumper; the ornamentation is obscure. U.S.N.M. no. 76758.

# Genus XYLOPHAGELLA Meek

# Type species.--Xylophaga elegantula Meek and Hayden.

This genus, originally proposed by Meek<sup>302</sup> in 1864, was later referred by him to Turnus Gabb, but the name Xylophagella was retained in a subgeneric sense.<sup>303</sup> Comparison with typical specimens of Turnus plenus Gabb (U.S.N.M. nos. 76422, 76422a) shows that in Xylophagella elegantula the internal posterior rib is farther back on the dorsal slope, and that in Gabb's species the anterior hiatus is bordered by a curved margin instead of a rectangular notch as in Xylophagella. These differences would seem to warrant restoring Meek's name to generic rank.

A species originally described by Gabb<sup>304</sup> as Teredo contorta from Burlington County, New Jersey, was subsequently transferred by the same author to Turnus (Xylophagella), but Weller<sup>305</sup> later included this species in the synonymy of Teredo irregularis Gabb. In the same volume (p. 652, pl. 74, figs. 4-6), Weller described Turnus kümmeli, from the Merchantville clay marl of New Jersey, and incidentally referred the Texas shells here described as Xylophagella whitneyi to his new species, an identification which neither the description nor a comparison of the specimens seems to justify. Although in the text Weller refers his species to Meek's subgenus Goniochasma, it clearly belongs to Xylophagella. The internal mold illustrated by Weller's figure 4 is in the Walker Museum at Chicago University (U.C. 18548), and was examined by me; the specimen illustrated by his figures 5 and 6 could not be found in the State Museum at Trenton, and may be lost.

<sup>&</sup>lt;sup>301</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, p. 348, pl. 87, figs. 1-11, 1923.

<sup>&</sup>lt;sup>202</sup>Meek, F. B., Cheek list of the invertebrate fossils of North America, Cretaceous and Jurassic: Smithsonian Mise, Coll., vol. 7, no. 177, p. 34, 1864.

<sup>&</sup>lt;sup>303</sup>Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, pp. 254–255, 1876.

<sup>&</sup>lt;sup>304</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 323, 1861; and vol. 28, p. 304, 1876.

<sup>&</sup>lt;sup>305</sup>Weller, Stuart, Geol. Survey New Jersey, Paleontology, vol. 4, p. 656, 1907.

# XYLOPHAGELLA WHITNEYI Stephenson, n.sp.

# Pl. 44, figs. 1-3

Shell very thin, subglobose in form, strongly inequilateral, equivalve. Anterior of shell wide open due to pronounced angular indentations in the anteroventral margins of the two valves; viewed from the front this opening, or hiatus, presents an outline suggestive of the vertical cross section of a globose jug. Anterodorsal slope above the anterior hiatus, steep, a little overhanging near the beak, the inner margins curling strongly upward, and the margins of the two valves standing rather widely apart; in adults the inner surface of these gaping margins is strengthened by a thick accessory deposit of calcium carbonate (perhaps of secondary origin) which extends upward and roofs over the top of the gape; an imprint in front of the beaks indicates a small, double protoplax. Posterodorsal slope steep, overhanging toward the beak, excavated below, the margins curving upward to form a dull keel; shell apparently slightly gaping at the upper part of the posterior margin; some shells seem to show a wider gape than others. Beaks prominent, strongly incurved, prosogyrate, approximate, situated about one-fourth the length of the shell from the anterior extremity. Hinge not seen in available material. The inner surface is characterized by three internal radiating ribs. The first of these, which marks the so-called umbonal groove of the outer surface, is narrow and strong, and makes a deep groove in the internal mold; on either side of the groove are rather coarse crenulations in the mold which reflect the stronger concentric ridges of the exterior. The second rib is marked on the internal mold as a relatively broad, shallow depression extending from the beak down over the shell a little back of the umbonal groove, and dying out as it approaches the ventral margin; the posterior edge of this groove is sharply defined and the anterior edge is much less distinct though not obscure. The third groove is on the posterodorsal slope, is relatively deep, broad and round-bottomed, and dies out The internal mold toward the margin.

also shows a faint groove extending from the beak to the angle of the anterior gape. posterodorsal margin is nearly The straight and horizontal for about 3 mm. back of the beaks: the posterior margin is rather sharply rounded above, with a mere suggestion of a subtruncation below; ventral margin broadly rounded to a point just in front of the lower end of the umbonal groove, where the margin turns sharply upward, extending nearly vertically to a point a little above the midheight, and about 2 mm, in front of the umbonal groove; at the latter point the margin turns sharply at an angle slightly greater than a right angle, and extends around to the forward end of the anterodorsal margin which it joins at almost a right angle; as previously stated the anterodorsal margins of the two valves are strongly upcurved and widely gaping.

The surface of the shell from the umbonal groove backward is marked by fine, sharp lines of growth and by low, broad, concentric ridges numbering 2 or 3 to the millimeter, separated by narrow, sharp interspaces; on some shells 10 or 12 faint, closely spaced radiating lines appear just below the posterodorsal margin on each valve, and the impressions of these on the internal mold are stronger than their external manifestation; just in front of the umbonal groove the coarser concentric markings turn sharply upward parallel to the margin of the anterior hiatus and, because they are crowded into a very narrow space, become very fine and closely crowded; at a point above corresponding to the inner angle of the anterior hiatus at its successive stages the ribs make another abrupt, angular turn, become noticeably wider, and extend parallel to the upper margin of the hiatus, around to the anterodorsal margin.

Dimensions of the holotype, a specimen with both valves attached, and with some of the shell partly peeled away: Length 9.6 mm., height 7.8 mm., thickness 8.2 mm.

Probably the nearest described species to *Xylophagella whitneyi* is *X. elegantula* Meek, but unfortunately Meek's type material is lost. Several lots from the Upper Cretaceous of Montana, which have been identified as belonging to Meek's species, appear to represent two or three species, and as it is not known which, if any, of the lots are typical, it is impossible to compare Meek's species with the Texas species. The latter is, however, distinct from any of the former. *Turnus kümmeli* Weller from New Jersey is a *Xylophagella*, but is not adequately described, and apparently does not retain the surface characters necessary for a critical specific comparison with *X. whitneyi*.

The Texas species was a wood borer and secreted a thick-walled calcareous tube; one young individual among the paratypes is incompletely uncovered in the large end of a tube in a piece of fossilized wood.

*Types.*—Holotype, U.S.N.M. no. 76759; 7 paratypes, U.S.N.M. no. 20883. Named in honor of Prof. Francis L. Whitney of Austin, Texas.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763).

#### Genus GONIOCHASMA Meek

Type species.—Xylophaga stimpsoni Meek and Hayden: Acad. Nat. Sci. Philadelphia Proc., vol. 9, p. 141, 1857.

This genus was proposed by Meek<sup>306</sup> in 1864 but, along with Xylophagella, was later referred by him to Turnus Gabb. Goniochasma is much more elongated than Xylophagella, but possesses characters which closely relate it to that genus. It presents a deep, rectangular, anterior hiatus, an internal umbonal ridge, and an internal posterodorsal rib; it seems to lack the broad internal rib back of the umbonal rib. Indications of the presence of a supplementary plate (mesoplax) over the beaks are present on several of the Texas specimens; this has not been observed on Xylophagella.

# GONIOCHASMA SCAPHOIDES Stephenson, n.sp.

# Pl. 46, figs. 1-4

Shell thin, elongate, subtrigonal in outline, inequilateral, equivalve, strongly ventricose near the front, tapering nearly to a thin edge behind; anterodorsal slope steep, a little overhanging near the beak, sharply upcurled at the margin; posterodorsal slope broadly rounded, flattening out somewhat posteriorly; umbonal ridge distinct, obtusely subangular in the younger stages, but tending to smooth out in adults; lower two-thirds of the front end of the shell wide open due to a deep rectangular hiatus which forms a shieldshaped opening; umbonal groove marked by a roughened but not deeply impressed band extending to the ventral margin, a millimeter or less in front of which is another narrow, much more sharply impressed, radiating groove which, however, does not extend all the way to the beak. Beaks prominent, broad, very strongly incurved, prosogyrate, approximate, situated about one-fifth the length of the shell from the anterior extremity. On several of the larger specimens there are the incomplete prints of a double supplementary plate (mesoplax) covering the beaks; the preserved parts of these imprints indicate a concentrically striated plate 5 or 6 mm. in diameter at right angles to the length of the shell, having an approximately half-moon shape from the beaks backward, and probably extending forward somewhat in advance of the beaks. The species is a wood-borer the dozen or more specimens all having been obtained from a piece of fossilized wood. The holotype has been only about half uncovered from its boring in this piece of The animal secreted a thin calwood. carcous tube. Hinge not uncovered. The internal mold shows the impression of a narrow, strong, internal, radiating, crenulated rib immediately beneath the roughened band representing the umbonal groove. In front of this rib is another much weaker internal rib which marks the previously described sharply impressed supplementary external groove. On the posterodorsal slope of internal molds is the impression of an internal oblique, radiating rib which is much stronger and wider than the internal umbonal rib, but which broadens out, becomes weaker and dies out toward the margin.

<sup>&</sup>lt;sup>300</sup>Meek, F. B., Check list of the invertebrate fossils of North America, Cretaceous and Jurassic: Smithson'an Misc. Coll., vol. 7, no. 177, p. 34, 1364.

The anterodorsal margin is short, the strongly upcurved margins of the two valves forming a high keel; the anterior margin of each valve presents a deep rectangular indentation or hiatus, the combined hiatus of the two valves forming a shield-shaped anterior opening; wide. ventral margin straight or slightly sinuous nearly to the posterior extremity; posterior margin sharply rounded, subpointed; posterodorsal margin long, descending, rounding broadly into the posterior mar-The surface of the shell from the gin. umbonal groove to the posterior extremity is covered with sharp-crested, concentric ridges separated by asymmetric V-shaped interspaces; near the outer margin the ribs are spaced 2 or 3 to the millimeter, but they become progressively more closely spaced toward the beaks; in front of the umbonal groove the ribs become somewhat more round-crested, and are finely and delicately crenulated by radiating lines which zigzag slightly in trend from the ribs to the interspaces where they become much weaker; a short distance in front of the umbonal groove the ribs curve broadly upward, trend parallel to the margin of the anterior hiatus, and become smaller and crowded into a narrower space as they ascend; above the inner angulation of the hiatus the ribs again turn forward at a right angle, become larger and extend around to the anterodorsal margin.

Dimensions of one of the paratypes, a shell with both valves attached, U.S.N.M. no. 76761: Length about 17 mm., height 9 mm., thickness 8 + mm. The holotype is about 18 mm. long and 10 mm. high.

This species has a close analogue in Goniochasma stimpsoni Meek from the Upper Cretaceous (Pierre group) of Montana, but differs in details of form, internal ribbing and sculpture. Martesia cuneata Meek, from the Fox Hills group, Dakota, probably also belongs to Goniochasma.

This species, though possessing features that relate it to *Xylophagella whitneyi*, is markedly elongated and differs decidedly in many details of sculpture, form, and internal ribbing. One internal mold, figured by Whitfield,<sup>307</sup> probably incorrectly, as *Martesia cretacea* (Gabb), and two internal molds from the Marshalltown clay marl of New Jersey, figured by Weller<sup>308</sup> under the same name, also probably incorrectly, appear to belong in the subgenus *Goniochasma*.

*Types.*—Holotype, U.S.N.M. no. 76760; 1 figured paratype, U.S.N.M. no. 76761; 14 or more unfigured paratypes, U.S.N.M. no. 20923.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763).

#### Genus RAMSETIA Stephenson, n.gen.

Type species.-Ramsetia whitfieldi Stephenson.

Etymology.—By anagram from Martesia. Gender, feminine.

There seems to be no described genus of Pholadidae to which the shells here under consideration can be referred, and the new generic name *Ramsetia* is proposed for them; they resemble *Martesia* except that they lack accessory plates in the umbonal region.

The shell is elongated, plump anteriorly, tapering posteriorly, having the general subconical shape which characterizes other borers in this family. The shell is somewhat gaping both in the front and in the rear in the younger stages, but the front becomes sealed by a callus in adults. The exterior is divided externally by one pronounced radial umbonal groove extending from the beak downward and backward to about the middle of the ventral margin; this groove marks the position of a strong internal rib that impresses itself on the internal mold as a deep groove. The surface is sculptured with coarse concentric ribs which, at the umbonal groove, turn steeply upward toward the front at a wide obtuse angle. Weak radial ribs are present and form small nodes where they cross the crests of the concentric ribs.

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<sup>&</sup>lt;sup>307</sup>Whitheld, R. P., U. S. Geol. Survey Mon., vol. 9, p. 190, pl. 25, figs. 20-22, (not fig. 23), 1885.

<sup>&</sup>lt;sup>305</sup>Weller, Stuart, New Jersey Geol. Survey, Palcontology, vol. 4, p. 654, pl. 74, figs. 8-11, 1907.

#### RAMSETIA WHITFIELDI Stephenson, n.sp.

# Pl. 45, figs. 7-9

Shell of moderate size, elongate, subtrigonal in outline, inequilateral, equivalve, strongly ventricose in front, tapering rapidly behind; umbonal groove moderately oblique, narrow, distinctly impressed, but not deep, with the surface of the shell sloping gently down to it from both sides; anterior slopes rounding down steeply; posterodorsal slope steep, overhanging just back of the beaks, excavated longitudinally, the margins curving up to form a long dull keel; posterior slope long, gentle; anterior of shell gaping in the young, sealed by a callum in the adult; posterior moderately gaping. Beaks broad, divided by prominent, the umbonal groove, strongly incurved, prosogyrate, approximate, situated one-fifth to onefourth the length of the shell from the anterior extremity. Hinge not uncovered. Posterior adductor scar small, elongatesubelliptical, lying close to, and parallel to the posterodorsal margin; anterior adductor not uncovered. Pallial sinus very broad, broadly rounded in front, extending forward to about the midheight. Internal umbonal rib narrow and sharp-crested above, broadening out on the posterior side as it approaches the ventral margin. Anterodorsal margin short, the edges of the shell upturned to form a keel; anterior margin bluntly rounded or subtruncated; ventral margin long, very broadly rounded, notched by the umbonal posterior margin sharply furrow: rounded, below the midheight; posterodorsal margin long, descending, gently arched. Surface of shell rather coarsely sculptured with concentric, narrow-crested ribs, each rib having in cross section a steep upper slope and a gentle lower slope; the ribs number about 25 in the holotype; at the umbonal groove the ribs turn upward toward the front at a wide obtuse angle; laterally the shell is further ornamented with faint radial ribs, rather closely spaced in front of the umbonal groove, and somewhat wider apart back of that groove; these ribs produce small nodes where they cross the concentric ribs, giving to the shell a faint cancellated appearance.

Dimensions of the holotype, a large, incomplete left valve: Length 37+ mm., height 20 mm., convexity about 7.5 mm. Dimensions of a smaller, nearly complete internal mold: Length 24.4 mm., height 14 mm., thickness 12 mm.

Types.—Holotype, U.S.N.M. no. 76762; 1 figured paratype, U.S.N.M. no. 76763; 2 unfigured paratypes, U.S.N.M. no. 21027.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

## Genus PHOLAS Linné

#### PHOLAS? PECTOROSA Conrad

#### Pl. 45, figs. 1, 2

- 1852. Pholas pectorosa Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 6, p. 200.
- 1854. Pholas pectorosa Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 2, p. 299, pl. 27, fig. 9.
- 1876. Martesia cithara Morton. Gabb (in part), Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 304.
- 1885. Pholas cithara Morton. Whitfield (in part), U.S.Geol. Survey Mon., vol. 9, p. 187, pl. 25, figs. 14-16. (Geol. Survey New Jersey, Paleontology, vol. 1, p. 187, pl. 25, figs. 14-16, 1886.)
- 25, figs. 14-16, 1886.)
  1905. Pholas pectorosa Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 18.
- 1907. Pholas cithara Morton. Weller (in part), Geol. Survey New Jersey, Palcontology, vol. 4, p. 653, not fig. 7.
- 1916. Pholas pectorosa Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 724, pl. 45, fig. 1.

The description is based on one internal mold with the surface features impressed upon it. Shell of medium size, elongated, subtrigonal in outline, inequilateral, equivalve, slightly gaping at the rear. Greatest inflation above the midheight, well toward the front, directly below the tip of the beaks; anterior slope short, steep, posterior slope long, gently sloping. Beaks broad, prominent, strongly incurved, slightly prosogyrate. situated about onefourth the length of the shell from the anterior extremity. Umbonal groove of right valve narrow, deeply incised, extending in a sinuous curve from the beak obliquely downward and backward, reaching the ventral margin about two-fifths the

length of the shell from the posterior extremity; on the left valve this groove is a little broader and shallower. Hinge and internal features not observable. Anterodorsal margin short, broadly arched, steeply descending; anterior margin regularly rounded, becoming more sharply rounded below where it passes into the long, nearly straight ventral margin; posterior margin sharply rounded; posterodorsal margin long, nearly straight, gently descending. Radial sculpture moderately strong and coarse on the anterior, inflated portion of the shell, becoming finer and more closely spaced posteriorly, finally becoming obscure and passing into a nearly smooth area toward the terminus; the 7 or 8 ribs on the anterior slope are much narrower than the interspaces and become weak to obscure toward the anterodorsal margin; the spacing of the ribs differs somewhat on the two valves. The concentric sculpture consists of numerous low, rather closely spaced ribs which produce low, dull nodes where they cross the radial ribs; the concentric ribs fade out toward the anteroventral margin and toward the posterior extremity. A smooth broadly excavated radial band borders the posterodorsal margin of each valve.

Dimensions of the figured specimen: Length 27.3 mm., height 16.7 mm., thickness 16.2 mm.

This internal mold appears to be identical with better preserved specimens from Owl Creek near Ripley, Mississippi. The shell, as seen in the latter, is very thin, and the upturned edges of the shell along the dorsal margin produce keels at both the anterior and posterior ends of the hinge. The Owl Creek shells exhibit considerable individual variation in details of ornamentation and in outline; some of the shells are less slender posteriorly than others.

The Texas specimen agrees well with the type from Tinton Falls, New Jersey, in the Academy of Natural Sciences of Philadelphia, except for details of sculpture; on the type the sculpture is a little coarser, especially on the anterior end.

Type.--Holotype, Academy of Natural Sciences of Philadelphia; from Tinton Falls, New Jersey; plesiotype, U.S.N.M. no. 76764.

Distribution in Texas.—Navarro group, Corsicana marl: Field 1 9/10 miles northeast of Quinlan (17381).

Outside distribution.--Mississippi: Owl Creek formation.

Maryland: Monmouth formation.

New Jersey: Red Bank sand (Tinton sand member).

## Class SCAPHOPODA

# Family DENTALIIDAE

## Genus DENTALIUM Linné

# DENTALIUM VAUGHANI Stephenson, n.sp.

# Pl. 46, fig. 15

Tube slender, tapering, gently arched, reaching a length of 25 mm. or more. Small end of tube 0.75 mm. or less in diameter; maximum measured diameter 4.4 mm. The surface is ornamented with numerous low, narrow, closely spaced, longitudinal ribs; these may number 25 or more at the small end and increase in number by intercalation, but decrease in strength, toward the large end, which may become nearly smooth. At any given place on the tube the newly intercalated ribs are smaller than the adjacent, continuous ones. The growth lines which encircle the tube are fine and trend somewhat obliquely.

Dimensions of the incomplete holotype: Length 23.4 + mm., greatest diameter 3.8 mm., least diameter 1.3 mm.

The types of Dentalium ripleyanum Gabb,<sup>309</sup> in the Academy of Natural Sciences of Philadelphia, consist of two specimens, one a long, slender smooth gently curved tube of very small diameter, the other a fragment of a larger, ribbed tube, the dimensions of which, as given by Gabb, are, length 0.5 inch, diameter 0.15 inch. The two specimens belong to two distinct species. Johnston<sup>310</sup> has expressed the opinion that the name D. ripleyanum can be applied only to the smaller specimen, by which he means, as shown by a notation on the label with the

<sup>&</sup>lt;sup>309</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Jour., n. s., vol. 4, p. 393, pl. 69, fig. 48, 1860.

<sup>&</sup>lt;sup>310</sup>Johnson, C. W., Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 18, 1905.

types, the long slender specimen, because "the other is D. subarcuatum Conrad." Since Conrad's species is based on a specifically unidentifiable internal mold from New Egypt, New Jersey, which may mean that it is Eocene, Johnston's identification of the fragment of the large tube with it can not be accepted, and since this appears to be the specimen described and figured by Gabb (his pl. 69, fig. 48, the short specimen of large diameter), it is hereby designated as the lectotype of D.ripleyanum. Compared with D. vaughani, D. ripleyanum, as judged by the type and topotypes from Eufaula, has only about a third as many ribs at the small end and these ribs are sharper, more prominent, and do not increase in number by intercalation.

Dentalium gracile Hall and Meek,<sup>311</sup> from the upper part of the Pierre shale in the Western Interior, is a related species, but is larger and longer, and has a more extended, nearly smooth area at the large end.

Types.—Holotype U.S.N.M. no. 76765; 17 unfigured paratypes (fragments), U.S.N.M. no. 76766. Named in honor of Dr. T. Wayland Vaughan.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, type lot; 17365; Tex. Bu. 17300).

#### DENTALIUM NAVARROI Stephenson, n.sp.

#### Pl. 46, figs. 16, 17

Tube slender, gently tapering, gently arched. Small end of tube about 0.75 mm. in diameter; large end of holotype 3.2 mm. in diameter. Longitudinal ribs small, narrow, closely spaced, numbering about 20 at the small end, increasing in number by intercalation and decreasing in strength toward the large end; the tube shows a tendency to become smooth toward the large end. In form and ornamentation this species is similar to *D. vaughani*, but the ribbing is coarser and the individual ribs stand out a little more prominently. Types.—Holotype, U.S.N.M. no. 76767; 1 paratype, figured (a small end), U.S.N.M. no. 76768; 1 unfigured paratype, U.S.N.M. no. 76769. Named in honor of José Antonio Navarro, an early Texas patriot for whom Navarro County is named.

Distribution in Texas.---Navarro group, Nacatoch sand: Vicinity of Kaufman (761); vicinity of Chatfield (762, type locality); road 5 miles south-southwest of Corsicana (7573); 2½ miles west by south of Corsicana (17368).

Navarro group, Kemp clay: ?Webberville (13910); ?3 miles southeast of Manor (16141).

#### **DENTALIUM LEVE Stephenson**

#### Pl. 46, figs. 18, 19

- 1923. Dentalium lere Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 351, pl. 88, figs. 1-3.
- 1926. Dentalium inornatum Wade, U.S.Geol. Survey Prof. Paper 137, p. 100, pl. 33, figs. 2, 3.
- 1927. Dentalium demersum Pilsbry, Nautilus, vol. 40, p. 142.

Tube small, smooth, slender, slightly arched, tapering gradually; in central and anterior portions the tube is very slightly flattened in the dorsoventral diameter, thus producing a broadly ovate cross section. The growth lines are very fine and slightly oblique. The small end of the tube is about 0.5 mm. in diameter and the large end generally does not exceed 1.5 mm. in diameter. The specimen shown in plate 46, figures 18, 19, is 15.5 mm. long. The type specimen of the species is slightly crushed toward its large end, for which reason the natural compression and ovate cross section of the middle and large end of the tube were overlooked at the time of the original description. Numerous specimens subsequently examined, from the Snow Hill member of the Black Creek formation at Mars Bluff, Peedee River, South Carolina, show these features clearly.<sup>312</sup>

There appears to be no essential difference between this species and *Dentalium* 

<sup>&</sup>lt;sup>311</sup>Hall, James, and Meek, F. B., Mem. Amer. Acad. Arts and Sci. Boston, vol. 5, new ser., p. 393, pl. 3, fig. 11, 1854.

<sup>&</sup>lt;sup>312</sup>Stephenson, L. W., U. S. Nat. Mus. Proc. (No. 2706), vol. 72, art. 10, p. 4, 1927.

inornatum Wade (preoccupied), which was renamed *D. demersum* by Dr. Pilsbry.

Dentalium pauperculum Meek and Hayden,<sup>513</sup> from the Fox Hills group of the Western Interior, and from the Neylandville marl, Texas, is a closely related species, but it appears to be less slender and more strongly arched.

Types.—Holotype, U.S.N.M. no. 31837; from the Blufftown formation (Exogyra ponderosa zone), in cut of Central of Georgia Railroad, ½ mile west of Union Springs, Alabama. Plesiotype from Texas, U.S.N.M. no. 76770.

Distribution in Texas.--Navarro group, Nacatoch sand: ?Field 2 miles southwest of Kaufman (7547).

Navarro group, Kemp clay: 3½ miles northwest of Bazette (12922, 1 specimen figured); ?branch 6½ miles southwest of Currie (14139); a well 2 miles west of Groesbeck, at depth of 800 feet (13124); same well at depth of 730 feet (13132); Webberville (7601, 13910).

Outside distribution.—East-central Alabama: Blufftown formation.

The Carolinas: Snow Hill member of Black Creek formation.

Range.—Ranges from about the middle of the Exogyra ponderosa zone to the top of the Exogyra costata zone; in Texas the species is common in the Kemp clay, and is questionably identified from the Nacatoch sand.

# DENTALIUM PAUPERCULUM Meek and Hayden

#### Pl. 46, figs. 20, 21

- 1861. Dentalium pauperculum Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 12, p. 138.
- 1876. Entatis? paupercula (Meek and Hayden). Meek, Rept. U.S.Geol. Survey Terr., vol. 9, p. 269, pl. 18, fig. 14.
- ?1885. Entalis paupercula (Meek and Hayden). Whiteaves, Geol. and Nat. Hist. Survey Canada, Contributions to Canadian Palaeontology, vol. 1, pt. 1, p. 81.
- ?1916. Dentalium pauperculum Meek and Hayden. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 510.
- 1917. Entalis paupercula (Meek and Hayden). Dowling, Canada Dept. Mines, Geol. Survey, Mem. 93, p. 46, pl. 28, fig. 10.

- ?1918. Dentalium (Entalis?) pauperculum (Meek and Hayden). Ravn, De mar. Kridtaf. i Vest-Grøn., Medd. om. Grøn., Bd. 56, p. 355.
- 1920. Dentalium pauperculum Meek and Hayden. Stanton, U.S.Geol. Survey Prof. Paper 128-A, p. 34, pl. 6, figs. 6, 7.

Shell small, smooth, slender, slightly arched; tube slightly flattened in middle and anterior parts, at right angles to the plane of curvature. The only Texas specimen is 6 mm. long, 0.8 mm. in diameter at small end, and 1.4 mm. in maximum diameter at large end. Compared with *Dentalium leve* this species is less slender and a little more strongly arched.

Types.—Holotype, U.S.N.M. no. 311; from the Fox Hills sandstone on Moreau River, South Dakota. Plesiotype from Texas, U.S.N.M. no. 76771.

Distribution in Texas.- Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

Outside distribution.—Western Interior: Fox Hills sandstone and Cannonball marine member of Lance formation.

Maryland: ?Monmouth formation.

Range.—Exogyra costata zone in Atlantic and Gulf Coastal Plain. Fox Hills sandstone and Cannonball marine member of Lance formation in Western Interior.

#### Unidentified specimens of DENTALIUM

An exposure of the Neylandville marl in the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170, U.S.N.M. no. 76772; 17365, U.S.N.M. no. 76773), yielded numerous fragments of *Dentalium* tubes, the largest of which is 3.9 mm. in diameter.

Prints of poorly preserved mediumsized ribbed tubes of *Dentalium* were found in the Corsicana marl in Limestone County on the Mexia road 2<sup>3</sup>/<sub>4</sub> miles east of Cooledge (13832); the ribs appear to be sharp and strong. U.S.N.M. no. 76774.

Several fragments of *Dentalium* related to *D. ripleyanum* Gabb, were found in the upper part of the Kemp clay in association with great numbers of *Crassatella* vadosa bexarensis Stephenson, in a public road  $1\frac{1}{5}$  miles north-northwest of Buffalo School,  $3\frac{1}{2}$  miles north-northwest

<sup>&</sup>lt;sup>\$13</sup>Meek, F. B., and Hayden, F. V., Acad. Nat. Sci. Philadelphia Proc., vol. 12, p. 178, 1860.

of Bazette, Navarro County (17375). The surface sculpture is badly corroded. U.S.N.M. no. 76775.

Numerous impressions of a Dentalium. indicating a tube exceeding 40 mm. in length, are present in a concretionary fragment from the Kemp clay in a field a mile west of Odds, in Falls County (17373, U.S.N.M. no. 76776); the outer surface of the tube is not clearly revealed. Another poorly preserved, sharply ribbed specimen came from the Kemp clay 1/2 mile west of Odds, in Falls County (15434, U.S.N.M. no. 76777).

Fragments from near the small end of ribbed tubes of Dentalium were obtained from the Kemp clay at the following two localities: From a depth of 800 feet in Cargile No. 1 well of the Robinson Oil and Gas Company, 2 miles west of Groesbeck, Limestone County (13124, U.S.N.M. no. 76778): Colorado River at Webberville. Travis County (7601, U.S.N.M. no. 76779). The Cargile No. 1 well also yielded fragments of a medium-sized smooth Dentalium at a depth of 675-700 feet (13131, U.S.N.M. no. 76780).

The exposure of Kemp clay on Colorado River at Webberville (7601) also vielded fragments of smooth Dentalium tubes, the largest of which measures about 3.5 mm. in diameter. U.S.N.M. no. 76781.

Two corroded fragments of a large Dentalium from the Kemp clay,  $1\frac{1}{2}$  miles west of Zuehl in Bexar County (7721), are each ornamented with about a dozen narrow, roundcrested, rather strong ribs, separated by wide interspaces. The maximum diameter is 5 mm. U.S.N.M. no. 76782.

#### Family SIPHONODENTALIIDAE

#### Genus CADULUS Philippi

The few small, simple, smooth shells of this genus thus far found in the Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plain offer little basis for separating them into species, except that of form. In the recognition of the two species described below allowance has been made for some individual variation in form.

#### CADULUS OBNUTUS (Conrad)

#### Pl. 46, fig. 22

- 1869. Gadus obnutus Conrad, Am. Jour. Conch.,
- vol. 5, p. 101, pl. 9, fig. 18. 1905. Cadulus obnutus (Conrad). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 18.
- 1907. Cadulus obnutus (Conrad). Weller, New Jersey Geol. Survey, Paleontology, vol. 4. p. 663, pl. 75, fig. 34.
- ?1923. Cadulus obnutus (Conrad). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 352, pl. 88, fig. 5.

Shell small, smooth, curved, tapering regularly from the equator toward the ends. Equator about one-third the length from the aperture; outer side of tube broadly and regularly convex; inner side broadly concave in the posterior twothirds, nearly straight in anterior third. Apical orifice subcircular; aperture broadly subovate; tube slightly compressed in its larger part at right angles to the plane of curvature, so that the greatest cross section is broadly subovate.

Dimensions of figured specimen: Length 3.7 mm.: apical orifice about 0.3 mm.; aperture about 0.6 mm.; greatest diameter 1.1 mm. An exceptional specimen from the Nacatoch sand measures 4.5 mm. in length. The topotypes exhibit slight individual variations in form and in the size of the openings.

Seven topotypes, two nearly complete, from the Woodbury clay at Haddonfield, New Jersey, are available for comparison. Although the figured shell from Texas is about 0.4 mm. longer than the longest of the topotypes, the proportions appear to be identical. The specimen from Snow Hill, North Carolina, identified by the writer as C. obnutus (Conrad), appears to have its equator a little farther from the aperture than is typical and its apical end tapers more abruptly; it may therefore belong to a different variety or species.

Types.-Holotype, Academy of Natural Sciences of Philadelphia, from the Woodbury clay at Haddonfield, New Jersey. Plesiotype from Texas, U.S.N.M. no. 76783.

Distribution in Texas.--Navarro group, Neylandville marl: ?21/2 miles north of Corbet (16170).

Navarro group, Nacatoch sand: 14/5 miles northeast of Quinlan (16162, figured); road, 2 miles southwest of Kaufman (7546).

Navarro group, Kemp clay: Webberville (13910); near Webberville (7602).

Outside distribution. — Chattahoochee region (Alabama-Georgia): Blufftown formation and Ripley formation (upper part).

North Carolina: Questionably in the Snow Hill member of the Black Creek formation.

New Jersey: Woodbury clay.

Range.--Ranges from the Exogyra ponderosa zonc, upward through the Exogyra costata zone, in the Atlantic and Gulf Coastal Plain.

# CADULUS COONENSIS Stephenson, n.sp.

## Pl. 46, fig. 23

1926. Cadulus obnutus (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 101, pl. 33, figs. 7, 8.

Wade refers this species to Cadulus "The (Conrad), but says: obnutus Tennessee specimens referred to this species are a little more inflated medially than the New Jersey specimens." His figured specimen is in fact strikingly inflated in comparison with C. obnutus, and fully warrants recognition as a separate species. The following description is based on Wade's figured specimen which is here designated the holotype; it is a nearly complete shell. Shell small, smooth, curved, strongly inflated; the equator appears to be a trifle in advance of the midlength, from which the tube tapers regularly toward the aperture; in the other direction the tube is noticeably constricted about halfway between the equator and the apex. The outer side of the curved tube is regularly convex from the equator to the aperture but in the other direction the curve becomes broadly concave as it approaches the apex; the regularity of the curve of the inner side of the tube is interrupted by a broad swell which centers slightly in advance of the midlength. The tube is slightly flattened centrally at right angles to the plane of curvature, making a broadly ovate cross

section. Twelve paratypes in a collection made in 1933 by H. D. Miser and G. A. Cooper show a noticeable variation in form, but all have the strong central inflation which characterizes the species. The apical orifice is circular and the aperture is broadly ovate.

Approximate dimensions: Length 3.2 mm.; greatest diameter 1.1 mm.; maximum diameter of aperture 0.6 mm.; diameter of apical orifice 0.25 mm.

The Texas specimens referred to this species are all slightly smaller than the holotype, but they have essentially the same inflated, slightly flattened form.

Types.—Holotype, U.S.N.M. no. 32824; 12 paratypes, U.S.N.M. no. 76784; from the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tennessee. One figured example from Texas, U.S.N.M. no. 76785.

Distribution in Texas.—Navarro group, Nacatoch sand: Road, 2 miles southwest of Kaufman (7546); Watkins' place 3 miles north of Corsicana (9552, figured); road 5 miles south-southwest of Corsicana (7573).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

## Class GASTROPODA

# Subclass STREPTONEURA

## Order ASPIDOBRAHCHIA

# Suborder DOCOGLOSSA

## Family ACMAEIDAE

## Genus ACMAEA Eschscholtz

# ACMAEA? OCCIDENTALIS (Hall and Meek)?

# Pl. 47, fig. 1

- ?1852. Orbicula Owen, Rept. U.S.Geol. Survey Iowa, Wisconsin, and Minnesota, pl. 7, fig. 11.
- 1856. Capulus occidentalis Hall and Meek, Am. Acad. Arts and Sci. Mem., Boston, n. ser., vol. 5, p. 385, pl. 1, figs. 13a-d.
- 1860. Tectura occidentalis (Hall and Meek). Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 12, p. 423.
  1876. Acmaea occidentalis (Hall and Meek). Merk US Cool Summer Terrend.
- 1876. Acmaea occidentalis (Hall and Meek). Meek, Rept. U.S.Geol. Survey Terr., vol. 9, p. 295, pl. 18, figs. 3a, b.

Shell thin, depressed, subconical, subcircular in outline, apex about one-fourth the length of the shell in advance of the middle. The surface is smooth with the exception of fine growth lines and descends in nearly straight slopes from the apex to the margins; there is, however, a slight humping a little back of the apex, and, because of the acentric position of the apex, the anterior slope is steeper than the posterior. The internal features are not preserved.

Dimensions of the shell shown in plate 47, figure 1: Length front to rear 16 mm., width 16 mm., height about 4 mm.

There are no apparent differences on which these Texas shells can be separated from A. occidentalis (Hall and Meek), and they are provisionally referred to that species. The species from Coon Creek, Tennessee, described by Wade<sup>314</sup> under the name Anisomyon wieseri may belong to Acmaea, but compared with A. occidentalis it is more ovate in outline, and its apex is less acentric.

Types.—The type material of this species was collected by F. B. Meek prior to 1856, in the upper part of the Pierre shale on Sage Creek, in T.1 or 2 S., R.14 E., about 40 miles east by south of Rapid City, South Dakota. The present whereabouts of the material is unknown. The specimen figured by Meek in 1876, cited in the synonymy, was also collected in the upper part of the Pierre shale, on Cheyenne River, near the Black Hills, South Dakota. Plesiotype from Texas, U.S.N.M. no. 76786.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (17365).

Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (15524).

Navarro group, Kemp clay: West of Zuehl (7720; 7721, includes 1 plesiotype); near Deatsville (764, 14125); branch, 6½ miles southwest of Currie (14139); Brazos River, 2 miles above Milam County line (13776).

Outside distribution.—Western Interior: Pierre shale.

Range.--The known range in Texas is through the Navarro group. The type came from the upper Pierre beds of South Dakota.

## Suborder RHIPIDOGLOSSA

#### Family EUOMPHALIDAE

#### Genus WEEKSIA Stephenson, n.gen.

Type species.—*Pseudomalaxis amplificata* Wade.<sup>315</sup>

Etymology.—In honor of Mr. Dave Weeks, owner of the classic Coon Creek fossil locality discovered by Bruce Wade in McNairy Co., Tennessee.

Shell moderately large, discoidal. Spire involute, immersed. Whorls 4 in adults, subrectangular in cross section, and increasing markedly in size to a much expanded body whorl. Protoconch dextral, small, smooth naticoid in form, elevated above the plane of the involution, coiled about twice. Anterior and posterior angulations somewhat irregularly and not closely nodose. The inner shoulders of the whorls round down to the rather open suture.

This genus differs from *Pseudomalaxis* Fischer, which was based on a Pliocene species from Sicily, in that the nucleus is elevated instead of being coiled in the plane of the volutions, the whorls expand much more rapidly, and the nodes on the anterior and posterior angulations, instead of forming closely and regularly spaced crenulations, are widely spaced and irregular; the genus also lacks nodes on the ,inner shoulders of the whorls next to the suture.

The two specimens from Coon Creek, Tennessee, which Wade described under the name *Pseudomalaxis ripleyana*, bear a closer resemblance to *Pseudomalaxis*, both in form and in the character of their protoconchs, than does *Weeksia amplificata* (Wade), and may belong to that genus, but the two specimens belong to two very distinct species; he designated the specimen shown in his plate 59, figs. 5-7, as the holotype of *P. ripleyana*; the other specimen, shown in figures 8 and 12 of the same plate, is in need of a new specific name.

<sup>&</sup>lt;sup>314</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 180, pl. 60, fig. 10, 1926.

<sup>&</sup>lt;sup>315</sup>Wade, Bruce, U.S. Gool, Survey Prof. Paper 137, p. 175, pl. 59, figs. 1 4, 1926.

Delphinula lapidosa Morton and Straparolus subplanus Gabb, both of which were described from specifically indeterminate internal molds, probably belong to this genus.

# WEEKSIA LUBBOCKI Stephenson, n.sp.

# Pl. 47, figs. 2-4

Shell of moderate size and thickness, discoidal. Spire involute and considerably sunken, making the top of the shell concave. Umbilicus wide and shallow, but deeper than the spiral concavity. Whorls three, increasing rapidly in size, subrectangular in cross section. wider in the horizontal than in the vertical direction: whorls flattish on top, base and side. Although compactly coiled, the body whorl of the type shows a slight tendency to become more loosely attached to the penultimate whorl just back of the aper-Protoconch roughened by surface ture. crystallization in the holotype, but apparently a small, smooth, dextral nauticoid shell, coiled 21/2 or 3 times, elevated above the flat-topped surface of the nearest whorl of the spire. The surface is nearly smooth except on the posterior and anterior angulations, which bear widely spaced, moderately prominent nodes, the spacing of which increases anteriorly to a maximum of about 6.5 mm. on the holotype; the nodes on the two angulations stand opposite each other. The fine incremental lines on the top and base of the whorls extend forward and inward from the angulations with a strong obliquity, curving more strongly inward as they approach the sutures; between the angulations these lines curve broadly The body whorl is broken backward. away for several millimeters back of the aperture.

Dimensions of the holotype: Height of the body whorl, which is the maximum height of the shell, 5 mm.; greatest diameter 14 mm.

This species is closely related to *Weeksia amplificata* (Wade), from Coon Creek, Tennessee, but it differs markedly in the wide spacing of the nodes on the posterior and anterior angulations.

Holotype.--U.S.N.M. no. 20908. Named for the Hon. Francis R. Lubbock, Governor of Texas, 1861-1863.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); road 2 miles southwest of Kaufman (7546); field 2 miles southwest of Kaufman (7547); vicinity of Kaufman (761).

# Genus PSEUDOMALAXIS Fischer

# PSEUDOMALAXIS? PATENS Stephenson, n.sp.

# Pl. 47, figs. 5-7

Shell of medium size, broadly dome-Spire flattish near the apex, shaped. rounding off broadly from the apex across the tops of the whorls to the posterior Whorls 6 in the holotype, angulation. subsquarish in cross section, increasing very gradually in size, closely appressed. Protoconch smooth, flat, dextral, coiled about twice. The posterior and anterior angulations are sharp and are finely The upper surface of the crenulated. whorls between the suture and the posterior angulation is very broadly rounded, with, however, a very broad shallow sulcus just back of the posterior angulation; the side between the posterior and anterior angulations is also very broadly rounded and inclines strongly inward; the surface of the whorls within the umbilicus is broadly rounded except for a shallow sulcus which lies just within the anterior angulation of the body whorl, and follows the suture to the apex within the umbilicus. The umbilicus is wide open and bowl-shaped. The surface is nearly smooth with the exception of the crenulations on the angulations and rather coarse growth lines; in a good light, however, one can detect a few very faint, fine spiral lines on the top of the whorls and on the outer side of the body whorl. The growth lines on the top of each whorl are directed strongly backward from the suture to the posterior angulation; between the angulations they bend broadly backward; and within the umbilicus they trend forward. The aperture is broken on the holotype, but is subsquarish.

Dimensions of the holotype: Height 4.5 mm., diameter 12 mm.

In the simple, flattish protoconch, in the crenulations on the posterior and anterior angulations, and in the squarish cross section of the whorls this species agrees closely with the juvenile shell from Coon Creek, Tennessee, incorrectly figured by Wade<sup>316</sup> as an example of *Pseudomalaxis ripleyana*. On account of the extreme youth and different state of preservation of the Tennessee shell it is not possible to establish its specific identity with the Texas species, but the two are certainly congeneric.

*P. patens* appears to agree in most of its essential characters, including that of the protoconch, with *P. zanclaea* (Philippi), the type species of the genus, from the Pliocene of Sicily. The great difference in age, however, suggests the advisability of caution in referring it to that genus.

Holotype.—U.S.N.M. no. 76787; 1 unfigured paratype, U.S.N.M. no. 76788.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, holotype); 21½ miles west by south of Corsicana (17368, paratype).

# PSEUDOMALAXIS? sp.

Two imperfectly preserved specimens representing this genus, found in the upper part of the Kemp clay in a draw a mile west of the Austin road 6 miles north of Lockhart, Caldwell County (13777), are similar in form to *P. patens*, but exhibit fine rather sharply developed spiral sculpture and are doubtless specifically distinct. U.S.N.M. no. 76789.

# Genus HIPPOCAMPOIDES Wade HIPPOCAMPOIDES sp.

#### Pl. 47, figs. 24, 25

An internal mold with the sculpture faintly impressed upon it, from the Corsicana marl at a bluff on the left bank of San Marcos River, half a mile below Martindale, Caldwell County (15526), appears to belong to the genus *Hippocampoides* Wade. The shell is of moderate size, only gently convex apically and gently convex on the side of the largest whorl; the whorls increase rapidly in size

and the height of the shell increases rapidly toward the aperture; the peripheral margin is angulated and the cross section of the outer whorl is quadrilateral; umbilicus apparently wide and deep, its outer margin greatly produced; in the mold a sharp thin sulcus separates the produced margin from the main shell; evidences of 7 or 8 revolving ridges on the side, and 7 or 8 on the top, of the largest whorl are afforded by faint depressions with rows of pits in their bottoms; at least three coils can be differentiated. Dimensions of the figured specimen: Height about 18 mm., greatest diameter about 21.5 mm. U.S.N.M. no. 76790.

#### Family DELPHINULIDAE

#### Genus CALLIOMPHALUS Cossmann

#### Type species .- Turbo squamulosus Lamarck.

If the recommendation of the International Commission, that a name is not to be rejected because it differs from a name already in use only in termination or in a slight variation in spelling, then the name *Calliomphalus* Cossmann (1888) should not be replaced by *Callomphalifer* Cossmann,<sup>317</sup> because of the previous use of *Callumphala* Adams and Angas (1864).

#### CALLIOMPHALUS BELLULUS Stephenson, n.sp.

#### Pl. 47, figs. 8, 9

Shell small, trochoid, umbilicate. Apical angle about 90 degrees, but anteriorly the spiral angle decreases to 65 or 70 degrees. Whorls 4 or 5, plump on the sides, nearly circular in cross section. Suture deeply impressed. The protoconch is not well preserved but is flattish. The growth lines have a strong forward obliquity in their trend from below upward. The periphery rounds down regularly to a subflattish base. The shell is characterized by tuberculated, spiral lirae; on the body whorl between the suture above and the border of the base below there are nine primary spirals, and in each of the lower four interspaces is a much smaller secondary spiral which is also finely tuberculated and which fades out as it passes backward toward the penultimate whorl; on the base are 10 rather

<sup>&</sup>lt;sup>319</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, pl. 59, figs. 8 and 12 (not figs. 5 7), 1926.

<sup>&</sup>lt;sup>317</sup>Cossmann, M., Essais Paléoconch. Comp., Liv. 11, p. 91, 1918.

closely crowded, low spiral lirae of somewhat irregular strength and bearing more or less obscurely developed tubercles which are aligned from lira to lira in the direction of the rather coarse growth lines. In general the tubercles are most prominent on the upper or posterior part of the body whorl and tend to decrease in prominence down over the whorl toward the base. Seven of the primary spirals are clearly exposed on both the penultimate and antepenultimate whorls, and of these, counting from above, the first, third, and sixth are stronger than the others. The umbilicus is moderately wide open and its subangular rim bears a row of coarse tubercles which are slightly elongated in the direction of the growth lines; the wall of the umbilicus is covered with coarse growth ridges, and with several obscure spiral lirae which bear low tubercles. The aperture is subcircular, but the lips are broken in the holotype.

Approximate dimensions of the incomplete holotype: Height 7.5 mm., diameter 8? mm.

This species is a very close analogue of C. *americanus* Wade<sup>318</sup> but is noticeably more coarsely sculptured, and differs also in detail with respect to the strength of development of the spiral lirae.

*Types.*—Holotype, U.S.N.M. no. 76791; 3 unfigured paratypes, U.S.N.M. no. 76792.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, type lot; 17365).

# CALLIOMPHALUS MICROCANCELLI Stephenson, n.sp.

#### Pl. 47, figs. 10-12

Shell small, trochoid, umbilicate: spiral angle about 60 degrees. Whorls 5, nearly flat on the sides. Suture narrow, deeply impressed, increasing in depth and width toward the aperture. Protoconch badly worn, but apparently small and flattish. Growth lines inclined strongly forward from below upward. Periphery subangular. Base broadly and regularly rounded. Surface of body whorl above the periphery ornamented with 5 unequal, finely tuberculated spiral ribs; the lowest rib at the peripheral angle is more than twice as large as the others; the uppermost rib just below the suture is a little stronger than the ones below it, and presents a row of beads obliquely elongated parallel to the growth lines; the 3 intermediate spirals are rather weak and of about equal size. The base is marked by the growth lines and by fine, densely crowded, daintily beaded The rim of the umbilicus is spirals. obtusely subangular and is strongly tuberculated. The umbilicus is small and is lined with very fine, obscurely tuberculated spirals. On the spire the sculpture becomes progressively finer toward the apex on the smaller whorls; on the whorls of the spire the peripheral rib remains relatively strong and lies exposed a little above the suture. Aperture subcircular, obtusely angular at the rear; outer lip thin; inner lip scarcely forming a thin callus on the parietal wall.

Dimensions of holotype: Height 5.5 mm., diameter 4.7 mm.

The paratype, the only other specimen available from the type locality, is of about the same size as the holotype, but differs in the following features: The spire is a little shorter and the spiral angle is wider  $(65^{\circ})$ ; the peripheral angle tends to round off as it approaches the aperture; the aperture tends to become subquadrangular; and the umbilicus is a little more flaring. These differences are interpreted to be individual variations; a large suite of specimens is needed to confirm this conclusion.

The incomplete internal mold from Falls County, a squeeze of which is shown in plate 47, figure 12, appears to have flatter sides, but is ornamented essentially like *C. microcancelli*, and is questionably referred to it.

The species is related to C. argenteus Wade,<sup>319</sup> but has fewer spirals, is much less strongly sculptured, and differs in other details.

*Types.*—Holotype, U.S.N.M. no. 76793; 1 paratype, U.S.N.M. no. 76794; 1 figured example questionably identified, U.S.N.M. no. 76795.

Distribution in Texas.—Navarro group, Corsicana marl: Well 7/20 mile south by west of St. Mary's University, Bexar Co. (16353, type loc.).

<sup>&</sup>lt;sup>318</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 178, pl. 60, figs. 1-3, 1926.

<sup>&</sup>lt;sup>319</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 179, pl. 60, figs. 4-7, 11, 1926.

Navarro group, Kemp clay:  $\frac{1}{2}$  mile west of Odds (15434, figured).

#### CALLIOMPHALUS sp.

A fragment of a shell of *Calliomphalus* from the Nacatoch sand on the Dallas highway, 3/5 mile west of Kaufman, Kaufman County (14098) is obviously a distinct species, but is closely related to *C. argenteus* Wade.<sup>320</sup> The flattened base is covered with fine spiral lirae crossed by relatively coarse growth lines that are concave toward the aperture in their trend. The perimeter bears a row of coarse nodes similar to the ones shown in Wade's figure 7, though more widely spaced. The specimen is too incomplete to serve as a type for a new species. U.S.N.M. no. 76796.

## Specimens questionably referred to CALLIOMPHALUS

The two internal molds from the Nacatoch sand in the northward-facing slope of Sulphur Creek valley in the northwestern corner of Franklin County (12931) are too imperfectly preserved for either specific or satisfactory generic identification. They are provisionally referred to Calliomphalus. Shell small, trochoid, probably narrowly umbilicate. Whorls 5 or 6, subcircular in cross section. The shell substance is nearly gone from the molds, but on one of them faint traces of numerous spiral lirae are visible, and there is a suggestion of a row of moderately coarse crenulations on the shoulder of the whorls just below the suture. In form this species closely simulates Calliomphalus americanus Wade, from Coon Creek, Tennessee, except that it is smaller. Dimensions of the smaller, but better preserved specimen: Height 6 mm., diameter 6.5 mm. U.S.N.M. no. 76797.

One small crushed shell from the Corsicana marl at a dug well 0.35 mile south by west of St. Mary's University, Bexar County (16353), has the form of *Calliomphalus*, but is more coarsely sculptured than any of the other recorded American species. The beading on the spiral ribs is strongly developed. U.S.N.M. no. 76798.

#### Genus URCEOLABRUM Wade

1916. Urceolabrum Wade, Acad. Nat. Sci. Philadelphia Proc., vol. 68, p. 470.

- 1917. Eucycloscala Cossmann, Rev. critique paléozoologie, année no. 3. p. 99.
- 1926. Eucycloscala Cossmann. Wade, U.S. Geol. Survey Prof. Paper 137, p. 179.

Type species .-- Urceolabrum tuberculatum Wade.

The genotype of Eucycloscala Cossmann  $(1893)^{321}$  is Scalaria binodosa (Münster) (= Trochus binodosus Münster), from the Triassic of Saint Cassian, southern Alps, subsequently designated by Cossmann.<sup>322</sup> This shell, as figured by Münster,<sup>323</sup> differs markedly in the character of its aperture, and is imperforate, and should not have been confused with Urceolabrum Wade. (See pl. 47, figs. 15, 16.).

The shell described by Johnson<sup>321</sup> under the name *Tuba? reticulata* appears to be an *Urceolabrum;* the lip, however, is not preserved on any of the 5 cotypes in the Academy of Natural Sciences of Philadelphia.

The genus is represented in the Cretaceous (lower Senonian) of the Aachen District, Germany, by *Liotia macrostoma* (Müller).<sup>525</sup>

# URCEOLABRUM TUBERCULATUM CRASSUM Stephenson, n.var.

#### Pl. 47, figs. 13, 14

Shell small, thick, turbinate, narrowly umbilicate, spiral angle about 55 degrees. Whorls 4 or 5 (estimated), circular in cross section; the protoconch and uppermost one or two whorls broken away. Suture deeply impressed. The inner lip is broken away but the aperture is probably circular. The peristome is greatly thickened forming a prominent flange standing at right angles to the surface; this was accidentally broken away in cleaning. The umbilicus is narrowly

<sup>&</sup>lt;sup>320</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 179, pl. 60, figs. 4-7, 11, 1926.

<sup>&</sup>lt;sup>321</sup>Cossmann, M., Annuaire géologique universal, Revue de Géologie et Paléontologie, Année 1893 (Gasteropodes), p. 742, 1893.

<sup>&</sup>lt;sup>322</sup>Cossmann, M., Revue Critique de Paléozoologie, no. 1, 1897, p. 12, 1897.

<sup>&</sup>lt;sup>323</sup>Münster, Georg Graf Zu, Beschreibung und Abbildung der in den Kalkmergelschichten von St. Cassian gefunden Versteinerungen: Betiräge zur Petrefacten-Kunde, Bayreuth, p. 107, pl. 11, fig. 12, 1811.

<sup>&</sup>lt;sup>324</sup>Johnson, C. W., Acad. Nut, Sci. Philadelphia Proc., vol. 50, p. 461, 1898.

<sup>&</sup>lt;sup>325</sup>Holzapfel, E., Paleontographica, Band 34, p. 170, pl. 18, figs. 3-7, 1888.

funnel-form, and its rim is bordered by a row of coarse tubercles. The shell is conspicuously ornamented with axials and spirals which are tuberculated at the intersections; the axials are much the stronger of the two elements. On the body whorl the axials number 13 or 14, are narrow, and trend slightly backward as they pass from the suture above down over the periphery; they are separated by wide, broadly concave interspaces. The spirals number 5 on the body whorl, of which the uppermost one is weak; they are small and narrow, and override the axials, on the crests of which they expand into prominent tubercles; three of the spirals remain uncovered on the penultimate and antipenultimate whorls, the uppermost one, however, becoming very weak on the latter.

A very close analogue of the typical *U*. *tuberculatum* Wade,<sup>326</sup> this variety is more coarsely sculptured, and appears to be a little less slender.

Holotype.-U.S.N.M. no. 76799.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

## Family TROCHIDAE

#### Genus GARRAMITES Stephenson, n.gen.

Type species.—Garramites nitidus Stephenson. Etymology.—By anagram from Margarites; treat as masculine gender.

This simple, nearly smooth, trochoid shell resembles *Margarites* in its general form and wide open umbilicus, but differs from that genus in having an angulated, rather coarsely crenulated, umbilical border. Within the umbilicus a broad, shallow, spiral sulcus closely borders the row of crenulations.

## GARRAMITES NITIDUS Stephenson, n.sp.

## Pl. 47, figs. 17-19

Shell small, thick, broadly conical; umbilicus deep and moderately wide; suture deep and bordered by a narrow shoulder. The peristome is incomplete, but the aperture appears to be broadly subovate and shows a tendency to separate from the parietal wall. The surface is nearly smooth and polished. A pair of narrow, shallow spiral grooves follows the upper

shoulder of the whorls, one of them lying close to the suture and the other half a millimeter or less below the suture. and another pair of similar grooves lying about half a millimeter apart appears on the periphery of the body whorl; the posterior one of the latter pair can be traced backward for several millimeters on the penultimate whorl, beyond which it sinks from view beneath the suture. The growth lines are fine but sharp, and are somewhat oblique to the vertical axis; the surface within the umbilicus is crossed by moderately coarse axial ribs each of which ends in a small node at the umbilical shoulder.

Dimensions of the holotype, the only known specimen: Height 5.5 mm., diameter 5.5 mm.

Holotype.-U.S.N.M. no. 76800.

Distribution in Texas.—Navarro group, Nacatoch sand: 3 miles northeast of Corsicana (9545).

#### Genus MONODONTA Lamarck

# MONODONTA? CANCELLOSA Stephenson, n.sp.

## Pl. 47, figs. 20, 21

Shell small, thick, turbinate, imperforate; umbilical fissure moderately deep; apical angle about 85 degrees. Whorls 4, plumply rounded, increasing rapidly in size; a proportionately wide but very obscure shoulder detectable. Suture deeply impressed. Protoconch very small, poorly preserved. Periphery and base regularly rounded. Aperture subcircular; outer lip broken away. There is a suggestion of a node or tooth at the lower end of the columella, but the shell there is corroded and poorly preserved. The growth lines bend broadly forward as they pass upward from the periphery, but swing back a little as they approach the suture. The surface is finely and sharply reticulated by narrow axials and spirals of nearly equal strength and spacing. The spirals number 13 or more on the body whorl, and 5 or 6 of the spirals are exposed on the penultimate whorl; the axials number about 5 to the millimeter.

Dimensions of the holotype: Height 4 mm., diameter 4 mm.

This species, represented by only one specimen, is unlike anything that has been found heretofore in the Upper Cretaceous of the Coastal Plain.

<sup>&</sup>lt;sup>223</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 179, pl. 60, figs. 13, 14, 1926.

# Holotype.-U.S.N.M. no. 76801.

Distribution in Texas.-Navarro group, Neylandville marl: 21/2 miles north of Corbet (16170).

Family EULIMIDAE

# Genus EULIMA Risso

# EULIMA CLARA Wade

Pl. 47, figs. 22, 23

# 1926. Eulima clara Wade, U.S.Geol. Survey Prof. Paper 137, p. 174, pl. 58, figs. 20, 21.

Shell large for the genus, elongate, slender, original luster dulled by weathering. Three of the larger whorls are preserved in the one available specimen; apical whorls and protoconch wanting. Suture closely appressed, slightly impressed. Whorls elongated, very broadly flattish rounded, becoming centrally toward the aperture on the body whorl. Periphery very broadly rounded. Aperture lanceolate, sharply acute at the rear, sharply rounded at the front. Outer lip thin, broadly arched; inner lip broadly excavated, moderately thick, simple, with the edge curving back broadly into the shell. Growth lines fine, broadly convex toward the aperture, trending a little forward from below upward. A few fine, very obscure spiral lines can be detected on the base and elsewhere on the shell.

Dimensions of the incomplete Texas shell: Height 15 + mm., diameter 4.4 mm.

Wade's holotype includes the body whorl only, which pertains to a shell somewhat larger than the Texas one. No essential difference can be detected between the two specimens.

Holotype.-U.S.N.M. no. 73093; from the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tennessee. Plesiotype from Texas, U.S.N. M. no. 76802.

Distribution in Texas.-Navarro group, Neylandville marl: 21/2 miles north of Corbet (Tex. Bu. 17300).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

# Order CTENOBRANCHIATA

Suborder PLATYPODA

# Superfamily GYMNOGLOSSA

#### Family PYRAMIDELLIDAE

# Genus CREONELLA Wade

1917. Creonella Wade, Acad. Nat. Sci. Phila-delphia Proc., vol. 69, p. 302, pl. 19, fig. 8.
1926. Creonella Wade, U.S.Geol. Survey Prof. Paper 137, p. 172, pl. 58, fig. 8.
Type species.--Creonella triplicata Wade.

The type species of the genus Pyramidella Lamarck, on which the family is based, is the Recent Pyramidella dolabrata (Linné) from the Antilles. In this species there is a false umbilicus extending less than the width of the body whorl into the shell; the anterior canal is narrow and shallow; on the inner lip are three folds, the posterior one being narrow, prominent, and separated from the parietal wall by a deep channel; the sides of the whorls are broadly convex; and the sutures are deeply impressed. In Creonella triplicata the type species of Wade's genus the shell is imperforate, the anterior canal is narrow and rather deep, the posterior fold is small, narrow and is set against the parietal wall, the sides of the whorls are flat, and the sutures are only moderately impressed. Among the shells of Pyramidellidae figured by Bartsch, the species nearest in form and surface features to Creonella is Pyramidella (Longchaeus) mazatlantica Bartsch,<sup>327</sup> but Creonella lacks a peripheral sulcus and the uppermost of the three plications is small and lies close against the parietal wall instead of being large and separated from the wall by a pronounced channel. These differences seem to justify a separate designation for the Cretaceous shells.

## CREONELLA WHITEI Stephenson, n.sp.

#### Pl. 48, figs. 1-3

Shell of moderate size, turreted. Spire acuminate, spiral angle 22 degrees, nearly constant throughout the height. Whorls 11 or 12 (estimated), nearly flat

<sup>327</sup> Bartsch, Paul, U.S. Nat. Mus. Bull. 68, p. 24, pl. 1, figs. 7, 7a, 1909.

on the sides but a narrow, slightly raised band closely borders the suture on the anterior side, in front of which is a very faint, shallow constriction. Suture narrow, closely appressed and sharply impressed. The growth lines cross the exposed part of each whorl of the spire in a nearly vertical direction, but are broadly concave backward. The surface is nearly smooth, but under a lens numerous very faint spiral lines can be detected. Periphery faintly subangulated, base descending steeply to the the columella. Aperture elongate-ovate. Outer lip broken away; inner lip formed by parietal wall and columella, deeply excavated medially. Anterior canal nardeep and strongly row, recurved. Columella with two strong plications, the anterior one bordering the canal narrow, and the posterior one thicker and very prominent; on the parietal wall back of the heavy fold is a third narrow distinct fold; the interspaces between the three folds form two deep, broadly concave spiral sulci around the columella, the anterior one of which is a little the broader.

Dimensions of the incomplete holotype, five or six whorls of which are broken away at the apical end: Height 13 + mm., diameter 5.5 mm. Dimensions of the paratype, a smaller individual, which is a little broken at the apex: Height 9.5 mm., diameter 4 mm.

This species is much less slender than *Creonella triplicata* Wade.

*Types.*—Holotype, U.S.N.M. no. 76803; 1 figured paratype, U.S.N.M. no. 76804. Named in honor of Dr. C. A. White, who, with C. B. Boyle, collected at this locality.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); ?vicinity of Corsicana (763).

## CREONELLA TRIPLICATA Wade

## Pl. 48, figs. 8, 9

- 1917. Creonella triplicata Wade, Acad. Nat. Sci. Philadelphia Proc., vol. 69, p. 303, pl. 19, fig. 8.
- 1918. Creonella triplicata Wade. Cossmann, Rev. critique paléozoologie, année 22, nos. 1-2, p. 21.

1926. Creonella triplicata Wade, U.S.Geol. Survey Prof. Paper 137, p. 173, pl. 58, figs. 8, 25.

Shell of moderate size, very slender. Spire acuminate, apical angle about 17 degrees. Whorls 10 or more (estimated), sides nearly flat, but slightly swollen anteriorly and slightly constricted pos-Suture closely appressed, teriorly. sharply impressed. The growth lines are very fine, nearly straight, and trend obliquely a little backward from below upward. Numerous exceedingly fine, faint spiral lines can be detected under a good lens. The periphery is rounded and the base is steep. Aperture subovate, angulated posteriorly. Inner surface of shell well back from the aperture marked by 4 distinct spiral lirae which, as shown by impressions on an internal mold, die out anteriorly before reaching the outer Anterior canal, short, narrow, deep lip. and strongly recurved. Columella bearing two distinct folds, the anterior one bordering the canal, of moderate strength, the posterior one strong and prominent; a third narrow lira near the base of the parietal wall parallels the two larger columellar folds. The three folds are separated by profound channels of nearly equal width, the posterior one being a little the deeper.

Dimensions of the largest of the three Texas shells: Height 13 + mm., diameter about 3.75 mm.

This species is markedly more slender than *C. whitei*, the interspaces between the three folds are more nearly equal in width, and the growth lines incline more to the right as they pass upward over the whorls.

Types.—Holotype and paratype, U.S.N.M. no. 73086. From the Coon Creek tongue of the Ripley formation on Coon Creek, McNairy County, Tennessee. Plesiotypes from Texas, U.S.N.M. nos. 76805, 76806.

Distribution in Texas.---Navarro group. Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (17365).

Navarro group, Nacatoch sand: 145 miles northeast of Quinlan (16162, 1 plesiotype; 16171); vicinity of Kaufman (761, 1 plesiotype). Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

Range.—In Texas ranges from the Neylandville marl into the Nacatoch sand.

#### CREONELLA DEUSSENI Stephenson, n.sp.

## Pl. 48, figs. 6, 7

Shell small. turreted, slender. Spire acuminate, spiral angle 23 degrees, nearly constant throughout height. Whorls 9 or 10. closely appressed, flat on sides. Suture narrow and sharply but not deeply impressed. The growth lines are only slightly sinuous as they pass obliquely backward from the anterior to the posterior suture of a given whorl. The surface is polished and nearly smooth, but numerous very fine, faint, spiral lines can be detected under a strong lens in a good The periphery is faintly sublight. angulated, in front of which the surface rounds down rather abruptly to the columella. Aperture elongate-ovate, angulated posteriorly and with a moderately broad, strongly recurved anterior canal. Outer lip broken away on both specimens; inner surface of shell just back of broken lip marked by 6 or more faint to distinct, narrow, nearly regularly spaced, spiral Inner lip formed below by lirae. columella and above by the parietal wall thinly glazed in part with callus; inner lip deeply excavated medially. The inner lip bears three folds, the two anterior ones of which are on the columella, and the third one on the parietal wall; the anterior fold is narrow, moderately prominent, and borders the canal; the middle fold is thick and very prominent; the posterior fold is narrow and moderately prominent; the interspaces between the folds are broadly concave and deep, the posterior one being much more profound than the anterior one. The holotype, the larger of the two available specimens, has 5 anterior whorls preserved, and 5 or 6 posterior whorls missing.

Dimensions of the holotype: Height 5 + mm., diameter slightly more than 2 mm. Dimensions of the paratype, a smaller, but nearly complete specimen: Height 5 mm., diameter slightly less than 2 mm.

Compared with *C. whitei* this species is much smaller and more slender, and the growth lines cross the whorls more obliquely. *C. triplicata* Wade is a little more slender than this species, and has a less deeply impressed anterior canal.

Types.—Holotype, U.S.N.M. no. 76807; 1 unfigured paratype, U.S.N.M. no. 76808. Named in honor of Mr. Alexander Deussen, Geologist, who accompanied the writer to Webberville when this collection was made.

Distribution in Texas.--Navarro group, Kemp clay: Webberville (7601).

#### Genus PSEUDOMELANIA Pictet

#### PSEUDOMELANIA RUNNELSI Stephenson, n.sp.

#### Pl. 48, figs. 4, 5

Shell small, moderately slender, smooth, and polished. Suture closely appressed, bordered below by a very shallow constriction. Whorls 8 or 9, flattish to very faintly and broadly convex on the sides, increasing regularly in size and width. Body whorl subangulated on the periphery, descending rather steeply to the aperture. Protoconch broken away on both available specimens. Aperture broadly elliptical with an incipient canal in front; outer lip broken; inner lip thin and closely adhering posteriorly, thickening a little anteriorly. Columella smooth.

Dimensions of the holotype, a slightly broken specimen: Height 6.5 + mm., diameter 2.2 mm.

This shell is similar to Eulima laevigata Wade (probably a Pseudomelania), from Coon Creek, Tennessee, but is larger, a little less slender, and the width of its whorls increases more rapidly. It is more slender and has smoother sutures than Pseudomelania monmouthensis Gardner, from the Monmouth formation of Brightseat, Maryland.

Types.—Holotype, U.S.N.M. no. 76809; 1 unfigured paratype, a broken shell, U.S.N.M. no. 76810. Named for the Hon. Hardin G. Runnels, Governor of Texas, 1857 to 1859.

Distribution in Texas.—Navarro group, Kemp clay: Webberville (7601).

# Superfamily PTENOGLOSSA

## Family EPITONIIDAE

# Genus EPITONIUM Bolten

# EPITONIUM BEXARENSE Stephenson, n.sp.

#### Pl. 48, figs. 19-21

Shell rather large, turreted, spiral angle about 27 degrees. In the holotype six whorls are preserved with several missing at the apical end; they increase regularly in size, and are strongly convex on the sides. Suture deeply impressed. Surface strongly ornamented with axial ribs which, though thin, differ in thickness, are rough on the outer edges, and trend from the suture with slight obliquity downward and backward across the whorl; the ribs range in trend from nearly straight to strongly convex backward; there is a definite tendency for the ribs to be reflected backward at their lower ends near the suture. On the body whorl of the holotype the ribs number 20 and range from 1 to 3 millimeters apart; the ribs decrease in number on the successive whorls from front to back. The periphery is marked by a rough, prominent carina against which the prominent ribs of the body whorl end; beyond this carina the weakly developed ridges continue across the steeply descending base to the columella. The shell is imperforate, but there is a rather wide umbilical fissure. The surface of the shell between the ribs is covered with fine, closely spaced, revolving ridges which, although somewhat irregular, show a definite tendency to alternate in size. Peristome subcircular, entire, attached for 3 or 4 millimeters along the parietal wall; outer lip thick; inner lip not quite so thick as the outer.

Dimensions: Height 42 + mm., diameter about 20 mm.; the total height is estimated to be about 55 mm.

Compared with *E. sillimani* (Morton), as figured,<sup>328</sup> this species is larger, has a rougher and more prominent development of the longitudinal ribs which, however, are narrower, is a little less tapering, and

has a somewhat stronger and coarser development of fine revolving ridges. The questionable types of Morton's species, in the Academy of Natural Sciences of Philadelphia, are two incomplete shells, neither of which appears to be the figured specimen; both are shorter and one is much smaller than the shell illustrated.

Holotype.-U.S.N.M. no. 76811.

Distribution in Texas.—Navarro group, Corsicana marl: 6 miles east of Castroville (15502, type loc.); well 7/20 mile south by west of St. Mary's University, Bexar County (16353).

# EPITONIUM PONDI Stephenson, n.sp.

Pl. 48, figs. 22, 23

1926. Scala sillimani (Morton). Wade, U.S. Geol. Survey Prof. Paper 137, p. 168, pl. 54, figs. 12, 13, 15, 16.

Shell of moderate size, turreted, spiral angle about 22 degrees. Four plus anterior whorls are preserved on the holotype, and it is estimated that there would be 10 or 12 additional whorls to the apex of the complete specimen; the whorls are plump and compactly coiled, and the suture is deeply impressed. Surface ornamented with strong, rather thin, rough-edged axial ribs which cross the whorls somewhat obliquely from above downward and backward, and are sharply reflected backward to form a distinct notch just above the suture. The ribs number 13 on the body whorl. The periphery is marked by a distinct spiral rib just below the notches on the main ribs, beyond which on the base of the shell the ribs are continued to the columella in lower but sharp, distinct varices. Shell imperforate with, however, a well marked umbilical fissure. Numerous fine, closely spaced spiral ribs cover the surface between the axial ribs; these spiral ribs are somewhat irregular in their development but show a marked tendency to alternate in size. Peristome subcircular, continuous, loosely attached for 2 or 3 millimeters along the parietal wall; outer lip thick; inner lip not so thick. Inner surface of shell smooth.

Dimensions of the incomplete holotype: Height 24 + mm., diameter 12.5 mm.

<sup>&</sup>lt;sup>325</sup>Morton, S. C., Synopsis of the organic remains of the Cretaceous group of the United States, p. 47, pl. 13, fig. 9, 1834.

Estimated total height about 37 mm. A small nearly complete shell, which is apparently a young individual of this species, is 4.5 mm. long and about 2 mm. in diameter; there are 8 axial ribs on the body whorl; the protoconch is not preserved.

This species is based on the shells which Wade figured under the name Scala sillimani (Morton). (See synonymy.) The larger of the two specimens figured by him (pl. 54, figs. 13, 15, 16) is the holotype. This species differs from *E. sillimani* (Morton) as figured in that it is more slender, has more prominent, more direct, and rougher axial ribs, has the backward reflected notches at the lower end of the ribs much more strongly developed, and has more sharply developed spiral sculpture.

One Texas specimen (pl. 48, figs. 22, 23) is imperfectly preserved and somewhat crushed, but appears to agree essentially with the Tennessee species, although its umbilical fissure is more nearly closed.

The species is smaller and much more slender than *E. bexarense*.

Types.--Holotype and 1 paratype, U.S.N.M. no. 32942. Described by Wade (see synonymy) under name of Scala sillimani (Morton). Two other paratypes (10198), collected by Wade, U.S.N.M. no. 76812. Figured example from Texas, U.S.N.M. no. 20907. Named in honor of Mr. Walter F. Pond, State Geologist of Tennessee.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, figured).

Navarro group, Corsicana marl: Road 3 7/10 miles southwest of Campbell (17384); 4 miles southwest of Quinlan (17385).

Outside distribution.—Tennessee: Coon Creck tongue of Ripley formation; from Coon Creek on Dave Weeks' farm in the northeastern part of McNairy County; this is the type locality of the species.

Range.—Lower part of Exogyra costata zone; known in Texas only from the Nacatoch sand of the Navarro group.

#### EPITONIUM sp.

# Pl. 48, fig. 24

Three small specimens from the Kemp clay at an earthern tank west of the road, about 2 miles south-southeast of Schumansville, 9/10 mile south-southeast of the crossing of Long Creek, Guadalupe County (16668), appear to differ from other described species mainly in having a wider apical angle, more deeply impressed sutures and more strongly convex whorls. The fine spiral lines are obscurely developed. The specimens are probably young or half grown individuals and are not considered complete enough to serve as types. U.S.N.M. no. 76813.

# Genus PROSCALA Cossmann

# PROSCALA AMERICANA Wade?

#### Pl. 48, fig. 11

1926. Proscala americana Wade, U.S.Geol. Survey Prof. Paper 137, p. 170, pl. 55, figs. 10, 11.

Shell small, turreted, elongated, apical angle about 22 degrees. Protoconch broken away. Shell incomplete anteriorly. As preserved there are 5 whorls which are very gently convex to almost flat on the sides. Suture closely appressed. Surface ornamented with numerous, moderately prominent, nearly straight axial ribs, narrower than the interspaces, which posteriorly are separated from the suture by a narrow spiral ridge, and trend downward and slightly backward across the whorl; these ribs number 18 on the largest whorl preserved and 16 or 17 on the smallest. Fine spiral lines such as are present on Wade's holotype are not detectable, but this may be due to poor preservation. The periphery is sharply rounded and the base descends abruptly almost at right angles to the columella.

Dimensions of the incomplete Texas shell: Height 9 + mm., diameter 4 mm.

The description is based on one small shell which is probably a juvenile example. This shell probably belongs to the same genus as Wade's *Proscala americana*, but the specimen is inadequate for a confident specific identification.

Holotype.-U.S.N.M. no. 32952; from Coon Creek tongue of Ripley formation

# at Coon Creek, McNairy County, Tennessce. Plesiotype? from Texas, U.S.N.M. no. 76814.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

Range.—Known only in the lower part of the *Exogyra costata* zone at the two foregoing localities.

#### Genus BELLISCALA Stephenson, n.gen.

Type species.—Belliscala rockensis Stephenson. Etymology.—Latin bellus, handsome; Scala.

Shell turreted, whorls plumply rounded, compactly coiled. Suture deeply impressed, bordered below by a poorly defined, narrow, constricted, posterior fasciole. Spiral angle of genotype about 34 degrees. Axial ribs 20 or more on the body whorl; the ribs are very weak on the posterior fasciole, but become moderately prominent as they pass with slight backward obliquity from the fasciole downward across the whorl. Spiral ribs numerous and fine but strong enough to produce a fine cancellation. Inner lip thin. The protoconch is not preserved. Compared with Epitonium this genus has a wider apical angle, less prominent and smoother axial ribs, and a narrow, rather weakly developed posterior fasciole. The shell from Coon Creek, Tennessee, which Wade questionably identified with Acirsa? cerithiformis Meek and Hayden probably belongs to this genus.

# BELLISCALA ROCKENSIS Stephenson, n.sp.

# Pl. 49, figs. 19, 20

Shell of medium size, turreted, with spiral angle of about 34 degrees. Protoconch and one or two apical whorls broken away; anterior canal and nearly half of body whorl also partly broken away. Whorls 7 or 8, plumply rounded; anal fasciole obscure, slightly excavated; shoulder narrow and weakly developed; body whorl broadly rounded on the periphery, with base descending steeply to the columella. Axials moderately prominent, rather narrow, rounded to subangular on the crests, narrower than the interspaces; they extend weakly across the

shoulder to the suture above, and extend weakly down over the base below. The whole surface is covered with fine, distinct, but not prominent, spirals, which are divisible into primaries, secondaries, and in places, tertiaries; about 10 primaries are exposed on the penultimate whorl. The aperture is broadly subovate, and the parietal wall is covered with a thin film of callus.

Dimensions of the incomplete holotype: Height 23 + mm., diameter 11 mm.

Holotype.--U.S.N.M. no. 76922.

Distribution in Texas.—Navarro group, Nacatoch sand: 3 miles northeast of Corsicana (9545).

# BELLISCALA FORSHEYI (Shumard)

# Pl. 49, figs. 13, 14

1861. Scalaria forsheyi Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 195.

Shell of moderate size, turreted, spiral angle about 40 degrees. Whorls plumply rounded, compactly coiled; 5 whorls preserved on the larger of the two available specimens, on which part of the body whorl and several apical whorls are missing. Suture deeply impressed, bordered below on the posterior part of the whorl by a rather weakly developed narrow fasciole. The axial ribs are narrow, moderately prominent, have a slight backward obliquity in trend from above downward and number 23 on the largest whorl preserved; the ribs become weak where they cross the posterior fasciole and fade out on the base before reaching the columella; between the ribs are numerous fine, filiform, axial lines. The body whorl rounds down steeply on the base to the columella. The surface is further ornamented with a system of small, distinct spiral ribs which are well developed both between and on the crests of the axial ribs; on the smaller whorls of the spire there are about 7 primary ribs and an equal number of intermediate secondary ribs; as the whorls increase in size still smaller tertiary ribs appear between the primary and secondary ribs, and this feature is especially marked on the penultimate whorl and on the base of the body whorl; the spiral ribs are well developed on the base to the border of the columella. The aperture and a considerable part of the body whorl are broken

away; apparently the aperture is broadly subovate in outline with its long axis slightly oblique to the vertical axis of the shell.

Dimensions of the figured spicimen: Height 19 + mm. diameter 11 mm. Estimated total height 24 mm.

Types.—The holotype is lost, and no other specimens have been found at Chatfield, the type locality. The incomplete specimen figured and an accompanying fragment are from near Corsicana, U.S.N. M. nos. 20892, 20892a.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518).

#### BELLISCALA CRIDERI Stephenson, n.sp.

## Pl. 49, figs. 15-18

This species is based on one incomplete specimen which includes part of the body whorl and most of the penultimate whorl, found with B. forsheyi (Shumard), near Corsicana. The shell is much like Shumard's species, but is more slender, having a spiral angle of about 30 degrees; the whorls are not quite so plump, the posterior fasciole is a little weaker, and the axial ribs are more prominent across it; there is a weakly developed peripheral angle, below which on the base the axial ribs become weak and fade out before reaching the columella. The spiral sculpture includes small primary ribs with still smaller intermediate secondary, tertiary and quaternary ribs, which produce a finer, more compactly crowded sculpture than that on B. forshevi; the base is also marked with fine closely crowded threads of nearly uniform size.

Holotype.--U.S.N.M. no. 76815. Named in honor of Mr. A. F. Crider, Geologist, Shreveport, Louisiana.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518).

#### Family MATHILDIIDAE

#### Genus TUBA Lea

The Texas species, *Tuba? manzaneti*, is similar in form to the genotype, *Tuba alternata* Lea (Eocene), but has a somewhat higher spire and lacks an umbilical perforation, which, however, in Lea's species is small and narrow.

#### TUBA? MANZANETI Stephenson, n.sp.

#### Pl. 48, figs. 15--17

Shell of medium size, thick and strong, turbinate, with spiral angle of about 48 degrees. Two and part of a third whorl preserved in the holotype, with part of the body whorl and 3 or 4 apical whorls missing: whorls plumply rounded, compactly coiled. Suture deeply impressed. Surface sculpture ornate. On the penultimate whorl are 10 spiral ribs of unequal size arranged in order from rear to front as follows: The second rib is larger than the first, the third is larger than the second, and the three cover a band about a millimeter wide; the fourth to the tenth ribs, starting with a small one, alternate markedly in prominence and width; three of the larger of these ribs are each about half a millimeter wide, and constitute the major ones of the series; the tenth rib is larger than the other intermediate ribs; forward from the tenth rib on the base of the body whorl the ribs continue to alternate in size to the fifteenth rib, between which and the columella are 15 small, closely packed, subequal ribs. The spiral ribs are crossed by axial rows of narrow. sharply defined, closely spaced beads, giving to the shell under a magnifying glass a handsomely cancellated appearance. There is no peripheral angle, the body whorl rounding down plumply and steeply to the columella. About a third of the body whorl is broken away, but the aperture is probably broadly subovate to subcircular; a thin callus partly preserved indicates a thin inner lip. Umbilical fissure narrow, distinct.

Dimensions of the holotype: Height 14 + mm., diameter 12 + mm. Total estimated height 20 mm.

This species is closely related to T. parabella Wade, from Coon Creek, Tennessee, but the spiral angle is greater, the axial beads are more closely crowded on the spiral ribs, and the major ribs on the periphery of the whorls are not quite so prominent, giving to the whorls a more smoothly rounded appearance.

It is unfortunate that the type of *Tuba* bella Conrad from the Ripley formation at Eufaula, Alabama, has been lost, for it is obviously closely related to both *T*.? manzaneti and *T. parabella*. Tuba? reticulata Johnson,<sup>329</sup> from the Cretaceous in a well near Mount Laurel, New Jersey, is generically and specifically distinct from both the Texas and Tennessee species of Tuba; it is probably an Urceo-labrum.

Holotype. --U.S.N.M. no. 21079. Named for Padre Manzanet, one of the founders of the Mission San Francisco de los Tejas, near Neches River, in 1690.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); vicinity of Corsicana (763); vicinity of Kaufman (761).

# TUBA? sp.

An imperfectly preserved fragment of the body whorl of a Tuba? from the Nevlandville marl in a roadside ditch  $2\frac{1}{2}$ miles south of Ben Hur, Limestone County (15543), exhibits sculpture very much like that of T.? manzaneti except that there is a marked alternation in size of the spiral ribs all the way up the side of the whorl to the suture. A peripheral angle is scarcely developed and the spiral ribs become smaller on the base toward the columella. The geologic age of this species is approximately the same as that of Wade's species, T. parabella from Coon Creek, Tennessee, but the axial beads are thicker and more closely crowded, and in this respect are more like T.? manzaneti. U.S.N.M. no. 76816.

#### TUBA? sp.

#### Pl. 48, fig. 18

A poorly preserved specimen, apparently a Tuba, associated with many individuals of Micrabacia navarroensis Wells, was found by Julia Gardner, in the upper part of the Kemp clay member of the Navarro formation, in a draw half a mile west of the Austin road, 6 miles north of Lockhart, Caldwell County (13777). The shell is small and slender for the genus. Four plus whorls including the body whorl are preserved, and 5 or 6 apical whorls are missing. The sides of the whorls are moderately convex, and the suture is deeply impressed. There is a barely perceptible peripheral angle below which the base declines steeply to the columella.

The surface is covered with evenly noded revolving ribs of somewhat variable size, numbering 5 or 6 on the penultimate whorl; the width of the interspaces is equal to or less than that of the ribs. The ribs on the lower part of the whorl and in the vicinity of the peripheral angle appear to be larger than elsewhere, and on the base toward the columella the ribs become considerably smaller. Aperture not well preserved, but apparently circular. The shell is estimated to have a length of about 16 mm. and a diameter of 5 mm. The apical angle is probably about 30 The shell is smaller and more degrees. slender than T.? manzaneti and lacks the alternation in the size of the spiral ribs on the outer, more convex part of the whorls of that species. U.S.N.M. no. 76817.

#### Genus MATHILDA Semper

#### MATHILDA CEDARENSIS Stephenson, n.sp.

#### Pl. 48, fig. 10

Shell small, turreted, slender, spiral angle about 19 degrees. Five whorls present as preserved, with whorls missing at both ends. The spiral ornamentation above the periphery consists of 2 prominent primary ribs, the lower one of which is bifid on the crest, and a small secondary rib in the bottom of the wide interspace; the lower bifid rib is situated at the periphery; the upper rib is a little below the suture; the flattish base is not perfectly preserved, but 2 secondary spirals may be seen on the side nearest the periphery. The axial sculpture consists of numerous, fine, sharp, closely spaced ribs which run nearly vertically across the whorls; these are present both on the crests of the spirals and in the interspaces, but are sharpest in the interspaces as preserved. The base, though not well preserved, appears to be nearly flat, descending abruptly from the periphery to the center. Aperture subquadrangular.

Dimensions: Height 5 + mm., diameter at large end 2.3 mm.

The character of the sculpture relates this species closely to *Mathilda ripleyana* Wade, but the Texas specimen is more slender, and has fewer revolving ribs at the same stage. The axial sculpture on the two species is closely similar.

<sup>&</sup>lt;sup>329</sup>Johnson, C. W., Acad. Nat. Sci. Philadelphia Proc., vol. 50, p. 461, 1898.

Holotype.—U.S.N.M. no. 76818.

Distribution in Texas.--Navarro group, Neylandville marl: 2½ miles north of Corbet (16170).

# Family ARCHITECTONICIDAE

#### Genus ARCHITECTONICA Bolten

#### ARCHITECTONICA VORAGIFORMIS Stephenson, n.sp.

#### Pl. 48, figs. 12-14

Shell of medium size and thickness, depressed conical, umbilicate; spiral angle about 95 degrees. Whorls 5 or 6, flattish on the side, with a spiral sulcus toward the lower edge. Suture closely appressed, sharply but not deeply impressed. Protoconch not preserved. Base flattish with, however, a broad, shallow, spiral sulcus near the periphery; this sulcus is opposite to the sulcus near the lower border of the outer side of the whorl and the two constrictions together produce a thin, projecting, flange-like carina on the periphery of the body whorl. Umbilicus wide and deep. Starting from the rim of the umbilicus the growth lines cross the base trending obliquely forward, and curving broadly forward as they cross the peripheral sulcus and flange; on the lateral surface of the whorl the growth lines continue upward and somewhat obliquely forward to the suture. The lateral surface of the body whorl near the aperture is ornamented with 7 primary, beaded, spiral lirae, the last two of which are on the peripheral flange; in each of the interspaces except between the fourth and fifth (counting from the suture downward) is a small, obscurely beaded secondary; the seven primary spirals are traceable backward on the whorls toward the apex to the place where the surface is too badly corroded to count them; the secondaries fade out posteriorly, the last trace of them disappearing at about the beginning of the penultimate whorl. The base is covered with about 15 closely crowded, beaded spiral lirae which are coarsest near the rim of the umbilicus. but become regularly smaller toward the periphery, fading out on the peripheral flange. The rim of the umbilicus is relatively coarsely nodose, the nodes being elongated in the direction of the growth lines. The wall of the umbilicus appears

to be covered with spiral lirae which are not clearly uncovered.

The lips are broken but the aperture is subsquarish with a slight obliquity in the direction of the peripheral flange.

Dimensions of the holotype: Height 8.8 mm., diameter 14.4 mm.

Holotype.—U.S.N.M. no. 76819.

Distribution in Texas. Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

#### Unidentified specimens of ARCHITECTONICA

Imperfectly preserved specimens which may belong to *Architectonica*, but which are hardly well enough preserved for either generic or specific identification, have been found in the Navarro group at several localities as follows:

At Crystal Lake, an artificial lake 5 miles south of Annona, Red River County (13093, U.S.N.M. no. 76820), an exposure of glauconitic sand belonging to the Nacatoch sand, at the outlet of the lake, yielded the internal mold of a medium sized gastropod having the form of Architectonica. The whorl is somewhat flattened and the periphery is angulated; the underside of the body whorl is broadly rounded and the umbilicus is wide open. The dimensions are: Height 7 mm., diameter 14 mm. An imperfect specimen which may be the same species was found in a field on the Simpson place about 2 miles southwest of Kaufman, Kaufman County (7517, U.S.N.M. no. 76821).

From the Corsicana marl on San Marcos River, half a mile below Martindale, Caldwell County (7621, U.S.N.M. no. 76822), a medium sized specimen mechanically flattened in the marl exhibits some of the shell characters. The surface is covered with fine spiral threads: the under surface of the apical whorls within the umbilicus are covered with fine, closely spaced axial ribs which appear to be fading out on the posterior part of the body whorl, but are not uncovered on the middle and anterior parts of the whorl. The diameter of the shell is about 13 mm. A smaller specimen preserved in the same way, and similarly but not quite so plainly marked, was found in the marl on the Mexia road, 234 miles east of Cooledge, Limestone County (13832, U.S.N.M. no. 76823), and a specimen of the same kind came from the marl

in a branch below public road, 2<sup>1</sup>/<sub>2</sub> miles north of Tona siding, 5 miles southwest of Quinlan, in Hunt County (15546, U.S.N.M. no. 76824).

The bluff on Onion Creek,  $2\frac{1}{2}$  miles west of old Garfield, Travis County (14156), yielded a small, flattened specimen of *Architectonica* from the Corsicana marl, which reveals only the imprint of the shell. A row of small nodes closely parallels the suture on the posterior side of the whorl; the rest of the surface appears to be smooth with the exception of fine spiral threads near the periphery. The diameter is about 5.5 mm. U.S.N.M. no. 76825.

A badly crushed small specimen of *Architectonica*? was found in the Kemp clay in a branch  $\frac{1}{2}$  mile south of McLeod school,  $\frac{61}{2}$  miles southwest of Currie, Navarro County (17377, U.S.N.M. no. 76826); the perimeter is sharply and finely crenulated. Another specimen from the Kemp clay is not quite so large but is similarly preserved and is identically ornamented; it came from  $\frac{1}{2}$  mile west of Odds (Limestone County) in Falls County (15134, U.S.N.M. no. 76827).

# Genus MARGARITELLA Meek and Hayden

# MARGARITELLA PUMILA Stephenson, n.sp.

# Pl. 49, figs. 9, 10

Shell small and thin, depressed domical. Whorls about 4 with very broadly rounded upper surfaces. Suture closely appressed, not deeply impressed. Protoconch flattish, coiled one and a half or two times. Periphery acutely angular. Base very broadly rounded; umbilicus deep and of moderate diameter. On the first whorl following the protoconch a row of low, rounded nodes borders the suture on the posterior side, but these nodes fade out about the middle of the penultimate whorl: otherwise the upper surface appears to be smooth. The base bordering the umbilicus is ornamented with low, closely spaced, longitudinal ribs which fade out about a third of the distance across the base toward the periphery. The rest of the base is nearly smooth, but in a good light under a lens several fine spiral lines can be detected near the periphery. The rim of the umbilicus is overhanging and the body whorl is loosely coiled, leaving an uncovered band on the base next to the periphery of the penultimate whorl.

Dimensions of the holotype: Height 2.8 mm., diameter 7 mm.

This little shell appears to be a member of the genus Margaritella Meek and Havden,<sup>330</sup> but differs from their type species, M. flexistriata (Evans and Shumard), in the details of ornamentation, and is a distinct species. Meek was mistaken in his statement that the margin of the umbilicus is not crenate: the specimen which he specified as the type of the genus is an internal mold and does not show crenulations, but another specimen from the same locality, on which his figure 11d. plate 19, is probably based, shows not only fine crenulations on the margin of the umbilicus, but a band bordering this margin is elegantly sculptured with longitudinal ribs which run part way across the base; this part of the shell may have been covered with matrix at the time he examined and identified the specimen.

*Types.*—Holotype, U.S.N.M. no. 76828; 2 paratypes, U.S.N.M. no. 76829.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

Superfamily TAENIOGLOSSA

Family LITTORINIDAE

Genus SPIRONEMA Meek

# SPIRONEMA PERRYI Stephenson, n.sp.

Pl. 49, figs. 11, 12

Shell thin, of medium size, turbinate, apical angle about 65 degrees. Whorls five, rapidly expanding, plumply rounded, compactly coiled. Suture deeply impressed. Protoconch broken away. The surface is ornamented with small, low, squarish, spiral ribs which are wider than the flat-bottomed interspaces. These ribs number 7 on the penultimate whorl, and about 17 on the body whorl; a smooth band about twice as wide as an ordinary interspace separates the posterior rib from

<sup>&</sup>lt;sup>330</sup>Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 300, 1876.

the suture. Very faint, broad, irregular axial undulations can be detected on the larger whorls in a good light. The aperture is not preserved but it apparently is broadly subovate. Umbilicus very small, nearly closed.

Dimensions of the holotype: Height 15 + mm., diameter 12 mm.

Compared with Spironema tenuilineata Meek and Hayden.<sup>331</sup> from the Fox Hills formation of the Western Interior, this shell is smaller, the spiral ribs are fewer, more regular, and more widely spaced, the suture is less deeply impressed, and the umbilicus is more nearly closed.

Holotype.--U.S.N.M. no 76830. Named for Captain Perry, an adventurer in Texas in the early part of the 19th Century.

Distribution in Texas.—Navarro group, Nacatoch sand: Road 3/5 mile west of Kaufman (7545).

#### Family CAPULIDAE

#### Genus CAPULUS Montfort

# CAPULUS SPANGLERI Henderson

# Pl. 49, figs. 1-4

1908. Capulus spangleri Henderson, U.S. Nat. Mus. Proc., vol. 34, p. 261, pl. 13, figs. 5-7.

Shell very thin, of moderate size, subconical or cap-shaped, noticeably twisted to left as viewed from above the apex. Apex curved rather strongly backward, but not coiled. Protoconch not preserved. The outline of the aperture is broadly subovate, but is variable in different individuals. The surface is corrugated with 12 or 13 radial ribs which differ markedly in prominence, and are variable on different individuals; viewed from the front, that is with the apex bent away from the observer, there are 3 widely spaced ribs on the left slope, the posterior one of which may be strong or weak, or may be wanting, and is very weak in the holotype. Continuing around the front to the right are a series of less widely spaced ribs, as follows: A narrow flat-topped rib, a slightly wider round-topped rib, a narrow

flat-topped rib, a round-topped rib, a narrow flat-topped rib, and a round-topped rib. In front of the latter is a deep, narrow interspace or sulcus which is present on all specimens, and following this to the right are a round-topped rib, a narrow flat-topped rib, a round-topped rib, and beyond a wide interspace a broad, weak, round-topped rib. A wide triangular space on the posterior side of the shell under the beak is smooth. There is a tendency for the round-topped ribs to be more prominent than the flat-topped ones, but they vary greatly in width and strength on different individuals.

The available material consists mainly of internal molds on some of which small patches of shell material remain adhering; on some of these patches fine, obscure axial lines can be detected.

Dimensions of a small but well preserved internal mold from Texas: Considering the aperture as base, the height of the tube is about 16 mm., the longest diameter is 19 mm., and the shortest diameter 18 mm. A larger specimen from the same locality is about 17 mm. high and 30 mm. in longest diameter (pl. 49, fig. 4).

There appears to be no essential difference between these Texas specimens and the type of *C. spangleri* Henderson, from the Pierre shale of the Western Interior.

The incomplete shell from Coon Creek, Tennessee, described by Wade,<sup>322</sup> under the name *C. corrugatus*, is very close to this species and the two may prove to be specifically identical when better material is available for comparison.

Holotype.-U.S.N.M. no. 30879; from the middle of the Fort Pierre shale, at Fossil Ridge, 6 miles south of Fort Collins, Colorado. Plesiotypes from Texas, U.S.N.M. nos. 76831, 20909; measured specimen and fragments from Texas, U.S.N.M. no. 21068.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, loc. of 1 plesiotype); vicinity of Corsicana (763, loc. of 1 plesiotype).

<sup>&</sup>lt;sup>331</sup>Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, pp. 341-342, 1876.

<sup>&</sup>lt;sup>332</sup>Wade, Bruce, U. S. Gool, Survey Prof. Paper 137, p. 166, pl. 58, fig. 4, 1926.

*Outside distribution.*—Middle part of Pierre shale of Colorado.

Range.- Known only from the Nacatoch sand of Texas and the middle part of the Pierre shale of Colorado. May be the same as *C. corrugatus* Wade from the Coon Creek tongue of the Ripley formation of Tennessec.

# CAPULUS CUTHANDENSIS Stephenson, n.sp.

# Pl. 50, figs. 24-26

Shell large, thin, subconical or capshaped, slightly twisted to the left as viewed from above the apex; apex curved backward so that the posterior slope is shorter and much steeper than the anterior. Protoconch not preserved. Outline of aperture subcircular to broadly subovate, but variable in different individuals. The surface is corrugated completely around the shell with prominent radial ribs differing markedly in size on any given individual, and variable in size and number on different individuals; on adults the ribs range in number from 30 to 40: passing from the apex toward the aperture new ribs appear by intercalation between the already existing ones. Viewed from the front, 3 of the ribs, as represented on the internal mold, are flattopped: on the holotype the 2 areas between these 3 ribs are each occupied by 2 round-topped ribs of about equal size and spacing; the left side of the shell is ornamented with 7 or 8 ribs of markedly unequal size and spacing, of which 2, separated by 3 smaller ones, stand out more prominently than the others; to the right of the flat-topped rib farthest to the right is first a weak rib, followed by a stronger one, in front of which is a deep narrow sulcus; from this sulcus, extending completely around the posterior side, is a series of ribs of unequal size and spacing, with a suggestion of pairing, a large with a small rib.

The preceding description is based on several internal molds, on which there remains a mere film of the calcareous shell material, and on one incomplete external mold. The latter shows a rather rough surface with an irregular development of nodes on the ribs. One prominent rib on the left side appears to lack these nodes.

Approximate dimensions of the holotype: Height of cone above the plane of the aperture 18 mm., greatest diameter from side to side 42 mm., least diameter front to back 39 mm.

Although this species is closely related to *C. spangleri* Henderson, it is larger, has more ribs, and has the surface ornamented with ribs all the way around the conch.

The species seem to have a close analogue in *Fissurella nechayi* Kner<sup>333</sup> (*= Helcion nechayi* (Kner) Favre<sup>334</sup>) from an Upper Cretaceous bed in the environs of Lemberg (at Nagorzany), Poland, presumably of Maestrichtian age and corresponding approximately in age to the Nacatoch sand.

*Types.*—Holotype, U.S.N.M. no. 76832; 3 paratypes, U.S.N.M. no. 76833.

Distribution in Texas.—Navarro group, Nacatoch sand; 412 miles cast by north of Rosali (14061).

Outside distribution. — Mississippi: Questionably in the Ripley formation.

# CAPULUS ERECTUS Stephenson, n.sp.

#### Pl. 49, figs. 5-7

Shell of medium size, high subconical or cap-shaped, markedly twisted to the left as viewed from above the apex which is bent strongly backward. Outline of aperture broadly subovate. The apical portion of the protoconch is broken away but the large anterior end of it remains; this fragment is smooth and its contact with the main shell is marked by a distinctly impressed suture. The surface, as expressed on the internal mold, presents about 23 radial ribs which differ greatly in strength. The character of the ribbing is like that of C. cuthandensis, but the ribs are fewer in number at the same stage of growth; this is especially true on the left side as viewed from the front, where the

<sup>&</sup>lt;sup>333</sup>Kner, Rudolph, Versteinerungen des Kreidemergels von Semberg und seiner Umgebung: Hald Abhandl., vol. 3, Abteil 2, p. 23, pl. 4, fig. 7, 1850.

<sup>&</sup>lt;sup>334</sup>Favre, Ernest, Mollusques Fossiles de la Craie des Environs de Lemberg: Geneve et Bale, p. 98, pl. 11, fig. 4, 1869.

two largest, most prominent ribs are separated by a smooth area destitute of subordinate ribs; the 3 flat-topped ribs are present on the front but in the state of preservation of the shell this feature is not strongly apparent. Several of the subordinate ribs intercalated on the front toward the anterior part of the shell are very weakly developed; a deep radial groove is present on the right slope, and the posterior surface bears 8 or 9 subequal ribs of only moderate strength. There is a suggestion of irregular noding on the ribs.

Dimensions of the holotype: Height of cone above the plane of the aperture about 17 mm., greatest diameter from side to side 25 mm., least diameter from front to back 20 mm.

The one internal mold on which this species is based is closely related to *C. cuthandensis*, but it is proportionately higher and more slender, and has fewer ribs. Its recognition as a separate species is justified on the evidence of the material available for comparison. The ribbing on the posterior surface serves to distinguish it from *C. spangleri*.

Holotype .--- U.S.N.M. no. 21037.

Distribution in Texas. --Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

# CAPULUS? MICROSTRIATUS Stephenson, n.sp.

## Pl. 50, figs. 17-20

Shell rather small, very thin, subconical cap-shaped, with the apex bent or strongly backward, but not twisted. Aperture subcircular to broadly subovate. Protoconch poorly preserved on two of the three available specimens; on the holotype it appears as a simple, dextral, low spiral of about two volutions. The main surface of the shell appears nearly smooth to the unaided eye, but under a lens presents numerous closely packed radial striae of more or less wavy, uneven trend; the surface also exhibits fine growth lines, and wavy growth undulations; stronger ridges marking more vigorous growth stages may or may not be present; two such ridges occur near the apex of the holotype.

Dimensions of the holotype: Height above the plane of the aperture 7 mm., diameter side to side 13 mm., diameter front to back 13.5 mm.

A species of similar aspect to this one, C. versus J. Böhm, occurs in the "Grünsand" (lower Senonian) of the Aachen district at Vaals, Germany.<sup>335</sup>

Types.—Holotype, U.S.N.M. no. 76834; 2 unfigured paratypes, U.S.N.M. no. 76835.

Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (15524).

# CAPULUS sp. 1

# Pl. 49, fig. 8

A fragment of the apical end of a *Capulus*, from the Neylandville marl near Cooper, Delta County (4064), is similar to *C. spangleri* Henderson, but differs in the details of its ribbing, and is probably specifically distinct. It is not sufficiently complete to serve as a type specimen. U.S.N.M. no. 76836.

#### CAPULUS sp. 2

# Pl. 50, figs. 21-23

One specimen of Capulus is included in the material from the Nacatoch sand on U.S. highway 75,  $3\frac{1}{5}$  miles north of Corsicana, Navarro County (16168). It is in the form of an internal and an external mold, both incomplete, with the very thin shell adhering in part to one and in part to the other. In form, size and ornamentation this shell resembles C. microstriata, but it is more elongated from front to back and lacks irregular growth undulations, and is therefore smoother and more shapely. Inasmuch as it occurs in a stratigraphically lower horizon, it seems best to regard it as specifically distinct, but it is hardly well enough preserved to serve as a type. U.S.N.M. no. 76837.

#### CAPULUS sp. 3

A small specimen from the Ncylandville marl, in the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170),

<sup>&</sup>lt;sup>335</sup>Holzapfel, E., Palacontographica, Band 34, p. 151, pl. 15, figs. 11, 13, 1385.

probably is a young individual. In form it is very much like *Capulus* sp. 2, and may be the young of that or a closely related species. As preserved no radial striations are visible. The protoconch is broken away, but the scar indicates a nuclear shell similar to that on *Capulus microstriatus*. Dimensions: Height above the plane of the aperture 1.5 mm., diameter side to side 2.8 mm., diameter front to back 3 mm. U.S.N.M. no. 76838.

# Family NATICIDAE

#### Genus POLINICES Montfort

#### POLINICES RECTILABRUM (Conrad)

# Pl. 50, figs. 1-6

- 1858. Natica (Lunatia) rectilabrum Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 334, pl. 35, fig. 28.
- 1926. Polinices (Euspira) halli (Gabb). Wade, U.S.Geol. Survey Prof. Paper 137, p. 163, pl. 56, figs. 11, 12.

Conrad's original description of this species is as follows: "Subglobose; spire conical, subscaliform; labrum straight in the middle; umbilicus moderate in diameter, profound."

The following description is based on a selected neotype and topotypes from the Owl Creek formation, Owl Creek, Tippah County, Mississippi.

Shell of medium size, moderately thick and strong. Angle of spire 90 to 100 degrees in young individuals, decreasing anteriorly to 70 or 75 in large shells. Whorls 5 or 6 in adults, broadly convex, and increasing rapidly in size. Suture moderately impressed, bordered below by a very narrow shoulder sloping inward. Protoconch not well preserved, but obviously a simple, dextral, low-spired shell. Surface smooth except for rather strong growth lines which cross the whorls obliquely downward and backward. Aperture entire, broadly subovate, rounded anteriorly, subangular posteriorly; outer lip thin, simple, broadly curved; inner lip thick, spreading tongue-like ahead of the aperture onto the parietal wall. Umbilical fissure narrow, moderately deep.

Dimensions of the neotype, plate 50, figures 1, 2: Height 24 + mm., diameter 20 mm. Dimensions of a medium-sized topotype: Height 12 mm., diameter 10 mm.

The suite of specimens from Owl Creek show some individual variation in the height of the spire, the plumpness of the whorls, and the distinctness of the narrow shoulder at the posterior margin of the whorls.

The shells from Texas that are referred to this species appear to differ in no essential respect from the typical ones from Owl Creek.

*P. halli* (Gabb), the 6 types of which came from the Navesink marl at Mullica Hill, New Jersey, is based on internal molds which are preserved in the collection of the Academy of Natural Sciences at Philadelphia; it has a higher spire and is more openly coiled than *P. rectilabrum*; the figured specimen bears a red diamond. Most of the representatives of *Polinces* in the Upper Cretaceous of New Jersey and Maryland have been referred to this species, but a holotype of this character does not lend itself to accurate comparison with well preserved material.

The shells from Coon Creck, Tennessee, which Wade referred to *P. halli*, do not appear to differ essentially from *P.* rectilabrum.

The species differs from the varietal form, *texana*, mainly in the greater height of its spire. This difference is, however, of somewhat doubtful value, since in the living species of *Polinices* the males are known to have higher, more conical spires than the females; the typical high-spired form and the varietal low-spired form occur together at Corsicana and at other localities.

Polinices obliquata (Hall and Meek), from the Pierre shale at the Great Bend of Missouri River in South Dakota, is a very closely related species, but an examination of the type (No.  $\frac{9165}{1}$ ) in the American Museum of Natural History at New York shews that it has a slightly lower spire, a slightly more open umbilicus, and is faintly ornamented with fine revolving lines. Although exceedingly fine, faint spiral lines may be detected on rare specimens from Texas

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and Mississippi, most of the shells seem to be without such lines.

Types.—The specimen originally described by Conrad came from the Owl Creek formation at Owl Creek, Tippah County, Mississippi; it is not listed in the collections of the Academy of Natural Sciences of Philadelphia. The neotype (U.S.N.M. no. 76839) is selected from a lot of 22 topotypes (U.S.N.M. no. 20439) from Owl Creek. Two plesiotypes from Texas, U.S.N.M. nos. 76840, 76841.

Distribution in Texas.—San Miguel formation: Burr's old ranch house, 2 miles northwest of Paloma siding, Maverick County (1887); Uvalde road, about 14 miles northeast of Eagle Pass, Maverick County (8251).

Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, 17365; Tex. Bu. 17300).

Navarro group, Nacatoch sand: 1½ miles west of Campbell (12925); vicinity of Kaufman (761, loc. of 1 plesiotype); road 3/5 mile west of Kaufman (14093); field 3/5 mile west of Kaufman (14103); field 2 miles southwest of Kaufman (7547); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762); 3 miles northeast of Corsicana (9545); north edge of Corsicana (518, loc. of 1 plesiotype); vicinity of Corsicana (763); 2½ miles west by south of Corsicana (17368).

Navarro group, Corsicana marl: ?2 3/5 miles north by east of Malta (16159); fuller's earth pit, 14 miles west of San Antonio (15520).

Navarro group, Kemp clay: 3½ miles northwest of Bazette (12922); ?San Gabriel River, 2/5 mile above San Gabriel (14130); near Deatsville (764); Webberville (7601); near old Garfield (7603); west of Zuchl (7721).

Escondido formation: Bed of Hondo Creek, ½ mile above the G. H. & S. A. R.R. bridge, 5 miles cast of Hondo, Medina County (7679); near Eagle Pass, Maverick County (487).

*Outside distribution.*—Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Coffee sand, Ripley formation, and Owl Creek formation.

Chattahoochee region, Alabama-Georgia: Upper part of Ripley formation. Range.—The known range of the species is through the *Exogyra ponderosa* zone and through the *Exogyra costata* zone; that is, through the Taylor marl and through the Navarro group.

## POLINICES RECTILABRUM TEXANUS Stephenson, n.var.

## Pl. 50, figs. 7, 8

This variety is like the typical *Polinices* rectilabrum (Conrad) except that the spire is lower, giving to the shell a more globose appearance; it occurs with rectilabrum at Corsicana and other localities in Texas. Apical angle 105 degrees, decreasing to 85 degrees on the spire below. Although some variation may be noted in the form of shells from Owl Creek, Mississippi, the type locality of the species, they do not appear to show as great variation as do those from Corsicana and other localities in Texas, for which reason a varietal name is given to the low-spired forms among the latter. It is known that, in Recent species of Polinices, the females have lower spires and more inflated shoulders just below the sutures than do the males. It is not known, however, how great a range in form among Cretaceous species may be explained on the basis of sex differences, and until more is known on the subject, the recognition of this varietal form seems justified.

The dimensions of the holotype, a medium-sized shell, are: Height 13.5 mm., diameter 13 mm. A larger shell measures: Height 20 mm., diameter 16.3 mm.

This variety is very similar in form to *Polinices concinna* (Hall and Meek), but lacks the fine spiral ornamentation of that species.

*Types.*—Holotype, U.S.N.M. no. 76842; 17 unfigured paratypes, U.S.N.M. no. 76843.

Distribution in Texas.—San Miguel formation: Private road, 16 miles northeast of Eagle Pass, 1 7/10 miles east of the old Eagle Pass-Uvalde road, Maverick County (10855); tank  $\frac{1}{2}$  mile east of the Uvalde road about 18 miles northeast of Eagle Pass (8249); Sauz Creek north of Burr ranch house, 2 miles northwest of Paloma siding, Maverick County (8233); Uvalde road, about 14 miles northeast of Eagle Pass (8251). Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles south of Ben Hur (15543).

Navarro group, Nacatoch sand: 3 miles north of town of Sulphur Bluff (5322); vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762); loose pieces of rock in street at Chatfield (7568); north edge of Corsicana (518, type loc.); vicinity of Corsicana (763); 4 miles north of Corsicana (17366); 5 miles northeast of Mc-Clanahan (17371).

Navarro group, Kemp clay: 3½ miles northwest of Bazette (12922); near Deatsville (764, 14125); Webberville (7601); near old Garfield (7603); 2 miles southsoutheast of Schumansville (16668).

Range.—This variety has about the same range as the typical form of the species, that is, through the zones of Exogyra ponderosa and Exogyra costata.

# POLINICES STEPHENSONI Wade

#### Pl. 50, figs. 9-11

# 1926. Polinices stephensoni Wade, U.S.Geol. Survey Prof. Paper 137, p. 163, pl. 56, figs. 13, 14.

Shell of medium size; angle of spire about 95 degrees. Whorls 4 or 5, closely appressed, increasing rapidly in size, broadly convex on the side, straightening out a little just below the shoulder; the posterior part of the whorl is sharply constricted to form a conspicuous shoulder which is traversed by a shallow channel with rounded bottom. The very small protoconch is broken away on all specimens. Aperture broadly subovate, angular at the rear, with a slight anal channel; peristome entire, outer lip thin, inner lip thin at the edge, thickening inward; umbilical fissure variable, but generally narrow and not very deep.

Dimensions of the figured specimen: Height 17 mm., diameter 15 mm.

This species is closely related to Lunatia altispira Gabb, the type of which was never figured and is apparently lost. The specimen figured by Whitfield,<sup>336</sup> as *Gyrodes altispira* (Gabb) was probably incorrectly identified. Specimens in the collection of the Academy of Natural Sciences of Philadelphia labeled in Gabb's handwriting as duplicates of *altispira* are thought by Weller to be identical with *Gyrodes obtusivolva* Gabb, the type of which is preserved in the same collection.

The specimen from the Merchantville clay marl, figured by Weller<sup>337</sup> as Gyrodes altispira (Gabb), has a much lower spire than Polinices stephensoni Wade, but is obviously a closely related species.

Specimens figured by Whitfield (pl. 16, figs. 10 and 12 of the volume cited above) as *Gyrodes obtusivolva* Gabb are certainly quite close to Wade's species, but it is not known that they are typical of either of Gabb's species, *altispira* or *obtusivolva*.

Types.—Holotype, U.S.N.M. no. 73075; from Coon Creek tongue of Ripley formation, at Coon Creek, McNairy County, Tennessee. Plesiotype from Texas, U.S. N.M. no. 76814.

Distribution in Texas.--Navarro group, Nacatoch sand: Road 3/5 mile west of Kaufman (14098); field 2 miles southwest of Kaufman (7547); road 2 miles southwest of Kaufman (7546); north edge of Corsicana (518, plesiotype); vicinity of Chatfield (762).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

Range.--Lower part of Exogyra costata zone; in Texas, Nacatoch sand of the Navarro group; in Tennessee, Coon Creck tongue of the Ripley formation.

#### POLINICES? sp.

An incomplete, mechanically deformed shell questionably belonging to *Polinices*, was collected from the Kemp clay in the Austin road near Deatsville, 2 miles northwest of Webberville, Travis County (14125); the general form is that of *Polinices*, but the spire is rather high, and the surface is covered with fine grooves which, though obscure, are nevertheless more distinct than those sometimes seen on *Polinices*. U.S.N.M. no. 76845.

#### Genus AMAUROPSIS Mörch

#### Unidentified specimens of AMAUROPSIS?

One smooth gastropod from the Corsicana marl of the Navarro group, from a westward-facing bluff on Guadalupe River,

<sup>&</sup>lt;sup>230</sup>Whitfield, R. P., U. S. Geol. Survey Mon., vol. 9, p. 128, pl. 16, figs. 7, 3, 1385.

<sup>337</sup>Weller, Stuart, Geol, Survey New Jersey, Paleontology, vol. 4, p. 687, pl. 77, figs. 19-21, 1907.
1 3/10 miles north of McQueeney, Guadalupe County (15524), shown in plate 50, figures 12, 13, appears to belong to the same genus as Wade's Amauropsis lirata<sup>338</sup> from Coon Creek, Tennessee, and is probably very close to that species. Except for the columella and inner lip the shell material is practically gone, leaving only the internal mold. The spire is of medium height; whorls 5 or 6, broadly rounded, expanding rapidly; suture deeply sulcate; aperture elongate-subovate, acutely angular in the rear, sharply rounded in front; inner lip of medium thickness, partly broken away; umbilical fissure narrow. The surface appears to be nearly smooth, but growth lines, which show clearly on the body whorl just back of the aperture, are nearly vertical above, curving backward below. There is a very faint suggestion of fine revolving lirae on the body whorl, and a perfect shell might show distinct spiral sculpture. Dimensions: Height 21 mm., diameter 13 mm. U.S.N.M. no. 76846.

A very much flattened internal clay mold showing the same general characters as the preceding, and perhaps belonging to the same species, was found in the Corsicana marl on San Marcos River,  $\frac{1}{2}$  mile below Martindale, Caldwell County (7621); spiral sculpture much like that of *A. lirata* Wade is, however, faintly impressed upon the mold. U.S.N.M. no. 76848.

Another closely similar specimen was obtained from the Kemp clay at an earthen tank west of the road, about 2 miles south-southeast of Schumansville, 9/10 mile south-southeast of the crossing of Long Creek, Guadalupe County (16668). U.S.N.M. no. 76847.

#### Genus BANIS Stephenson, n.gen.

Type species.—Banis siniformis Stephenson. Etymology.—By anagram from basin. Gender, masculine.

The genus is characterized by its smooth surface, depressed spire, a form resembling that of *Sinum*, and a wide umbilicus, nearly filled by a thick reflected inner lip. The genus is to be distinguished from *Sinum* by its total lack of spiral sculpture and its greatly thickened inner lip. No shell more closely related to this genus than *Polinices* is known in the Cretaceous of the Atlantic and Gulf Coastal Plain.

#### BANIS SINIFORMIS Stephenson, n.sp.

# Pl. 50, figs. 14-16

Shell of moderate size and thickness. Spire depressed, broadly dome-shaped, rising but slightly above the body whorl. Whorls 4, closely appressed, rapidly expanding, broadly convex on outer surface. Suture not deeply impressed, bordered in front by a narrow shoulder which is variable in strength on different individuals. Protoconch small, smooth, flattish, dextral, perfectly preserved in available not material, but apparently coiled only once. Aperture elongate - subovate, sharply rounded in front, sharply angular in the Outer lip thin, simple; inner lip rear. greatly thickened, reflected so as to overhang the umbilical fissure, with an extra knob-like thickening at the base of the columella. The umbilical fissure, or false umbilicus, is rather wide, and curves from the inner lip backward and downward around the columella, becoming deep posteriorly.

Dimensions of the holotype, a medium sized shell: Height 8 mm., diameter 14 mm. Other shells range in diameter up to a measured maximum of 24 mm.

This genus has not been identified in the American Upper Cretaceous outside of the Nacatoch sand of Texas.

Types.—Holotype, U.S.N.M. no. 76849; 8 selected paratypes, U.S.N.M. no. 76850.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Kaufman (761); field 2 miles southwest of Kaufman (7547); road 2 miles southwest of Kaufman (7546); north edge of Corsicana (518, loc. of holotype); vicinity of Corsicana (763, loc. of paratypes).

#### Genus GYRODES Conrad

Type species.—Natica (Gyrodes) crenata Conrad. Proposed as subgenus. Type designated by Gardner.<sup>339</sup> Gyrodes crenatus (Conrad) is now considered a synopym of Gyrodes supraplicatus (Conrad).<sup>340</sup>

<sup>3830</sup>Gardner, Julia A., Maryland Geol, Survey, Upper Cretaceous (2 vols.), p. 496, 1916.

<sup>319</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, pp. 357-359, 1923.

<sup>&</sup>lt;sup>355</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 165, pl. 57, figs. 5, 8, 1926.

#### GYRODES SUPRAPLICATUS (Conrad)

## Pl. 51, figs. 13–16

- 1858. Rapa supraplicata Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 332, pl. 35, fig. 20.
- 1860. Natica (Gyrodes) crenata Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 289.
- 1892. Gyrodes crenata Conrad. Whitfield. U.S. Geol. Survey Mon., vol. 18, p. 126, pl. 16, figs. 5, 6. (Geol. Survey New Jersey, Paleontology, vol. 2, p. 126, pl. 16, figs. 5, 6).
- 1905. Gyrodes crenata Conrad. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 21.
- ?1907. Gyrodes crenata Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 685.
- 1923. Gyrodes supraplicatus (Conrad). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, pt. 1, p. 357, pl. 89, figs. 3-6 (questionably figs. 1, 2).

Shell of medium to very large size; the shell wall, which in young individuals is thin, becomes thick and strong in large adults. Spire strongly depressed; whorls 4 or 5, rapidly expanding, broadly rounded on the sides. Suture moderately impressed, bordered in front by a rather broad, shallow sulcus which is bordered in turn by a low, coarsely crenulated ridge, the crenulations grading into coarse growth lines on large individuals. Protoconch small, simple, dextral, coiled 2 or 3 times. Umbilicus wide and deep, extending to the apex, bordered externally by a strong, elevated carina which is normally crenulated, but varies from nearly smooth to coarsely plicate; one large, overgrown individual (pl. 51, fig. 16), if correctly identified, shows that this carina continues to the aperture as an increasingly strong, prominent ridge, instead of rounding off as in other species. On the inner wall of the umbilicus is a weaker, narrower spiral carina which on medium sized shells lies 5 to 8 mm. distant from the outer carina and the two carinae are separated from each other by a broad, shallow sulcus. Aperture subovate, somewhat elongated, truncated behind at the shoulder, obtusely angular in front. Outer lip thin, simple; in medium sized shells the inner lip is thin and simple where it borders the umbilicus, and spreads as a thin callus over the whorl above; in the large shell previously cited the inner lip becomes markedly thickened, and centrally bends forward overhanging the umbilicus. Surface smooth with the exception of distinct growth lines which are slightly sinuous and strongly oblique backward in their trend from the shoulder down over the whorls.

Dimensions of a medium-sized shell from near Corsicana: Height 25 mm., diameter 32 mm. Dimensions of the one large shell from near Corsicana, already mentioned: Height 73 mm., diameter 91 mm.

The Texas shells referred to this species agree with typical shells from Mississippi in that the carina bounding the umbilicus continues strong and prominent to the aperture, with no tendency to become rounded off anteriorly; this carina is, however, less strongly crenulated in the few Texas shells available for comparison, but the strength of these crenulations and the thickness of the carina are believed to be variable on different individuals. The crenulations on the shoulder of the whorls of the Texas shells are a little finer than on typical shells, but this is also clearly a variable character on shells from the same locality. Should better suites of specimens show constant differences between the typical shells from Mississippi and those from Texas, the latter would hardly deserve a distinguishing rank higher than that of variety.

The shells which Wade<sup>341</sup> described under the new name *Gyrodes major* appear to describe recognition as a separate species, on account of the more constricted umbilicus and the anterior rounding off of the umbilical carina, but the one shell which he identified as *G. crenata* Conrad is probably only an individual variant of *G. major*.

The state of preservation of the figured shell from the Snow Hill member of the Black Creek formation in North Carolina (see synonymy) is hardly such as to permit its reference with confidence to G. supraplicatus; it might equally as well be G. major Wade.

Types.—The type of Rapa supraplicata Conrad is believed to be lost. Cotypes of Gyrodes crenata Conrad are preserved in the collections of the Academy of

<sup>&</sup>lt;sup>241</sup>Wade, Bruce, U. S. Geol. Sucvey Prof. Paper 137, p. 164, pl. 57, figs. 4, 7, 11, 1926.

Natural Sciences of Philadelphia; one of these was figured by Whitfield. A typical shell from Owl Creek, Tippah County, Mississippi, was figured by me in 1923 (U.S.N.M. no. 20140). Plesiotypes from Texas, U.S.N.M. nos. 76851, 20922.

Distribution in Texas.—Navarro group, Nacatoch sand: Field 3/5 mile west of Kaufman (14103); north edge of Corsicana (518, figured); vicinity of Corsicana (763, figured).

Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924).

Navarro group, Kemp clay: ?3½ miles north-northwest of Bazette (17375).

Outside distribution.—Mississippi: Owl Creek formation and Ripley formation.

North Carolina: Questionably from the Snow Hill member of the Black Creck formation.

Range.—Ranges questionably from the upper part of the Exogyra ponderosa zone through the Exogyra costata zone. In Texas it occurs in the Nacatoch sand and in the Corsicana marl of the Navarro group, and in Mississippi in the Ripley and Owl Creek formations.

#### GYRODES ROTUNDUS Stephenson, n.sp.

# Pl. 51, figs. 8-12

Shell of medium to large size, rotund, thick in adults. Spire strongly depressed; whorls 4 or 5, broadly rounded on the sides, rapidly expanding. Suture a narrow, sharply outlined, deeply impressed channel, bordered in front by a flattened shoulder 6 or 7 millimeters wide in adults; this shoulder is more or less crenulated or plicated, a feature which is, however, variable on different individuals; the crenulations tend to grade into coarse lines anteriorly. growth Protoconch small, simple, dextral, coiled about twice. Umbilicus of medium width, deep, and well-like, extending to the apex, bordered externally by a rounded, slightly inrolled ridge which is typically rather coarsely plicated, but which is variable in coarseness on different individuals; this ridge is paralleled on the inner side by a moderately impressed sulcus; the ridge shows a tendency to round off and become less plicated anteriorly. Aperture subovate, rather narrowly rounded anteriorly, narrowing posteriorly to a subacute angle in

which is a shallow anal canal. Outer lip thin and simple; inner lip rather thin below where it borders the umbilicus, spreading a little forward as a thin callus over the side of the whorl above. Surface smooth with the exception of distinct growth lines and the plications on the shoulder and on the umbilical ridge; the growth lines bend inward and are slightly convex forward where they cross the shoulder; the growth lines are coarser on the wall of the umbilicus than on the sides of the whorls.

Dimensions of the holotype: Height 38 mm., diameter 50 mm.

Viewed from above this species is similar to G. supraplicatus (Conrad), but the suture is more distinctly channelled, the shoulder is flat instead of broadly excavated, and the spire is less depressed. Viewed from below the two species are strikingly different. The umbilicus of G. rotundus is much less widely expanding; the ridge bordering the umbilicus is thicker, more plumply rounded, and tends to become smoother, and more broadly rounded anteriorly on adults, and a spiral ridge is wanting on the inner face of the umbilicus.

Compared with the type of Gyrodes abbottii Gabb, from the Navesink marl at Mullica Hill, New Jersey, rotundus has a narrower umbilicus and is plumper on the base, but is otherwise quite similar. Compared with the type of G. abyssinus (Morton), an internal mold, rotundus is less flaring in the umbilicus; the sculpture is not preserved on abyssinus. The umbilicus of G. rotundus is also narrower and much less widely expanding than that of G. major Wade from Coon Creek, Tennessee.

Types.—Holotype, U.S.N.M. no. 76852; 1 figured paratype, U.S.N.M. no. 76853; 1 figured paratype, U.S.N.M. no. 76855; 1 unfigured paratype, U.S.N.M. no. 76854.

Distribution in Texas.—Navarro group, Neylandville marl; 22<sup>1</sup>/<sub>2</sub> miles northeast of Royce City (13834).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103); field 2 miles southwest of Kaufman (7547); vicinity of Chatfield (762, loc. of 1 figured paratype); 7 miles north of Chatfield (17236); 3/4 mile east of Chatfield (7571); 21/2 miles north of Corsicana (14114); north edge of Corsicana (518); vicinity of Corsicana (763, loc. of holotype and 2 paratypes, 1 figured); 4 miles north of Corsicana (17366); 4 miles southwest of Corsicana (Tex. Bu. 17310).

Navarro group, Corsicana marl: 3 7/10 miles southwest of Campbell (15547); 1½ miles N. 20° W. of Tona siding (15545); west of Kaufman (7548); 2½ miles east of Cooledge (13832); ½ mile below Martindale (15526); 1 3/10 miles north of McQueeney (7637, 15524).

Navarro group, Kemp clay: ?San Gabriel River, 2/5 mile above San Gabriel (14130); ?well 2 miles west of Groesbeck, at depth of 730 feet (13132) and 800 feet (13124); near Deatsville (764); ?west of Zuehl (7721); ?Leon Creek valley above Southern Pacific (G.H.&S.A.) R.R. bridge, Bexar County (15518).

Range.—Ranges questionably from the Neylandville marl upward to the Kemp clay of the Navarro group.

# GYRODES PETROSUS (Morton)

# Pl. 51, figs. 1-7

- 1834. Natica petrosa Morton, Synopsis of the organic remains of the Cretaccous group of the United States, p. 48, pl. 19, fig. 6.
- 1861. Gyrodes petrosa (Morton). Gabb, Synopsis of the Mollusca of the Cretaceous formation, Am. Philos. Soc. Proc., vol. 8, p. 61 (117).
- 1876. Gyrodes petrosa (Morton). Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 295. (In part.)
- 1905. Gyrodes petrosus (Morton). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 21.
- ?1907. Gyrodes petrosus (Morton). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 689, pl. 77, figs. 13-15. (Not figs. 17-18.)

The following description is based on an internal mold from Prairie Bluff, Alabama River, Alabama, the type locality (pl. 51, figs. 4–6). Shell rather small for the genus. Spire depressed, broadly domeshaped; whorls 4, closely appressed, rapidly expanding, broadly rounded on the sides. Suture narrow, not deeply impressed; the presence of a very narrow, flattened shoulder bordering the suture is indicated on the mold. Protoconch not seen but probably small and simple. Umbilicus widely flaring, extending to the apex, apparently without a bordering Aperture subovate, carina. rounded anteriorly, subangular posteriorly; outer lip simple; inner lip not well preserved, but a little of the shell preserved on the figured specimen indicates a moderate thickening anteriorly. Surface probably smooth; shell material adhering in the umbilicus exhibits moderately coarse growth lines.

Dimensions of the internal mold from Prairie Bluff: Height about 14 mm., diameter 20 mm. Dimensions of the Texas specimen shown in plate 51, figures 1-3: Height 12 mm., diameter 20 mm.

Specimens which appear to be essentially like typical shells from Alabama occur in Texas in the Neylandville marl and in the Corsicana marl; they are a little flatter, a feature which may be due to mechanical flattening in the marl in which they were found.

This species differs from *G. subcarinatus* mainly in having a much less pronounced shoulder and a more depressed spire. Both species exhibit individual variation in these characters, and in the case of small lots or imperfectly preserved specimens some difficulty is apt to be encountered in separating them. *G. subcarinatus* is represented by numerous individuals from several localities in the Nacatoch sand, which appear to be consistently higher and to exhibit a more pronounced shoulder and a deeper suture than do the representatives of *G. petrosus*.

The specimen from the Monmouth formation at Brightseat, Maryland, referred to this species by Gardner,<sup>3+2</sup> is probably more nearly related to *G. subcarinatus*.

Type.—Academy of Natural Sciences of Philadelphia. From the Prairie Bluff chalk at Prairie Bluff, Alabama River, Alabama. One topotype, U.S.N.M. no. 76856; 1 plesiotype from Alabama, U.S.N.M. no. 76857; 1 plesiotype from Texas, U.S.N.M. no. 76858.

<sup>&</sup>lt;sup>342</sup>Gardner, Julia, Maryland Geol. Survey, Upper Cretaceous (2 vols.), pl. 13, fig. 8, 1916.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (17365).

Navarro group, Corsicana marl: 1<sup>1</sup>/<sub>4</sub> miles south by east of Oak Grove (16160); 1<sup>4</sup>/<sub>5</sub> miles N. 20° W. of Tona siding (15545); 1 3/10 miles north of McQueeney (7637; 15524, 1 specimen figured); well 7/20 mile south by west of St. Mary's University, Bexar Co. (16353).

*Outside distribution.* — Mississippi: Prairie Bluff chalk.

West-central Alabama: Prairie Bluff chalk.

Delaware: Marshalltown formation.

New Jersey: Questionably in the Navesink marl.

*Range.*—Ranges throughout the *Exogyra* costata zone.

### GYRODES SUBCARINATUS Stephenson, n.sp.

# Pl. 52, figs. 22-26

Shell of medium size, thin. Spire de-Whorls 4 in adults, broadly pressed. rounded on the sides, steepening below, rapidly expanding. Suture narrow, moderately impressed, bordered by a narrow, flattened, rather distinct shoulder which varies somewhat in sharpness on different individuals. Protoconch not well preserved but on some shells appears to be a small, simple, dextral conch, coiled about twice, standing rather high and somewhat tilted. Aperture subovate, rather sharply rounded anteriorly; posteriorly an acute reflected angle is formed by the anal canal. Outer lip thin, simple; the inner lip is thin anteriorly, slightly overhangs the umbilicus centrally, and forms a thin, scarcely reflected callus over the parietal Umbilicus deep, flaring widely, wall. bordered on the rounded periphery by a pair of obscure ridges about a millimeter apart, the inner one of which is a little the more distinct. The surface exhibits numerous, sharp, incremental lines which are strongly oblique backward on the sides of the whorls; these lines are reflected inward a little where they cross the shoulder to the suture and are sharpest and coarsest within the umbilicus; except for the growth lines the surface appears smooth, but under a lens in a strong light properly directed exceedingly fine spiral lines can barely be detected on the holotype and on some other specimens.

Dimensions of the holotype: Height about 17 mm., diameter about 19 mm. Diameter of the largest specimen measured about 32 mm.

Compared with *G. petrosus* (Morton) this species has a more strongly developed, flattened shoulder and is proportionately higher. It lacks the excavated shoulder and sharply developed bordering carina of *G. spillmani* Gabb. The species is intermediate between *petrosus* and *spillmani*.

The specimen from the Monmouth formation of Maryland, figured by Gardner<sup>343</sup> as *G. petrosus* (Morton), probably belongs to *G. subcarinatus*, although it is much larger (diameter 36 mm.) than the Texas shells.

Types.—Holotype, U.S.N.M. no. 76859;

1 figured paratype, U.S.N.M. no. 76860;

1 figured paratype, U.S.N.M. no. 76861.

Distribution in Texas.—Navarro group, Nacatoch sand: 1½ miles west of Campbell (12925); 1½ miles northeast of Quinlan (16162); vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103); field 2 miles southwest of Kaufman (7547); vicinity of Chatfield (762, holotype and 1 paratype); Watkins' place 3 miles north of Corsicana (14114); vicinity of Corsicana (763, loc. of 1 figured paratype).

Navarro group, Corsicana marl: 1¼ miles south by east of Oak Grove (16160); ?3 7/10 miles southwest of Campbell (15547); 1 ½ miles N. 20° W. of Tona siding (15545); about 3 miles south-southwest of Campbell (12927); west of Kaufman (7518). The specimens from these five localities are phosphatic internal molds.

Outside distribution. -- Mississippi: Questionably in the Ripley formation.

Maryland: Probably in the Monmouth formation.

Range.—Ranges from the Nacatoch sand into the Corsicana marl. Probably

<sup>&</sup>lt;sup>343</sup>Gardner, Julia A., Maryland Geol. Survey, Upper Gretaceous (2 vols.), p. 496, pl. 13, fig. 8, 1916.

has a wide geographic range, and a somewhat longer geologic range than that indicated by the Texas occurrences.

# GYRODES SPILLMANI Gabb

#### Pl. 52, figs. 20, 21

- 1860. Natica (Gyrodes) alveata Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 289, pl. 46, fig. 45. Preoccupied by Natica alveata Conrad, Rept. Expl. and Survey, Pacific R.R., Mississippi River to Pacific Ocean; App. Prelim. Geol. Rept. of W. P. Blake, Paleontology, p. 10, 1855.
- 1861. Gyrodes spillmanii Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 320.
- 1892. Gyrodes petrosus (Morton). Whitfield, U.S. Geol. Survey Mon., vol. 18, p. 127, pl. 16, figs. 1-4. (Geol. Survey New Jersey, Paleontology, vol. 2, p. 127, pl. 16, fig. 1-4, 1892.) The two figured specimens appear to belong to this species.
- 1907. Gyrodes petrosus (Morton). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 689. (In part, not the figured specimens.)
- 1926. Gyrodes alveata Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 164, pl. 57, figs. 6, 9.

The five Texas specimens referred to this species are all internal molds more or less pressed out of shape.

Gabb's description of *G. spillmani* is as follows: "Shell wide, spire low; whorls three, oblique on the sides, truncated above. The truncation is at times flat, sometimes concave; angle generally acute. Mouth biangular above, obliquely expanded below. Umbilicus broad, open, margin subcarinated."

In general form and in the character of the umbilicus the species is very much like that of *G. subcarinatus*, but is distinguishable from that species by its more or less excavated shoulder bounded by a sharply angular carina. In several of the Texas specimens this feature has been emphasized by later mechanical compression.

Wade has figured a nearly perfect shell from Tennessee, but the two figures given are side views and do not show the channelled and carinated shoulders; besides these views are so posed as to give a false impression of the plumpness of the shell. On this specimen the channelled shoulder is sharply and perfectly preserved. Conrad's type of *Natica (Gyrodes)* alveata, which came from Tippah County, Mississippi, presumably from the Ripley formation, was sent by Dr. W. Spillman. Gabb's types of *G. spillmani*, from "The Cretaceous limestone of Mississippi," were also sent by Doctor Spillman. It is conjectural as to just what was meant by "Cretaceous limestone," but matrix attached to the type suggests that it came from the Prairie Bluff chalk.

This species reminds one of *Gyrodes* acutimargo (Roemer) from the Cretaceous (lower Senonian) of the Aachen district, Germany.<sup>344</sup>

*Types.*—Two cotypes, internal molds, in the collection of the Academy of Natural Sciences of Philadelphia. Plesiotype from Texas, U.S.N.M. no. 76862.

Distribution in Texas.—Navarro group, Nacatoch sand: 4½ miles east by north of Rosali (14061): near Avery (13534).

Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924, figured).

Outside distribution.—Tennessee: Coon Creck tongue of Ripley formation.

Mississippi: Ripley formation and questionably in the Prairie Bluff chalk.

West-central Alabama: Prairie Bluff chalk.

New Jersey: Navesink marl.

Range.—-Known in Texas from the Nacatoch sand and the Corsicana marl of the Navarro group, but the outside distribution indicates a range through the *Exogyra costata* zone.

#### Family XENOPHORIDAE

#### Genus XENOPHORA Fischer

#### XENOPHORA LEPROSA (Morton)

#### Pl. 52, figs. 17-19

- 1834. Trochus leprosus Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 46, pl. 15, fig. 6.
- 1861. Phorus leprosus (Morton). Gabh, Synopsis of the Mollusca of the Cretaceous formation, p. 85.
- 1864. Phorus leprosus (Morton). Meek, Check list of invertebrate fossils of North America, Cretaceous and Jurassic, p. 18.
- 1868. Onustus leprosus (Morton). Conrad, in Cook, Geology of New Jersey, p. 728.
- <sup>314</sup>Holzapfel, E., Palcontographica, Band 34, p. 142, pl. 14, fig. 27, 1888.

- 1892. Xenophora leprosa (Morton). Whitfield, U.S.Geol. Survey Mon., vol. 18, p. 135, pl. 17, figs. 16-19. (Geol. Survey New Jersey, Paleontology, vol. 2, p. 135, pl. 17, figs. 16-19, 1892.)
- 1892. Xenophora conchyliophora (Born). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 2, p. 360. (In part.)
- 1905. Xenophora leprosa (Morton). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 21.
- 1907. Xenophora leprosa (Morton). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 690, pl. 78, figs. 1–3.
- 1916. Xenophora leprosa (Morton). Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 495.
  1926. Xenophora leprosa (Morton). Wade, U.S.
- 1926. Xenophora leprosa (Morton). Wade, U.S. Geol. Survey Prof. Paper 137, p. 162, pl. 56, figs. 7, 8.

This species is represented in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain mainly by internal molds, but an incomplete distorted shell was found by Wade at Coon Creek, Tennessee. Shell low, trochiform. Whorls about 4, broad, flattish, gently inclined on the sides. Surface rough and very irregular, due to the agglutination of extraneous shell fragments and other objects. Base broad, flattish, broadly excavated, gently inclined away from the center. The molds suggest a narrow umbilicus, but this was probably filled by the shell leaving only a rather deep umbilical fissure. The shell from Coon Creek indicates a smooth base except for rather pronounced incremental lines. A cross section of the flattish whorl would present a long narrow opening but the outer lip of the aperture is broadly concave backward making the opening broadly subovate or nearly circular. The Coon Creek shell exhibits a thin, simple outer lip, and the thin inner lip bends sharply over into the umbilical fissure.

Dimensions of the medium-sized internal mold shown in plate 52, figures 17-19: Height 17 + mm., diameter 33 mm. The large shell figured by Wade, though too badly crushed for exact measurement, must have been fully 50 mm. in diameter.

Internal molds of this genus are frequently found in the Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plain, but they present no characters that serve as a basis for the recognition of

more than one species. Perfect shells might afford evidence of two or more species, and this is suggested by the somewhat higher spires of some individuals. Dall could see no differences between Cretaceous, Tertiary, and Recent species which have been described under different specific names, and he referred all of them to the older Recent species, Xenophora conchyliophora (Born). In the specimen which he figures, however,345 the whorls are narrower and more numerous and should certainly be differentiated from the Upper Cretaceous shells. It seems highly probable that, if well preserved fossil shells could be found for comparison, the Cretaceous ones could be shown to be specifically distinct from the Tertiary and Recent ones.

The Cretaceous genus Endoptygma, Gabb,<sup>346</sup> which is like Xenophora except for a spiral groove on the base of the internal mold, is based on a feature which may be only a specific, perhaps only a senile, character. Internal molds of Xenophora from the Upper Cretaceous of the Gulf region exhibit a smooth base, but toward the aperture a groove at the position of the one described and figured by Gabb makes its appearance and grows stronger anteriorly, suggesting an adult or old age character.

Types.—Holotype, Academy of Natural Sciences of Philadelphia. From the Prairie Bluff chalk at Prairie Bluff, Alabama River. Alabama. Plesiotype from Texas, U.S.N.M. no. 76863.

Distribution in Texas.—Blossom sand (upper Austin chalk age): Bed of a small creek, ¼ mile southeast of the crossing of the Texas & Pacific and Texas Midland railroads, southwest edge of Paris, Lamar County (7508); Forest Hill church, 7 miles northeast of Honey Grove, in Lamar County (9701).

Pecan Gap chalk (upper Taylor age): The Cox place, 3 miles east by south of Wolfe City, Hunt County (9712).

Navarro group, Corsicana marl: 14/5 miles N. 20° W. of Tona siding (15545,

<sup>&</sup>lt;sup>315</sup>Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 2, pp. 360-362, pl. 4 (in pt. 1), figs. 10, 10a, 1892.

<sup>&</sup>lt;sup>315</sup>Gabh, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 302, 1876.

figured); well 7/20 mile south by west of St. Mary's University, Bexar County

(16353); near Castroville (7665).

Outside distribution .-- Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Prairie Bluff chalk.

West-central Alabama: Prairie Bluff chalk.

Delaware: Crosswicks clay.

New Jersey: Navesink marl.

Range .- The distribution in Texas indicates a range from beds of upper Austin age, upward through the Taylor marl and the Navarro group, that is, through the Exogyra ponderosa and E. costata zones.

#### Family TURRITELLIDAE

#### Genus TURRITELLA Lamarck, sensu lato

## TURRITELLA TRILIRA Conrad

## Pl. 52, figs. 1-5

- 1860. Turritella trilira Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 285. 1861. Turritella corsicana Shumard, Boston Soc.
- Nat. History Proc., vol. 8, p. 196, 1901. Turritella trilineata Hill, U.S.Geol. Survey 21st Ann. Rept., pt. 7, pl. 48, fig. 3. (Figure only.)
- 1902. Turritella trilineata Hill and Vaughan, U.S. Geol. Survey Geol. Atlas, Austin Folio (No. 76), illustration sheet, fig. 47. (Figure only.)
- 1906. Turritella trilira Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 699, pl. 79, figs. 4, 5.
- 1906. Turritella trilira Conrad. Veatch, U.S. Geol. Survey Prof. Paper 46, pl. 11 (op. p. 26), fig. 4. (Figure only.)
- 1916. Turritella trilira Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 489.
- 1923. Turritella trilira Conrad. Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 360, pl. 90, figs. 2-9.
- 1926. Turritella trilira Conrad. Wade, U.S.Geol. Survey Prof. Paper 137, p. 161, pl. 56, fig. 3.
- 1926. Turritella trilira Conrad. Stephenson, Alabama Geol. Survey Special Report No. 14, p. 250, pl. 92, fig. 15. (Figure only.)

The original of this species was collected by Dr. W. Spillman in Tippah County, Mississippi, but the exact locality was not specified. The type was not figured and was subsequently lost. There remains therefore only the author's brief verbal description, quoted below, on which to base an identification:

Turreted; whorls with three equidistant, very acute, prominent ribs; revolving lines micro-scopic, closely arranged. Length  $2\frac{1}{2}(?)$  inches.

Although the specimens ordinarily referred to the species include forms that might logically be given a separate recognition as varieties, as a whole they constitute a compact group, widely distributed in the Upper Cretaceous deposits of Atlantic and Gulf Coastal Plain. The following description is based mainly on specimens from Lee's old mill site, 2 miles northeast of Keownville on the road to Molino, Union County, Mississippi. This locality, though now in Union County, within Tippah County was as its boundaries existed at the time Doctor Spillman made his collections. Stratigraphically the locality is in the upper part of the Ripley formation.

Shell high, imperforate; the angle of the spire near the tip is about 17 degrees, but the angle increases to about 23 degrees near the middle of the spire of adults, thence, decreases to 14 or 15 degrees near the large end. The protoconch was not seen perfectly preserved, but appears to be a simple, dextral, prominent shell. Whorls 15 or more, probably exceeding 20 in large individuals. The sides of the whorls are broadly rounded and are ornamented with three equally spaced, prominent acute spiral ribs; the whole surface of the larger whorls is further marked by very fine, almost miscroscopic, closely spaced spiral lines which become obscure and fade out toward the apex. On the smaller whorls toward the apex of the spire of many specimens a fourth revolving rib, much less prominent than the other ribs, is present between the suture and the uppermost of the three main ribs; this rib gradually fades out and generally disappears less than midway of the spire; it is unequally developed on different individuals being traceable to the body whorl in some and being entirely absent on others.

The suture is closely appressed and typically lies a little below the broad, rather deep sutural channel; the suture is bordered above by a thin, low, slightly overhanging carina; the space between

the suture and the first rib below is The fine lines of slightly excavated. growth are strongly concave backward on the sides of the whorls. The base of the shell was not seen in the Tippah County material, but on specimens from other localities. especially Eufaula, Alabama, it is flattish and almost at right angles to the outer surface; the forward edge of the body whorl is bordered by a sharp carina which simulates a fourth rib, and this carina is closely bordered on the base by a shallow channel; obscure revolving lines appear on the base of some specimens; the growth lines on the base are broadly concave toward the aperture. The aperture is subcircular to broadly subovate, and on adults flares slightly; the lips are thin to moderately thick; on young individuals the inner lip forms a thin callosity on the base but on adults this lip rises free from the base. Large shells from Eufaula. Alabama, attain a height of 70 mm. and a diameter of 20 mm.

The Texas shells are essentially like those from Mississippi, except that on most specimens the fine spiral lines are so weakly developed that they can scarcely be seen even under a lens; but in a good light at a favorable angle they are generally faintly discernible. An occasional specimen, however, shows the fine lines almost as strongly developed as they are on the Mississippi shells. Some of the Texas shells attain an estimated height of 85 or 90 mm. and a diameter of 23 mm.

Turritella quadrilira Johnson, T. trilira Conrad, and T. bilira Stephenson form a closely related, probably evolutionary group, of which the first is restricted to the Exogyra ponderosa zone, the second ranges through the E. ponderosa and E. costata zones, and the third occurs only in the uppermost beds of the E. costata zone.

Types.—The holotype of this species, which should be in the Academy of Natural Sciences of Philadelphia, is apparently lost; it was collected by Dr. W. Spillman in Tippah County, Mississippi; it was never figured. The specimen

figured by Stephenson<sup>347</sup> from Bullock's old mill near Dumas, Tippah County, Mississippi, shows an immature fourth rib below the suture, and since this feature was not mentioned in Conrad's original description, this specimen can not be regarded as strictly typical. The two specimens (plesiotypes) shown in plate 52, figures 3, 4, of the present paper (U.S.N.M. no. 76861) are from the Ripley formation at Lec's old mill site in Union County (formerly a part of Tippah County), Mississippi: for all practical purposes they may be regarded as neotypes, although they can not be known to be from the same locality and stratum as the holotype. Plesiotypes from Texas, U.S.N.M. nos. 76865, 76866.

Distribution in Texas.—Wolfe City sand member of Taylor marl: Near the G.C. & S.F. R. R. about 4/5 mile east of Pecan Gap. Delta County (9713); cut of Santa Fe R. R., 11/2 miles northeast of Wolfe City, Hunt County (9562); cut of G.C. & S.F. R. R., about 2 miles east by north of Wolfe City (9709).

Anacacho limestone: The King water hole on Hondo Creek, about 3 miles north by west of Hondo, Medina County (7680): Medina River at the bridge at Castroville, Medina County (7664).

San Miguel formation: Carter ranch, 12 miles by road northwest of Eagle Pass, Maverick County (8227): ?on the Del Rio road. 12.5 miles northwest of Eagle Pass (1513); northward-facing slope of Agua de Fuera Creek valley, about 5 miles southeast of Spofford, Kinney County (8262).

Navarro group, Neylandville marl:  $3\frac{1}{2}$ miles west-northwest of Corsicana (16166);  $2\frac{1}{2}$  miles north of Corbet (16170, Tex. Bu. 17300);  $2\frac{2}{2}$  miles south of Ben Hur (15543).

Navarro group, Nacatoch sand: 3 miles north of town of Sulphur Bluff (5322); vicinity of Kaufman (761); 2½ miles north of Corsicana (14114); vicinity of Chatfield (762, 1 specimen figured); loose pieces of rock in street at Chatfield (7568); ¾ mile east of Chatfield (7571);

<sup>&</sup>lt;sup>317</sup>Stephenson, L. W., North Carolina Geol, and Econ. Survey, vol. 5, pl. 90, fig. 9, 1923,

3/5 to 4/5 mile northeast of Chatfield (7572, 14117); field south of Chatfield (7569); 2 miles north of Corsicana (9553, 9554, 9555); 3 miles northeast of Corsicana (9545); Watkins' place 3 miles north of Corsicana (9552); north edge of Corsicana (518, 1 specimen figured); 4 miles north of Corsicana (17366); vicinity of Corsicana (763); road 5 miles south-southwest of Corsicana (7573); 5 miles northeast of McClanahan (17371).

Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924).

Outside distribution. --- Arkansas: Brownstown marl, Saratoga chalk, and Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Coffee sand, Ripley formation, and Owl Creek formation.

Central and west-central Alabama: Prairie Bluff chalk.

East-central Alabama and Chattahoochee region (Alabama - Georgia): Blufftown formation, Ripley formation, and Providence sand.

North Carolina: Snow Hill member of Black Creek formation; Peedee formation (upper part).

Maryland: Matawan formation and Monmouth formation.

New Jersey: Wenonah sand.

Range...In Texas the species ranges from beds of Taylor age upward to the Corsicana marl of the Navarro group. In general in the Atlantic and Gulf Coastal Plain the range of the species is through the zones of *Exogyra ponderosa* and *E. costata*.

# TURRITELLA BILIRA Stephenson, n.sp.

# Pl. 52, figs. 9-16

This species is based on well preserved material from near the top of the Ripley formation (Upper Cretaceous) exposed on Pataula Creek, Clay County, Georgia. Shell of small to medium size for the genus. Apical angle 28 or 30 degrees, decreasing to about 20 degrees on the larger whorls below. Whorls about 12 (estimated) in a specimen the size of the incomplete holotype. Protoconch not preserved, but obviously very small. Suture closely appressed lying a little below the middle of a deep, broadly U-shaped channel; this channel is noticeably wider on some individuals than on others. The ernamentation consists of two prominent spiral lirae which vary in thickness on different individuals from thin and sharp to nearly three-quarters of a millimeter, with rounded crests. The interspace between the two lirae is broadly U-shaped to flattish on the bottom. The periphery of the body whorl is marked by a narrow carina, against which the succeeding whorl fits tightly as growth proceeds, in such a manner that the carina is not apparent in the bottom of the sutural depression. The growth lines are strongly concave in trend toward the aperture, the deepest part of the curve being at the intersection of the upper of the two lirae. Base of body whorl broadly excavated. Aperture subcircular, peristome entire, slightly flaring in the adult.

Dimensions of the slightly incomplete medium-sized holotype: Height 19.2 mm., diameter 6.7 mm.; the larger shells reach diameters of 12 mm. or more.

The species exhibits a noticeable individual variation in the acuteness of the spire, in the width of the sutural depression, and in the thickness of the lirae. Incomplete specimens have been found in Texas at 3 localities. Good specimens have been found reworked from the Owl Creek formation into the base of the Paleocene in Pontotoc County, Mississippi.

Types.—Holotype, U.S.N.M. no. 76867; 4 figured paratypes, U.S.N.M. no. 76868; 9 unfigured paratypes, U.S.N.M. no. 76869. Figured example from Texas, U.S.N.M. no. 76870; 1 unfigured example from Texas, U.S.N.M. no. 76871. The type locality is the "Narrows" of Pataula Creck, 2 miles upstream from the junction of the creck with Chattahoochee River, Clay County, Georgia.

Distribution in Texas.—Navarro group, Kemp clay: ?Brazos River, 2 miles above Milam County line (13776); Webberville (7601); 4½ miles northwest of Lockhart (16151).

Outside distribution. — Chattahoochee region (Georgia): Providence sand.

Mississippi: A bilirate Turritella, probably T. bilira, was observed in the base of the Clayton formation of the Midway group (Paleocene) in association with numerous other shells, all mechanically derived from underlying Cretaceous beds, in a deep cut of the Gulf, Mobile and Northern Railroad, 1/2 mile south by west of Pontotoc, Pontotoc County. The state of preservation was such that the shells disintegrated quickly on exposure to the air. Better preserved shells were found at the same stratigraphic position 3 miles south of New Albany. Pontotoc County.

Range.-This species appears to be restricted in its vertical range to the uppermost part of the Exogyra costata zone of the Gulf series.

## TURRITELLA WINCHELLI Shumard

# Pl. 53, figs. 1-3

1862. Turritella winchelli Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 196. 1928. Turritella winchelli Shumard. Adkins,

Univ. Texas Bull. 2838, p. 184.

Shumard described, but did not figure, this species as follows:

Shell of moderate size, clongate-conical, gradually tapering from base to apex; volutions nine to ten, gently convex; last one convex beneath: suture distinct, situated in a moderately deep channel; aperture subquadrate, longer than wide; surface of volutions of spire bearing three, moderately prominent, rounded, revolving carinae, with fine, elevated, revolving lines, in the interspaces. In the specimen under examination, there are two of these lines, between the upper and middle carinae, one between the middle and inferior and two in the sutural channel. The last volution has four carinae, and the space between the upper two, is wider than between the inferior ones, and bears two fine revolving lines. Spiral angle 16°; length 1.5 inches; width at base, 0.45 inch.

Shumard states that this species occurs in great abundance in Cretaceous septaria at Corsicana and Chatfield, but he does not indicate at which of the two localities the specimens which served as the basis for the above quoted description were obtained. These type specimens are lost. In a suite of 29 specimens from near Corsicana, collected by Dr. T. W. Stanton in 1890, there is so general individual variation in the spiral ornamentation that no two shells exactly match each other, although there is an obvious general resemblance among them that justifies referring them to the same species. One incomplete specimen which seems to fit Shumard's description most closely is selected as neotype (pl. 53, figs. 2, 3).

On the selected shell there are three moderately prominent, rounded, revolving ribs: there are two subordinate spiral ribs between the upper and middle main ribs. the lower of the two being the more prominent, but several additional obscure ribs can also be seen under a lens: one subordinate rib occurs between the middle and lower main ribs, but here also additional obscure lines can be detected: two subordinate ribs are present in the sutural depression, one above and one below the suture, the upper one of which is the more prominent and more rounded; the periphery of the body whorl is rounded and bears two revolving ribs, the upper one the more prominent. The base rounds sharply in to the columella, and is marked by 7 or 8 fine, obscure revolving ribs. The trend of the growth lines is markedly concave toward the aperture on the sides of the whorls, the center of the concavity being a little above the middle.

Dimensions of the neotype: Height 42 mm. (estimated), diameter 12.5 mm.

The nearly complete shell shown in plate 53, figure 1, is 46 mm. high, and has a spiral angle of 16 degrees at the apex, but this angle widens a little anteriorly.

The species is characterized by its marked individual variation in surface sculpture.

Types.—-The type material, which came from either Corsicana or Chatfield, is lost. The specimen from near Corsicana, shown in plate 53, figures 2, 3, is selected as neotype, U.S.N.M. no. 76872; 1 figured specimen, U.S.N.M. no. 76873; 11 unfigured specimens, U.S.N.M. no. 76874.

Distribution in Texas. -- Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); 2 miles north of Corsicana (9553, 9554); 3/5 to 4/5 mile northeast of Chatfield (14117); northwest corner of Franklin County (12931).

# TURRITELLA VERTEBROIDES TENUISPIRA Stephenson, n.var.

## Pl. 53, figs. 4-9

Shell large, elongate-conical, more slender near apex than on the larger part of the spire below. Apical angle on the first 10 or 12 whorls, 10 degrees, expanding to 18 degrees below. Protoconch not well preserved, but apparently smooth, turreted, and having 2 or 3 volutions. Suture closely and neatly appressed, lying at the bottom and a little above the center of a rather deep, broadly flaring channel.

The sculpture on the larger whorls consists of 4 primary spiral ribs and intermediate smaller ribs as indicated below; the primary ribs are narrow, smooth, subequal, angular on their crests, and only moderately prominent; the three primary ribs farthest forward are evenly spaced; the space between the posterior primary rib and the one next in front of it is wider than the spaces separating the other three ribs: between the suture and the first primary rib in front of it are two fine secondary ribs, the upper one of which is the larger; a little below the center of the space between the first and second primary ribs is a small secondary rib and in each of the two subspaces is a tertiary rib; one secondary rib is present between the second and third primary ribs, one between the third and fourth, and one between the fourth primary and the suture below; still finer, obscure, microscopic lines may be present between the other ribs on any part of the surface; slight individual variation in details of sculpture is exhibited by the species. The base of the shell is flat and smooth, and the periphery of the body whorl is sharply augular and carinated.

Dimensions: Height, estimated from incomplete fragments, 85 mm., greatest measurable diameter about 12 mm.

Compared with the type of *T. verte-broides* Morton, the sculpture on this varietal form is weaker, the primary ribs are thinner and less regularly spaced, and smaller ribs between the larger ones are fewer, weaker, or even wanting especially on the smaller whorls.

*Types.*—Holotype, U.S.N.M. no. 76875; 4 figured paratypes, U.S.N.M. nos. 76876; 13 unfigured paratypes, U.S.N.M. no. 76877.

Distribution in Texas.—Navarro group, Neylandville marl: 3½ miles west-northwest of Corsicana (16166); 2½ miles north of Corbet (16170, type lot; 17365).

Navarro group, Nacatoch sand: ?Vicinity of Kaufman (761).

# TURRITELLA VERTEBROIDES JONESI Stephenson, n.var.

# Pl. 53, fig. 11

Shell large, elongate-conical; spiral angle probably 17 or 18 degrees at the apex, spreading slightly toward the front. Suture closely and neatly appressed. Sides of whorls broadly convex. The larger whorls are ornamented with 4 primary spiral ribs, the first, second and third of which are moderately thick, prominent, and round crested, and the fourth of which is smaller and sharper; numbered from rear to front the first and second primary ribs are a little more widely spaced than the others; centrally in each of the spaces between the primary ribs is a secondary rib, and in each of the subspaces is a tertiary rib; the secondary and two tertiary ribs between the second and third primaries are more widely spaced than the corresponding ribs in other interspaces; the first secondary below the suture approaches a primary in strength; still finer, almost microscopic lines complete the ornamentation over practically the entire surface of the larger whorls; the ornamentation becomes weaker posteriorly, and the whorls, 10 mm. or less in diameter, appear to be practically smooth. A sharp, moderately prominent carina bounds the periphery of the body whorl; a shallow channel borders this carina, but otherwise the base is nearly flat and descends abruptly to the columella. The aperture is not well preserved in the available material but is probably subcircular or broadly subovate. The body whorl of large individuals tends to separate from the penultimate whorl, causing the inner lip to rise free from the base of the shell.

Dimensions of the holotype, in which only the six larger whorls are preserved: Height 64 -+ mm., diameter 23 mm.

This variety differs from T. vertebroides Morton in the greater irregularity in the spacing of its spiral ribs; only the larger end of the type of Morton's species is preserved and it is badly crushed. Compared with T. vertebroides tenuispira, jonesi has a stronger ornamentation medially and anteriorly, and a weaker ornamentation posteriorly, the whorls toward the apex apparently becoming smooth.

Types.—Holotype, U.S.N.M. no. 76878; named for the Hon. Anson Jones, President of the Republic of Texas, 1844-1846.

Distribution in Texas.---Navarro group, Kemp clay: West of Zuehl (7721); 2 miles south-southeast of Schumansville (16668); near Deatsville (764); 3<sup>1</sup>/<sub>4</sub> miles east by north of Manor (13861, type loc.); 1 mile west by south of Odds (17373); branch 6<sup>1</sup>/<sub>2</sub> miles southwest of Currie (14139).

# TURRITELLA VERTEBROIDES LONGI Stephenson, n.var.

#### Pl. 53, figs. 12, 13

This variety is much like T. vertebroides jonesi but is a more slender, elongated form, having the posterior part of the whorl more flattened, and the sutural depression wider and shallower. Between the first and second of the four primaries are two secondary ribs, the posterior one the stronger, and in the subspaces formed by these secondaries are weak tertiaries. The variety is distinguished by its slenderness, having an estimated apical angle of only about 12 degrees. The broken holotype includes 4 whorls at the large end of a shell having an estimated height of about 110 mm., and a measured diameter of 22.5 nm. The shell has a flattish base bounded on the periphery by a narrow, prominent carina, and in this respect is typical of the *vertebroides* group.

Accompanying the holotype is a fragment of a *Turritella* which includes 3 whorls, with a maximum diameter of 12 mm.; the sides of the whorls appear to be smooth. This fragment may or may not belong to the variety *longi*. Holotype.—U.S.N.M. no. 76880; fragment, U.S.N.M. no. 76879. Named for James Long who, in 1810, led a filibustering expedition into Texas to aid the State in becoming a republic.

Distribution in Texas.--Navarro group, Kemp clay: 2 miles northwest of Deatsville (14128); 2 2/5 miles southeast of Manor (18196).

## TURRITELLA VERTEBROIDES LEONI Stephenson, n.var.

### Pl. 53, fig. 10

In general form and sculpture this variety resembles T. vertebroides jonesi, but the primary ribs are much coarser and the secondary and tertiary ribs, which are poorly preserved, are consequently more crowded in the narrower interspaces: the sutural depression is also narrower. The variety is based upon three incomplete specimens of which the larger one is designated the holotype; the latter includes about  $4\frac{1}{2}$  of the larger whorls, with the body whorl and base partly broken away. The shell has the characteristic flattish base of the vertebroides group. The apical angle appears to be about 16 degrees, the height of the restored shell about 85 mm., and the measured diameter 20 mm.

Holotype.—U.S.N.M. no. 76881; 1 unfigured paratype, U.S.N.M. no. 76882. Named for Alonzo de León who, with Padre Manzanet, founded Mission San Francisco de las Tejas, near Neches River, in the year 1690.

Distribution in Texas.—Navarro group, Kemp clay: 3<sup>1</sup>/<sub>4</sub> miles east by north of Manor (13861, type locality).

# TURRITELLA AUSTINI Stephenson, n.sp.

# Pl. 54, figs. 4-6

Shell thin, of moderate size, elongateconical, with an apical angle of about 18 degrees. Sides of whorls plumply rounded, fullest below. Suture closely appressed and occupying a deep depression, the upper or posterior slope of which is the steeper. The ornamentation consists of 8 or 9 narrow, sharp, nonprominent, spiral primary ribs, with smaller,

equally sharp, secondary ribs in the interspaces; the obscure beginnings of tertiary ribs may be faintly seen in places in the smaller subspaces; fine, sharp ribs of secondary and tertiary strength produce a fine lining on the opposing slopes of the sutural depression; there is some unevenness in the spacing of the spirals, the anterior ones being a little more widely spaced than the posterior ones. The base is flattish, descending abruptly to the columella, and appears to be nearly smooth, although fine, obscure, microscopic, spiral lines may be faintly seen on one specimen; the base is bounded at the angular periphery by a sharp, modcrately prominent carina. The aperture is not well preserved.

The dimensions of the holotype, an incomplete specimen slightly distorted by a calcite vein, are: Height 23 + mm., diameter 11.5 mm. The largest paratype has a diameter of 13 mm.

The species is characterized by the plumpness of the whorls, and by the fine, sharp, subregular system of spiral lirae.

The only other described Turritella in the Coastal Plain, comparable to this one, is T. houstoni, a species with flattish whorls, a subrounded periphery, and a distinctly ornamented base. The two species occur together at their type locality.

Types. - Holotype, U.S.N.M. no. 76883; 1 figured paratype, U.S.N.M. no. 76884; 5 f r a g m e n t a r y, unfigured paratypes, U.S.N.M. no. 76885. Named for Stephen F. Austin, a Texas leader during and before the time of the Republic.

Distribution in Texas.- Navarro group, Nacatoch sand: 3/5 to ½ mile northeast of Chatfield (14117, type loc.); vicinity of Chatfield (762); ¾ mile east of Chatfield (7571).

# TURRITELLA HOUSTONI Stephenson, n.sp.

# Pl. 54, figs. 1-3

Shell of moderate size and thickness, clongate-conical, with an apical angle of about 22 degrees. Sides of whorls flattish to slightly concave in upper or posterior half, swelling to a gentle bulge in the lower half. Suture closely appressed; sutural depression moderately deep. The surface is ornamented with 9 primary spiral ribs which are of moderate but unequal strength, and between the primaries are smaller, but distinct, secondaries; faint tertiaries appear in places on some specimens; the primaries are strongest and most widely spaced on the anterior bulge of the whorl, and are closest together in the slight constriction just above the middle of the whorl. The periphery of the body whorl is subrounded, but passes into a steeply descending flattish base; the periphery bears two moderately strong spirals separated by a smooth interspace; the base is nearly as strongly ornamented as the sides, the spirals including 7 or 8 primaries, weaker intermediate secondaries, and faint tertiaries in the subspaces. The growth lines on the sides of the whorls are distinctly concave toward the aperture, but are a little sinuous where they cross the anterior bulge. The aperture is not preserved.

Dimensions of the incomplete holotype: Height 22 + mm., diameter 9.5 mm. The largest specimen in the collection has a diameter of about 15 mm.

This species is ornamented much like *T. austini*, with which it is associated, but the spirals are stronger, the sides of the whorls are markedly flatter, the periphery is subrounded, and the base is distinctly ornamented. *T. menairyensis* Wade, from the Coon Creek tongue of the Ripley formation at Coon Creek, Tennessee, is a closely analogous species, but its whorls are not so flat, its sculpture is stronger, and its peripheral angle and base are more plumply rounded.

Holotype.—U.S.N.M. no. 76886. Named for the Hon. Sam Houston, President of the Republic, 1841–1844, and Governor of the State of Texas, 1859–1861.

Distribution in Texas.—Navarro group, Nacatoch sand: 3/5 to 4/5 mile northeast of Chatfield (7572; 14117, type lot); field south of Chatfield (7569); vicinity of Kaufman (761).

# TURRITELLA DEATSVILLENSIS Stephenson, n.sp.

# Pl. 52, figs. 6-8

Shell small, turreted, apical angle about 21 degrees. Whorls 6, rather strongly convex on the sides; protoconch broken away. Suture closely appressed, situated at the bottom of a wide, deep, asymmetric depression, the shorter slope of which is above the suture. Each whorl is ornamented with 3 rather strong, sharp, primary lirae, the center one of which is slightly the more prominent; between the two lirae farthest forward is a small, obscure secondary. The peripheral angle of the body whorl is angular, and bears a prominent, narrow ridge; the base is flattish, smooth and descends sharply to the columella.

Dimensions of the holotype: Height 17 mm., diameter 7 mm.

The three sharp lirae of this species suggest relationship to T. trilira Conrad, from which the species differs in having a wider apical angle, and a secondary lira between the second and third primaries. The holotype is much smaller than trilira, but it may be a young shell.

A second specimen which occurs with the holotype, has the same general form and the same wide, deep, asymmetric sutural depression, but has four instead of three about equally strong lirae; it is questionably referred to this species on the supposition that it may be an individual variant; in the absence of a large suite of specimens showing intermediate forms it might reasonably be regarded as a separate variety, or perhaps even a distinct species.

*Types.*—Holotype, U.S.N.M. no. 76887; 1 figured example(?) U.S.N.M. no. 76888.

Distribution in Texas.--Navarro group, Kemp clay: Near Deatsville (14125).

# Unidentified specimens of TURRITELLA

Two fragments of a moderately large species of *Turritella* from the Corsicana marl, at the crest of a hill south of the Seguin-San Antonio highway, 2<sup>1</sup>/<sub>2</sub> miles west of McQueeney, Guadalupe County (15523), probably represent a new

species, but are hardly well enough preserved to serve as types (pl. 54, fig. 8). The sides of the whorls are flat, and the sutures are closely appressed and are very narrow and shallow; the sculpture consists of 12 or 13 small, nonprominent, primary spirals, with very fine, almost obscure secondaries in the interspaces. The species resembles T. subtilis from the upper part of the Peedee formation of North Carolina, but has a less deeply sunken sutural depression and a somewhat more regular alternation of large and small spiral costae. U.S.N.M. no. 76889.

Several young gastropods from the Kemp clay on Colorado River at Webberville, Travis County (7601, 1 specimen figured, U.S.N.M. no. 76890), and between depths of 675 and 800 feet (13132, U.S.N.M. no. 76891; 13124, U.S.N.M. no. 76892) in Cargile No. 1 well of the Robinson Oil & Cas Company, 2 miles west of Groesbeck, Limestone County, appear to represent a new species of Turritella. The best preserved shell (pl. 54, fig. 7) is from the first-named locality. It is a small thin shell, having an apical angle of 18 degrees, with 8 whorls and a badly broken protoconch. The closely appressed suture is at the bottom of a deep, wide asymmetric sutural depression, the posterior side of which is the steeper. The sculpture on the larger whorls consists of 4 sharp, spiral lirae with small secondaries in the interspaces; on the posterior slope of each whorl are 3 small lirae, the central one of which is the larger; on the anterior slope between the fourth primary and the suture is another small lira. The base is flattish, is bordered by a sharp carina, and is ornamented with 7 or 8 fine, evenly spaced lirae; the aperture is broken but appears to be broadly subovate; the inner lip forms a thin polished callus over the base of the shell. Dimensions: Height 8 mm., diameter 2.5 mm. This specimen is excellently preserved and were it not probably a juvenile example it would serve well as a type.

Imperfectly preserved specimens of *Turritella*, which probably represent varietal forms of *T. vertebroides* Morton, but which are specifically unidentifiable, have been collected at the localities indicated below.

Distribution in Texas.---Navarro group, Corsicana marl: 1<sup>4</sup>/<sub>5</sub> miles N. 20° W. of Tona siding (15545, U.S.N.M. no. 76893); west of Kaufman (7548, U.S.N.M. no. 76894); fuller's earth pit, 14 miles west of San Antonio, Bexar County (15520, U.S.N.M. no. 76895); Castroville road, 1<sup>1</sup>/<sub>5</sub> miles west of Leon Creek, Bexar County (15522, U.S.N.M. no. 76896).

Navarro group, Kemp clay: Webberville (7601, U.S.N.M. no. 76897).

## Family CERITHIIDAE

## Genus CERITHIUM Bruguière

# CERITHIUM SIMPSONENSE Stephenson, n.sp.

# Pl. 54, fig. 9

Shell small, elongate-conical, apical angle 22 degrees. The protoconch is a simple, smooth dextral cone, having about the same angle of divergence as the main shell; the latter includes 8 regularly increasing flat-ribbed whorls. Suture closely appressed, occupying a sharply impressed depression. The sculpture consists of numerous, rather fine axials which on the larger whorls are crossed by four moderately strong, flat-topped spirals, the posterior one of which is narrower than the others; on the body whorl the interspaces are as wide as, or wider than, the spirals, but the spirals tend to become more crowded posteriorly; the first and third spirals in front of the suture become weaker as they pass backward, and practically disappear before reaching the protoconch: the crossing of the axials and spirals produces a regular, beaded pattern. The peripheral shoulder on the body whorl rounds rather sharply into a flattish base which descends abruptly to the columella; the periphery is marked by a carina which is weaker than the spirals above; the base is ornamented with 6 or 7 spirals which become progressively weaker from the shoulder inward to the columella. The aperture is not preserved.

Dimensions of the holotype: Height 7.5 mm., diameter 2.5 mm.

Holotype.-U.S.N.M. no. 76898.

Distribution in Texas--Navarro group, Nacatoch sand: Road 2 miles southwest of Kaufman (7546).

# CERITHIUM sp.

# Pl. 54, fig. 10

One young individual of Cerithium, probably an undescribed species, was found in the Kemp clay at a depth of 730 feet in Cargile No. 1 well of the Robinson Oil & Gas Company, 2 miles west of Groesbeck, Limestone County (13132). The shell is small and has an apical angle of about 18 degrees. The suture is closely appressed and occupies the bottom of an asymmetric depression the posterior slope of which is the steeper; the whorls are traversed by two spirals separated by a flat, rather broad interspace; the anterior spiral is rather coarsely, though not prominently noded, and is closely paralleled on either side by fine threads; the posterior spiral is smaller and smoother than the anterior one, and is only obscurely noded; the interspaces bordering the spirals are rather coarsely and obscurely undulating. A strong, smooth carina marks the peripheral angle and the flattish base is ornamented with fine spiral threads. The body whorl is broken away for more than half its length. Only a fragment of the larger end of the protoconch is preserved; it indicates a simple, polished dextral shell. Dimensions: Height about 5.5 mm., diameter about 2.25 mm. U.S.N.M. no. 76899.

#### Genus NUDIVAGUS Wade

# NUDIVAGUS? COOPERENSIS Stephenson, n.sp.

# Pl. 54, figs. 11, 12

Shell large, simple, turreted, spiral angle about 30 degrees. Whorls 6 as preserved, with 3 or 4 missing at the apex. Whorls very broadly convex on the side, slightly constricted below the suture. Suture closely appressed. Surface smooth to the naked eye, but under the microscope fine, closely spaced spiral lines appear in a band below the suture, and similar lines can be faintly seen elsewhere; the apparent absence of these lines on parts of the surface is probably due to the poor

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state of preservation of the shell. The periphery of the body whorl is broadly rounded; on the side of the body whorl just back of the aperture the base descends gradually to the beginning of the anterior canal where there is a sharp constriction. The aperture is elongated, is acutely angular at the rear, and passes into an elongated canal in front; the latter is broken away, but in the type species from Coon Crcek, Tennessee, it is narrow, of moderate length, and noticeably sinuous. The outer lip is broken away; the inner lip is imperfect, but is broadly excavated and forms a thin coating of callus.

Dimensions of the incomplete holotype: Height 57+ mm., diameter about 20.5 mm.

The description is based on one imperfect shell, which differs from N. simplicius Wade, from Coon Creek, Tennessee, in the greater convexity of the whorls, and in the apparent weakness of the fine microscopic spiral lines.

Holotype .--- U.S.N.M. no. 76900.

Distribution in Texas.—Navarro group, Neylandville marl: 2/5 mile north of Cooper (14063).

# NUDIVAGUS? sp.

# Pl. 54, figs. 13, 14

A small internal mold with the shell adhering over most of the body whorl, from the Nacatoch sand on Postoak Creek at the north edge of Corsicana, Navarro County (518), appears to belong to Nudivagus. It is similar to N. cooperensis, but the spire is less slender, having an apical angle of about 38 degrees, and the sides are less rounded. The surface of the shell where preserved is covered with numerous, obscure, microscopic threads. The specimen probably represents an undescribed species, but is considered too incomplete to serve as a type. U.S.N.M. no. 76901.

#### Family APORRHAIDAE

#### Genus ANCHURA Conrad, sensu lato

Type species .- Anchura abrupta Conrad.348

Anchura abrupta Conrad is the type of this genus by monotypy, and Cossmann<sup>349</sup> is in error in citing another species as type.

The genotype of this species is a large, plump, regularly sculptured gastropod, having a long, slender anterior canal and a lip expansion which forks into two parts, one a long, thick, tapering spur-like projection curving outward and upward and the other, a much shorter projection extending outward and downward. Many species differing markedly in form, sculpture, and in the character of the lip expansion have been included in the genus and it is to be expected that when this cosmopolitan group has been critically studied it will be subdivided into several genera and subgenera. The material available to the writer does not seem adequate to justify an attempt to reclassify the group.

#### ANCHURA NOACKENSIS Stephenson, n.sp.

# Pl. 55, figs. 6, 7

Shell large, thick, turreted. Suture closely appressed and only moderately impressed. Three of the larger whorls, including the body whorl are preserved in the holotype. Spiral angle about 40°; apex more slender. Number of whorls 10 or more. The sides of the whorls above the body whorl are moderately convex in the anterior two-thirds and strongly constricted in the posterior one-third bordering the suture. The sculpture includes both axials and spirals. On the penultimate whorl there are 24 moderately thick and prominent axials, each a little narrower than the adjacent interspaces; the trend of the axials forms an asymmetric curve, concave toward the front, the strongest part of the curve being on the constricted posterior band. The spirals are 8 in number, are moderately strong, are of unequal thickness and spacing, and form bluntly rounded nodes at their intersections with the axials; the two posterior spirals occupy the constricted band, and are more widely separated than the others; the closest spacing of the spirals

<sup>&</sup>lt;sup>348</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 284, pl. 47, fig. 1, 1860.

<sup>349</sup>Cossmann, M., Essa's Paléce, Comp. 6th Liv., p. 92, 1904.

is on the crest of the more swollen anterior part of the whorl. The body whorl rounds broadly down from the periphery to the columella; the base bears 5 primary spirals of unequal prominence and spacing, the two posterior ones of which are the stronger and the more widely spaced, and are separated by an interspace bearing a weak secondary spiral; the other three spirals become progressively smaller toward the columella. Numerous, obscure, spiral threads appear in places on the better preserved parts of the surface and probably a perfectly preserved shell would exhibit these threads over the greater part of its surface, including the interspaces, axials and spirals. The aperture is narrowly subovate. On the holotype the outer lip is broken away, but, approaching the aperture, the shell shows the characteristic generic expansion and divergence of the ribs, and doubtless the complete shell would exhibit an expanded birostrate lip such as that possessed by the type species, A. abrupta Conrad. The inner lip forms a thick callus on the base of the body whorl, and is deeply and broadly notched where it intersects the columella. The posterior or anal channel is moderately impressed; the anterior channel is broken away, but may be assumed to form a narrow, greatly extended spine-like projection.

Dimensions: Holotype, height 60+ mm., diameter about 34 mm.; paratype, height 84+ mm., diameter 35 mm.

This species is closely related to the type species, *A. abrupta* Conrad, from Tippah County, Mississippi. It is larger, more coarsely sculptured both with respect to the axials and spirals, is more strongly constricted on the posterior part of the whorls, and differs in numerous minor details of sculpture.

Anchura substriata Wade, a smaller species, is less constricted on the posterior part of the whorl, and has 6 instead of 8 spirals on the penultimate whorl.

A. lamari, a nearly related Texas species, has fewer axials and spirals, the axials are thicker and there are minor differences of sculpture. The posterior part of the whorl is also less strongly constricted. *Types.*—Holotype, U.S.N.M. no. 76902; 1 paratype, U.S.N.M. no. 76903.

Distribution in Texas.- Navarro group. Kemp clay: 3 miles S. 30° W. of Thrall (15537, holotype; 17370, paratype); ?San Gabriel River, 2/5 mile above San Gabriel (14130).

# ANCHURA LAMARI Stephenson, n.sp.

# Pl. 55, figs, 1-3

Shell rather large, turreted, apical angle about 22 degrees. Protoconch not preserved. Suture closely appressed, moderately impressed. Whorls 10 in the holotype, slightly convex on the anterior half of each whorl, flattening out posteriorly toward the suture. The axials are thick and moderately prominent on the most inflated part of the whorl, but become weaker both toward the front and rear; they number 22 on the body whorl and 19 on the penultimate whorl; the trend of the axials is a little concave toward the aperture, the deepest part of the curve being about midway of the width of the whorl. On the antepenultimate whorl are 6 spirals, but on the penultimate whorl the posterior margin of the body whorl has overriden the sixth spiral, leaving only 5 exposed; the spirals are of subequal strength, but tend to be a little stronger and a little more closely crowded on the most inflated part of each whorl. The intersecting of the axials and spirals produces a distinct, rather coarse noding, but the first spiral below the suture is more finely noded than the others. The base exhibits 7 nearly smooth spirals; the second spiral below the periphery is the strongest of the seven, in front of which the spirals become successively narrower and weaker toward the columella, the last one being very faint. Numerous fine spiral threads are present over the entire outer surface of the shell. The aperture is broken away on the holotype, and the thinness of the inner lip suggests that this shell has not reached maturity; one specimen from the type locality, though no larger than the holotype, possesses a thick inner lip, notched centrally, and the posterior portion of an expanding, thick outer lip which is mostly broken away. Two

incompletely preserved specimens from near Chatfield show a greatly extended expanding, broad, thick outer lip similar to that of A. abrupta Conrad; the fourth spiral in front of the suture of the body whorl continues out onto this lip, curving upward toward the base of the long, upward, spinose projection which, though broken away in the available material, doubtless would be present in perfect shells, as it is in A. abrupta; at the outer lower extremity of the lip is a short, blunt downward projection: two or three of the spirals in front of the fourth one die out as they pass forward onto the lip, but the surface of the lip is further ornamented with obscure, fine threads. The anterior canal lacks these threads.

Dimensions of the incomplete holotype: Height 68+ mm., diameter 27.5 mm.

This species is closely related to A. noackensis, but is smaller, has fewer axials and spirals, thicker axials, and a less pronounced constriction on the posterior part of the whorl. It is also closely related to A. abrupta Conrad, but is more coarsely sculptured.

Compared with *A. substriata* Wade the species is more coarsely sculptured and the spirals on the base are smoother and less numerous.

*Types.*—Holotype, U.S.N.M. no. 76904; 5 incomplete, unfigured paratypes, U.S.N.M. no. 20986. Named for the Hon. Mirabeau B. Lamar, President of the Republic of Texas, 1838–1840.

Distribution in Texas.--Navarro group, Nacatoch sand: 4½ miles east by north of Rosali (14061); vicinity of Kaufman (761, type loc.); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762); field south of Chatfield (7569); ¾ mile east of Chatfield (7571).

# ANCHURA BEXARENSIS Stephenson, n.sp.

# Pl. 55, figs. 4, 5

Shell of moderate size, turreted, apical angle about 30 degrees. Suture closely appressed, moderately impressed. Whorls 5 in the incomplete holotype, slightly convex on the sides, a little constricted posteriorly below the suture on the larger whorls. The axials are of moderate thick-

ness and prominence, but are narrower than the interspaces; on the largest whorl the axials number 15 and on successively smaller whorls respectively 18, 20 and 24. As in other similar species the trend of each axial forms a curve broadly concave toward the aperture; on the largest whorl the axials end abruptly at the periphery. On each of the larger whorls are 8 primary revolving ridges which override the axials: the still smaller spirals are not very clearly preserved but in each interspace is one, or in the wider ones two, secondaries, and in places tertiaries can be detected in the smallest interspaces. The periphery of the largest whorl, which presumably is the body whorl of an immature specimen, is subobtusely angular and the base descends steeply to the columella; on the base are 4 or 5 widely spaced, primary revolving ridges which become successively smaller from the periphery downward, and in the interspaces are numerous fine riblets which are not clearly preserved. The aperture is moderately wide but is somewhat elongated, and passes anteriorly into a siphonal canal whose anterior portion is broken away and is therefore of undetermined length.

Dimensions of the incomplete holotype: Height 37+ mm., diameter 16.5 mm.

In the matrix with the holotype was found the apical portion of a shell, probably this species, with the protoconch and 3 or 4 additional whorls, all poorly preserved. The axial sculpture on the two larger whorls is fine and closely spaced and traces of fine revolving ridges may be seen. The protoconch is small and apparently simple.

This species is closely akin to A. lamari, but is more finely sculptured with respect to both the axials and spirals. The species is also close to A. abrupta Conrad, from the Ripley formation in Tippah County, Mississippi. The type of the latter is, however, lost and its exact locality in Tippah County is not known, so that an exact comparison cannot be made with that species. A. bexarensis is more closely similar to one shell from Owl Creek, 2½ miles northeast of Ripley, Tippah County, than to specimens from other localities in that county.

Types.—Holotype, U.S.N.M. no. 76906; 1 unfigured paratype?, U.S.N.M. no. 76907.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7721).

# ANCHURA? LOBATA Wade

#### Pl. 56, fig. 15

1926. Anchura lobata Wade, U.S.Geol. Survey Prof. Paper 137, p. 150, pl. 52, figs. 11, 12.

Shell of medium size and thickness. Spire about half the total height of the shell. Whorls seven, slightly convex on the sides, slightly constricted just below the suture, the constriction becoming most pronounced on the penultimate whorl and the body whorl. Suture closely appressed and only moderately impressed. Protoconch as seen on the holotype, small, smooth, trochoid, dextral, coiled three The penultimate whorl is ornatimes. mented with about 19 somewhat unequal, conspicuous axial ribs whose sides slope moderately forming interspaces wider than the ribs, and whose bottoms form rather sharply concave troughs; most of the ribs are subangular on their crests, but every eighth to tenth rib is a broad, roundcrested varix of medium prominence; the ribs become progressively weaker and decrease in number toward the apex; passing from the penultimate to the body whorl the axial ribs become wider apart, at first extending well down over the base, but toward the outer, expanded lip becoming abbreviated and subnodose toward the upper ends; below these short ribs the surface appears smooth and slopes off gently toward the anterior extremity; the whole surface of well preserved shells is covered with delicate, spiral threads so fine they cannot be seen with the unaided eye; these are not wanting on the body whorl of the type, as stated in the original description, although they are more weakly developed, and less completely preserved there than on the spire. Body whorl broadly rounded on the periphery, becoming constricted and smooth anteriorly, and passing into a straight, very

narrow canal, which is almost pointed at the terminus. Aperture elongated, produced in front into a long, nearly straight, narrow canal, and less strongly produced posteriorly into a subangular anal canal. The outer lip expands into a broad wing which in the holotype is produced at the outer, upper extremity into a sharp spur, and at the outer lower extremity into a duller, somewhat retreating spur. The upper margin of this wing is produced upward completely across the penultimate whorl; in more mature specimens than the type the margins of the wing become greatly thickened, destroying the sharpness of the spurs. The inner lip is broadly excavated and forms a thin polished callus which spreads conspicuously forward over the base for 5 or 6 mm. from the aperture, and upward past the anal canal to and beyond the suture.

The Texas shell, although less perfectly preserved, agrees in all essential respects with the holotype in size, form and sculpture. Both it and the holotype suffered severe injury shortly before reaching the adult stage, and each succeeded in healing the broken shell and in developing an expanded outer lip.

Dimensions of the Texas specimen shown in plate 56, figure 15: Height 47.5 mm., diameter, including outer lip, about 29 mm., exclusive of outer lip, 18.5 mm.

This species belongs to a closely related group of species and varieties, of which *Rostellaria rostrata* Gabb,<sup>350</sup> from Burlington County, New Jersey, was the first described. One other species and one varietal form from Texas are described on subsequent pages.

Close analogues of this species are Lispodesthes schlotheimi (Roemer) from the Cretaccous of the Aachen district (Germany), as figured by Holsapfel,<sup>331</sup> and Dicroloma (Perissoptera) bailyi (R. Etheridge, Jr.) from the Cretaceous of Pondoland, South Africa, as figured by Rennie.<sup>352</sup> Neither of these appears to

<sup>&</sup>lt;sup>350</sup>Gabb, Wm. M., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 390, pl. 63, fig. 7, 1860.

<sup>&</sup>lt;sup>351</sup>Holzapfel, Edward, Die Mollusken der Aacher Kreide: Palaeontagraphia, Band 34, p. 118, pl. 12, figs. 11-13, 1888. <sup>352</sup>Rennie, John V. L., New Lamellibranchia and Gastropoda from Upper Cretaceous of Pondoland, etc.:

belong to the genus or subgenus to which it is assigned.

Types.—Holotype, U.S.N.M. no. 32925, from the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tennessee. One plesiotype from Texas, U.S.N.M. no. 76908.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

*Outside distribution.*—Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Ripley formation.

Range.—In Texas known only from the Nacatoch sand of the Navarro group. In Mississippi and Tennessee ranges through the Ripley formation (lower and middle parts of *Exogyra costata* zone).

#### ANCHURA? LOBATA MEDIA Stephenson, n.var.

# Pl. 55, figs. 8-10

This varietal form is like A. lobata Wade in all essential respects, except that the axial ribs are somewhat more numerous and are sharply developed farther back toward the apex, the constriction below the suture is a little more pronounced, and the average size is somewhat smaller. These differences hold good among a suite of over 20 specimens. The variety is intermediate in size and in the coarseness of its ornamentation between the typical A.? lobata and A.? elegans.

Dimensions of the holotype, which is incomplete at the apex and has part of the outer lip broken away: Height 34+ mm., diameter exclusive of the outer lip about 12.5 mm. Dimensions of the small paratype shown in plate 55, figure 10, which is also incomplete at the apex: Height 24+ mm., diameter, including the expanded outer lip, 19 mm.

Types.—Holotype, U.S.N.M. no. 76909; 1 figured paratype, U.S.N.M. no. 76910; 1 unfigured paratype, U.S.N.M. no. 76911.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); vicinity of Corsicana (763); vicinity of Kaufman (761).

# ANCHURA? PLENOCOSTA Stephenson, n.sp.

#### Pl. 56, fig. 14

In size, form, and general appearance this species is much like Anchura? lobata Wade. The axial ribs are thicker and extend fully developed to the suture above on all the whorls except the ultimate. The body whorl is slightly constricted just below the suture. but a constriction is lacking on the other whorls. Approaching the expanded outer lip the axials become definitely shortened, the last 2 or 3 of them forming nearly round, rather prominent nodes. The surface of the body whorl is densely crowded with fine microscopic spiral lines of irregular trend; these are much too fine to be shown in the illustration. The outer lip is incomplete around the margins in the holotype, but, as more completely preserved in one of the paratypes, it appears to be essentially like that of A.? lobata.

Dimensions of the incomplete holotype: Height 38+ mm., diameter exclusive of the expanded outer lip 16 mm., diameter including this lip 28 + mm.

*Types.*—Holotype, U.S.N.M. no. 76912; 8 unfigured paratypes, U.S.N.M. no. 20988.

Distribution in Texas.—Navarro group, Nacatoch sand: Near Kaufman, Kaufman County (761).

## ANCHURA? ELEGANS Stephenson, n.sp.

## Pl. 56, figs. 11-13

Shell small for the genus, thin, turreted; apical angle about 35 degrees; body whorl about half the total height of the shell. Whorls 5, broadly rounded on the sides, only slightly constricted Suture closely apbelow the suture. pressed, moderately impressed. Protoconch smooth, trochoid, with 3 volutions, and with apical angle noticeably greater than that of the main spire. Axial ribs small, narrow, somewhat variable, numbering 24 to 28 on the penultimate whorl; they become smaller and less numerous toward the apex, near which they fade out; on the body whorl the ribs become coarser, wider apart, and tend to become short, strong, and nodose as they approach the aperture. Back of the outer lip the

Ann. South African Mus., vol. 28, pt. 2, p. 217, pl. 25, figs. 11-15, 1930.

body whorl descends anteriorly in a long gentle slope, becoming constricted near the terminus; passing around toward the aperture the body whorl becomes sharply constricted. The aperture is elongated with an angular anal notch behind, and a relatively short, straight, narrow, almost pointed canal in front. The outer lip is widely expanded very much as in A.? lobata with a sharp spur above and a dull one below; the outer margin shows a tendency to thicken though none of the specimens appears to be mature; the inner lip is broadly excavated, and forms a callus which spreads somewhat forward on the base and upward past the anal notch across the penultimate whorl to and beyond the suture; this callus becomes thickened on the larger specimens. The whole outer surface, including the broad outer lip, is densely crowded with fine microscopic threads, which are somewhat variable in strength on different individuals and on different parts of the same shell; this spiral sculpture is, however, more strongly developed than in Anchura? lobata media.

Dimensions of the holotype, the protoconch of which is partly broken away, and the anterior canal of which is incomplete: Height 21+ mm.; diameter, including expanded lip, 15 mm., excluding this lip 9 mm.

This species is closely related to A.? lobata Wade, but is much smaller and has much finer axial sculpture. A.? lobata media is intermediate in size and coarseness of axial sculpture between this species and A. lobata. The three forms mentioned and A. rostrata (Gabb) together form a compact subgroup.

Types.—Holotype, U.S.N.M. no. 76913; 1 figured paratype, U.S.N.M. no. 76914; 10 unfigured paratypes, U.S.N.M. no. 76915.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); 5 miles northeast of McClanahan (17371).

# ANCHURA? CIBOLOENSIS Stephenson, n.sp.

# Pl. 56, figs. 5, 6

Shell of moderate size, thin, turreted. Spire about half the total height of the shell; apical angle about 30 degrees. Whorls six, slightly convex to almost flat on the sides. Suture closely appressed, distinctly but narrowly impressed. Protoconch simple, smooth, coiled three times, with apical angle corresponding to that of the main shell. The surface is unevenly ornamented and varies markedly on different individuals; on the holotype the half of the body whorl nearest the aperture exhibits 3 to 6 widely spaced, low, dull axial ribs or folds which are strongest just below the suture and fade out downward, separated by broad shallow interspaces; this whorl is slightly constricted below the suture. The penultimate whorl and apparently the anterior half of the antepenultimate whorl are smooth, flattish to very slightly convex, and slightly constricted below the suture; the posterior half of the antepenultimate whorl, and two or three whorls back of that present numerous low rather sharp axial ribs; these have an extremely variable strength of development on different individuals and seem to be almost wanting in some. The aperture is elongated, with a distinct anal notch behind, and extends forward in a moderately long narrow, slightly sinuous canal. The inner lip is broadly excavated and forms a thick callus extending somewhat forward on the base; on some specimens this callus extends upward about halfway across the penultimate whorl; the outer lip is broken away on all the numerous specimens from the type locality and is evidently thin and frail; the holotype, however, and several other specimens show the beginning of an expanded lip, and a distinct reflection of the posterior margin of this lip onto the penultimate whorl.

Dimensions of the holotype: Height about 31 mm., thickness exclusive of outer lip about 10 mm.

This species is definitely distinct from previously described species.

*Types.*—Holotype, U.S.N.M. no. 76916; 1 figured paratype, U.S.N.M. no. 76917; 20 selected paratypes, U.S.N.M. no. 76918.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7720; 7721, type lot).

#### ANCHURA? LYNNENSIS Stephenson, n.sp.

# Pl. 56, figs. 16, 17

Shell of medium size, elongate-conical, apical angle not measurable, but the species appears to be more slender than any of the other Texas Navarro species. Whorls 5+, broadly convex to flattish on the sides. The suture appears to be closely appressed and not deeply im-pressed. The suture is bordered below by a flattish posterior fasciole, 1/2 to 1/1 the total width of the whorl, and the lower edge of this fasciole is marked by a slightly impressed revolving sulcus. Protoconch not preserved. The surface is ornamented with numerous, narrow, moderately prominent, nearly direct axial ribs which are much narrower than the interspaces and which in their trend exhibit a broad, very slight concavity toward the aperture: these ribs cross the posterior fasciole to the suture: the axials number about 19 on the penultimate whorl and 14 on the antepenultimate whorl. The periphery of the body whorl is broadly rounded and the anterior constriction is less abrupt than on most species of the genus: the axials on the body whorl pass down over the periphery but die out quickly on the upper slope of the base. The molds exhibit obscure traces of fine revolving ridges which have been largely destroyed in the process of fossilization. The body whorl is poorly preserved, but the aperture is elongated, and the siphonal canal though not complete appears to be rather long; the inner lip forms a rather thick callus: the outer lip is not preserved.

Dimensions of the incomplete holotype: Height 51+ mm., thickness approximately 15 mm.

The species is distinguished from other Atlantic and Gulf Coastal Plain species chiefly by its proportionately more slender spire.

Holotype.---U.S.N.M. no. 76919.

Distribution in Texas.--Navarro group, Corsicana marl: 3 7/10 miles southwest of Campbell (15547).

# ANCHURA? COOKI Stephenson, n.sp.

# Pl. 56, figs. 7-10

Shell of moderate size, turreted, apical angle about 28 degrees. Whorls 7 or 8. broadly convex on the sides. On the internal molds the suture is apparently not closely appressed, and on some of them the suture is bordered above by a rather thick, round-crested ridge representing a ridge of callus; this ridge marks the posterior margin of the inner lip, which left the ridge of callus behind it as it grew forward. This ridge was probably overlapped by the shell so that the suture was just back of the ridge instead of in front of it as it appears in the mold. Protoconch not preserved. With the exception of the forward part of the body whorl, and probably several small volutions near the apex, the shell is covered with subangular axial ribs which vary somewhat in form and spacing, but are in general narrower than the interspaces; these ribs number 10 to 14 on each of the larger whorls, and on any one individual tend to increase slightly in number from the body whorl backward toward the apex; the ribs trend downward and slightly forward, and are covered at their anterior ends by the ridge of callus, previously mentioned. On the half of the body whorl farthest back from the outer lip the axials pass down over the periphery and die out on the base; on the half nearest the outer lip they become more widely separated and progressively shorter at the expense of their forward ends. Faint traces of fine spiral threads may be seen on one or two of the specimens and their apparent absence on most specimens may be due to their poor state of preservation. The aperture is elongated and passes posteriorly into an anal notch; anteriorly it passes into a rather short, pointed canal. The outer lip of adults is broad at the beginning of its expansion, but narrows abruptly into a long (10+ mm.), slightly descending projection, or wing, having a minimum width of about 2.5 mm. at the narrowest part preserved: this wing is incomplete on all the available specimens, none of which

show the upward projection at the extremity, which presumably would be present on perfect shells; the wing is traversed longitudinally a little above the center by an obtusely subangular ridge which dies out posteriorly at the base of the wing; on the lower margin of the wing about 4 mm. in front of the columella is a broadly rounded projection associated with a broad, shallow, inward plication. The inner lip is broadly excavated, and forms a thick callus which spreads forward several millimeters on the base, and a little upward on the penultimate whorl, forming a ridge which, as previously stated, parallels the suture on all of the larger whorls.

Dimensions of the cotype shown in plate 56, figure 10: Height about 34 mm., diameter exclusive of the wing about 12 mm.

Individuals of the species are numerous at the type locality, the collection including 16 or more. The shell substance is not preserved, but the external and internal molds reveal the features of the shell with a fair degree of accuracy. The specimens are all more or less distorted by mechanical pressure.

The species appears to be distinct from anything heretofore described.

Types.—Four cotypes figured, U.S.N.M. no. 76920; 14 unfigured cotypes, U.S.N.M. no. 76921. Named in honor of Mr. Carroll E. Cook of Austin, Texas, who assisted in finding the locality and in making the collection.

Distribution in Texas.—Navarro group, Corsicana marl: 2 3/5 miles north by east of Malta (5310, 12934, 16159); ?<sup>1</sup>/<sub>2</sub> mile north of the town of Sulphur Bluff (5321); about 5 miles east by north of Greenville (12924, type loc.); ?3 7/10 miles southwest of Campbell (15547); ?1.<sup>4</sup>/<sub>5</sub> miles N. 20° W. of Tona siding (15545); ?west of Kaufman (7548).

# ANCHURA CADDOENSIS Stephenson, n.sp.

# Pl. 56, figs. 3, 4

Shell small for the genus. Spiral angle about 38 degrees. Whorls 6, evenly rounded, approaching plumpness. Axials numerous and prominent, but irregular in

strength and spacing, an occasional one forming a nonprominent varix; the axials number 15 to 18 on each of the larger whorls; they decrease in size, but apparently not in number, on the successively smaller whorls toward the apex; in trend each axial is broadly concave toward the front and is a little obligue toward the front in its trend from above downward across the whorl. On the body whorl the axials fade out as they pass downward over the broadly rounded periphery onto the moderately constricted base. The surface is covered with fine closely spaced spiral ridges which override the axials. The aperture is elongated, ending posteriorly in an acute angle, and anteriorly in a narrow straight channel which is incomplete on all the available specimens. The outer lip expands and is projected above into a narrow upbent process, the maximum incomplete observed length of which is about 5 mm.; running centrally along this process is a ridge which passes backward onto the body whorl where it fades out within a few millimeters; the upper margin of the process is thickened and this thickening continues along the upcurved margin of the outer lip to the point where it joins with the upper margin of the inner lip; the lower obliquely sloping margin of the outer lip presents two downfolds, separated by a broader upfold; the downfolds are coincident with two short pointed projections of the margin. The inner lip is broadly excavated and spreads forward as a thin callus covering a band about 2 millimeters wide on the parietal wall in advance of the aperture. The columella as revealed in broken shells is twisted.

Dimensions of the holotype: Height 18+ mm.; diameter including outer lip 11.6 mm., exclusive of outer lip about 7.8 mm.

Anchura? johnsoni Stephenson<sup>353</sup> is a closely related, somewhat larger species.

*Types.*—Holotype, U.S.N.M. no. 76923; 1 figured paratype, U.S.N.M. no. 76924; 12 unfigured paratypes, U.S.N.M. no. 76925.

<sup>&</sup>lt;sup>353</sup>Stephenson, L. W., North Carolina Geol, and Econ. Survey, vol. 5, p. 370, pl. 92, figs. 1-4, 1923.

Distribution in Texas.—Navarro group, Nacatoch sand: 14/5 miles northeast of Quinlan (16162, type lot; 16171); vicinity of Kaufman (761).

# ANCHURA? CAMPBELLI Stephenson, n.sp.

# Pl. 56, figs. 1, 2

Shell of medium size. Apical angle 50 degrees, decreasing to 30 degrees on the large part of the spire. Whorls 6, each broadly rounded on the side. Protoconch smooth, forming a low spire with about 21/2 volutions. Axials numerous, closely spaced, rounded on the crests, slightly curved in trend with the concavity toward the front; 24 axials on the penultimate whorl, decreasing to 15 or less on whorls near the apex; an occasional axial is slightly enlarged to form a nonprominent varix. On the body whorl the axials become broader, more prominent, more widely spaced, but weaken toward the aperture and practically fade out just back of the expanded outer lip; these axials also weaken and fade out downward on the base a little below the broadly rounded periphery. The whole surface is covered with fine, closely spaced, almost obscure threads. The aperture is clongated, ending posteriorly in an acute angle, and becoming narrow anteriorly; the siphonal channel is broken away in the available material. The outer lip expands into a spur-like process which bends slightly upward, but the anterior portion is broken away; this lip bears a narrow subangular rib which doubtless continues out toward the tip of the process; the lower part of the outer lip is broken away; the upper part of this lip is moderately thick, and curves up-ward, joining the side of the whorl about 2 mm. above the suture. The inner lip is broadly excavated below and forms a thin callus spreading forward 2 or 3 mm. on the parietal wall. The columella is not well exposed.

Dimensions of the incomplete holotype: Height 22+ mm.; greatest diameter, exclusive of the expanded lip, 10.5 mm.

Compared with Anchura? caddoensis this species has a wider apical angle, is plumper, has finer and more numerous axials, and a proportionately larger outer lip.

Types.—Holotype, U.S.N.M. no. 76926; 4 unfigured paratypes, U.S.N.M. no. 76927. Named for the Hon. Thomas M. Campbell, Governor of Texas, 1907-1911.

Distribution in Texas.--Navarro group, Neylandville marl: Corsicana road 2<sup>1</sup>/<sub>2</sub> miles north of Corbet (16170, 17365; Tex. Bu. 17300, type lot).

## ANCHURA? HOGGI Stephenson, n.sp.

# Pl. 57, figs. 18-20

This species is based on two specimens, one adult and the other about half grown, both of which are incomplete at each end. Shell thick and of medium size with spiral angle of about 35 degrees. Whorls closely appressed, suture sharply but slightly im-Sides of whorls pressed. broadly rounded; on the whorls of the spire the greatest convexity is a little below the midheight. The body whorl is moderately plump and very broadly rounded on the periphery; the base slopes gently to the anterior canal. Axials numerous and gracefully sinuous on the body whorl where they number 23; they are roundcrested, only moderately prominent, and die out well down toward the base. Spirals numerous, rather obscure, overriding the axials; they are more distinct en the base of the body whorl than elsewhere. Aperture lenticular with a narrow anal canal at the rear, and passing into a well defined siphonal canal in front, only the upper end of which is preserved in each specimen. Outer lip broken away. Inner lip broadly excavated, forming a thick callus above just below the anal canal, becoming only thinly covered with callus on the lower part of the parietal wall. Columella smooth, slightly twisted.

Dimensions of the holotype: Height 32 + mm., diameter 18 + mm.

*Types.*—Holotype, U.S.N.M. no. 76928; 1 paratype, U.S.N.M. no. 76929.

Named for the Hon. James S. Hogg, Governor of Texas, 1891–1895.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7721).

# Unidentified specimens of the ANCHURA group

Among the collections from the Navarro group are numerous poorly preserved specimens which are referred to *Anchura*, some of them questionably.

Two immature specimens from the Neylandville marl on the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170), have the axial sculpture dominant, as in most species of *Anchura*, but the whorls are rather strongly constricted below the suture and they may belong to another genus. U.S.N.M. no. 76930.

Fragments of specifically indeterminate internal molds of large individuals of *Anchura* were found in the Nacatoch sand at two localities as follows: In the Dallas road, 3/5 mile west of Kaufman, Kaufman County (7545, U.S.N.M. no. 76931); public road <sup>3</sup>/<sub>4</sub> mile northeast of Chatfield, Navarro County (7572, U.S.N.M. no. 76932).

Poorly preserved specimens of Anchura from the Corsicana marl at one locality in Guadalupe County, and three localities in Bexar County, are similar to each other in form and sculpture, but their state of preservation is such that they cannot be satisfactorily compared and none of them is well enough preserved to serve as a type. They all appear to be different from any described species of Anchura, and some of them may not belong to this genus. The apical angle of these specimens ranges from 35 to 40 degrees. The body whorl is elongated, and the periphery broadly rounded. Axials are numerous but are not well preserved on some specimens; on the body whorl the axials sweep well down over the base in broadly sinuous curves; the revolving sculpture is not well preserved on most specimens but on some appears as relatively fine, numerous, closely spaced, flattish ridges, broader than the interspaces, and overriding the axials. Dimensions of an incomplete but only slightly deformed specimen (15520, pl. 57, fig. 16): Height 35 + mm., diameter 17 mm. One other specimen (15524) is shown in plate 57, figure 21. The localities are as follows: Cut in San Antonio road, 6 miles east of Castroville in Bexar County (15502, U.S.N.M. no. 76933); pit of Standard Fuller's Earth Company,  $\frac{4}{5}$  mile north of the Castroville road, 14 miles west of San Antonio, Bexar County (15520, U.S.N.M. no. 76934); abandoned earth tank north of the Castroville road, 11/5 miles west of the crossing of Leon Creek, Bexar County (15522, U.S.N.M. no. 76935); westward-facing bluff of Guada-lupe River valley 1 3/10 miles north of McQueeney, Guadalupe County (7637, U.S.N.M. no. 76936; 15524, U.S.N.M. no. 76937).

A specimen (pl. 57, fig. 17) found in the Corsicana marl, in a cut of the San Antonio road, 6 miles east of Castroville (15502), in Bexar County, is a moderately large internal mold, including 3 rapidly enlarging whorls on which the external sculpture has been rather weakly impressed. The apical angle is 35 or 36 degrees: the whorls are broadly convex, becoming flattish to slightly excavated above, and the suture is moderately impressed: the sculpture consists of rather evenly spaced subangular axials numbering 23 to 25 on each of the three largest whorls; the revolving ridges are rather weakly developed but on the penultimate whorl consist of 7 or 8 primaries with very dimly preserved fine intermediate threads; the periphery is rounded, and the base rounds down rather abruptly to the columella. Dimensions of the incomplete specimen are: Height 41+ mm., diameter about 23 mm.; the maximum diameter has been increased somewhat by lateral pressure. U.S.N.M. no. 76938. Another adult specimen from the same locality (16156) has 3 of the larger whorls rather poorly preserved. U.S.N.M. no. 76940.

A similar incomplete specimen from the Corsicana marl was found in a pit of the Standard Fuller's Earth Company,  $\frac{4}{5}$ mile north of the Castroville road, 14 miles west of San Antonio (15520). This specimen includes nearly 5 whorls, and its dimensions are: Height 39+ mm., diameter 21 mm. It may belong to the same species as the preceding specimen. U.S.N.M. no. 76939.

In the Corsicana marl are specifically indeterminate molds and prints of specimens referred, in part questionably, to

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Anchura as follows: Branch east of road  $2\frac{1}{2}$  miles north of Tona siding, 5 miles southwest of Quinlan, Hunt County (15546, U.S.N.M. no. 76911); road ditch, 14% miles N. 20° W. of Tona siding, in Hunt County (15545, U.S.N.M. no. 76942): road ditch in westward-facing slope of Lynne Creek valley, 3 7/10 miles southwest of Campbell, Hunt County (15547, U.S.N.M. no. 76943); Dallas road west edge of Kaufman, Kaufman at County (7548, U.S.N.M. no. 76944); ditch in Cameron-Buckholtz road, 3/4 mile west of Pettibone station, Milam County (14131, U.S.N.M. no. 76945); 2 miles south-southeast of Marion, Guadalupe County (13389, U.S.N.M. no. 76946).

The pathologic specimen shown in plate 57, figure 22, from the Corsicana marl in a westward-facing bluff on Guadalupe River, 1 3/10 miles north of McQueeney, Guadalupe County (15524), probably belongs to *Anchura*, and is an undescribed species, but it is not satisfactory as a type specimen. U.S.N.M. no. 76947.

The Kemp clay has yielded numerous internal and external molds of an undescribed species of Anchura? from a wash in a field 3 miles southeast of Manor, Travis County (16141). The form, as shown by the internal molds, is much like that of A. ciboloensis, but is less slender, the spiral angle being about 40 degrees. The external molds are imperfect, but many of them show fine axial ribbing on the smaller whorls toward the apex; anteriorly these axials fade out and are practically wanting on the body whorl, which is nearly smooth; the axials extend from the suture down and a little forward and in trend are broadly concave toward the front; the species differs from ciboloensis in the absence of axial folds on the body whorl. The outer lip is not preserved in any of the material, though the initial expansion of the lip appears on the adult internal mold of one specimen. Dimensions of this incomplete mold: Height 22- mm., diameter, exclusive of the outer lip, 11 mm. U.S.N.M. no. 76948.

One internal mold with the axial ribs imperfectly impressed upon it, from the Kemp clay near Deatsville, 2 miles northwest of Webberville, Travis County (764), resembles A.? cooki in the character of the axial ribs, but the spire is not so slender and the lip is wanting. U.S.N.M. no. 76949.

An incomplete shell in another collection from the same locality (14125), questionably referred to *Anchura*, exhibits numerous, rather long axial ribs on a plumply rounded body whorl; on the base below the ends of the axials are 7 or 8 spiral ribs of medium fineness. The diameter is about 9 mm. U.S.N.M. no. 76950.

Another shell from the preceding collection (14125), probably an Anchura, includes part of the body whorl and the penultimate whorl; it is not so plump as the preceding shell, and is distinctly flattened on the upper part of the body whorl; the axial ribs are numerous and die out high on the basal slope; the shell is covered with very fine spiral ribs which are distinct on the basal slope and very obscure over the rest of the shell. U.S.N.M. no. 76951.

A small tip of an *Anchura?* spire was found in the Kemp clay at a depth of 730 feet in a well of the Robinson Oil & Gas Company, Cargile No. 1, 2 miles west of Groesbeck, Limestone County (13132). The fragment shows a smooth protoconch and fine axial ribbing on the two earliest whorls of the spire. U.S.N.M. no. 76952.

# Genus DREPANOCHILUS Meek

Type species.—Rostellaria americana Evans and Shumard,<sup>354</sup> preoccupied; renamed Arroges (Drepanochilus) evansi Cossmann.<sup>355</sup>

According to Meek<sup>356</sup> this group is characterized as follows: "Shell with outer lip terminating in a single backwardly curved, scythe-shaped, pointed process; beak short." To this should be added: A spirally striated, flattish to gently convex, strongly constricted base with a

<sup>&</sup>lt;sup>2:4</sup>Evans, John, and Shumard, B. F., Acad. Sci. St. Louis Trans., vol. 1, p. 42. 1857.

<sup>355</sup>Cossinann, M., Essais Paléoc. Comp. 6th Liv., p. 75, 1904.

<sup>&</sup>lt;sup>256</sup>Meek, F. B., Rept. U.S. Geol. Survey Terr., vol. 9, p. 324, 1876.

strong peripheral lira on the body whorl; anteriorly this lira continues out onto the spur-shaped prolongation of the lip as a pronounced, narrow ridge, and apically it dies out on or before reaching the penultimate whorl; below the periphery on the base may be 1, 2, or 3 primary lirae and numerous small secondary lirae.

# DREPANOCHILUS TEXANUS Stephenson, n.sp.

# Pl. 57, figs. 1-4

Shell small for the group. Spire conical with apical angle of about 45 degrees. Whorls 5, moderately convex on the sides, with no constriction below the suture. Suture closely appressed, deeply impressed. Protoconch not preserved on the available material. The surface is ornamented with numerous rather closely spaced, axial ribs which vary somewhat in prominence and in the sharpness of their crests; in general these ribs are about equal in width to the interspaces; they trend downward and slightly forward, and the trend is broadly concave toward the aperture. The ribs number 33 on the body whorl, 28 on the penultimate, and 24 on the antepenultimate whorl of the holotype. The axials on the body whorl terminate below against a moderately strong, obscurely noded spiral rib which occupies the periphery of this volution; and dies out apically before reaching the penultimate whorl; a second similar but less prominent spiral parallels the first one about 1.5 mm. farther forward on the base. The periphery of the body whorl is obtusely subangular, and the base rounds down abruptly to the columella. The whole surface is covered with fine spiral threads which override the axials: on the base these threads are stronger than elsewhere and tend to alternate in size. The aperture is imperfect in the available material, but is elongated, passes backward into an angular anal canal, and forward into an anterior narrow canal, which is broken away in all the specimens. The outer lip is mostly broken away on all the shells, but at the posterior margin in adults it is reflected outward and also upward about one-third of the way across the penultimate whorl. The inner lip forms a rather thick callus which is broadly excavated, spreads noticeably

forward over the base, and folds neatly forward over the columella in front.

Dimensions of the incomplete holotype: Height 17.5+ mm., diameter 9.3 mm. (exclusive of the expanded outer lip).

The material includes eight incompletely preserved shells from the type locality, on all of which the outer lip is largely or completely broken away. The species is closely allied to *Drepanochilus evansi* Cossmann from the Fox Hills sandstone and the upper part of the Pierre shale of the Upper Cretaceous of the Western Interior, but it is not so slender and the axial ornamentation is somewhat coarser and is more strongly developed on the posterior part of the body whorl.

Types.—Holotype, U.S.N.M. no. 76953; 1 figured paratype, U.S.N.M. no. 76954; 6 unfigured paratypes, U.S.N.M. no. 76955.

Distribution in Texas.—Navarro group, Kemp clay: 3 miles S. 30° W. of Thrall (15537, type lot; 17370).

# DREPANOCHILUS? MARTINI Stephenson, n.sp.

# Pl. 57, fig. 5

Shell of medium size, turreted, apical angle 28 degrees. Five whorls can be counted on the incomplete holotype; they are broadly and regularly rounded on the side. Suture closely appressed, moderately impressed. Protoconch and an undetermined anterior part of the holotype broken The surface is characterized by away. numerous narrow, moderately prominent, somewhat irregularly spaced axials, narrower than the interspaces, which sweep downward and a little forward across the whorl in a broad curve concave toward the aperture; on the largest whorl preserved on the holotype these axials number 23; on three successively smaller whorls back toward the apex the axials number respectively 26, 30, and 32, thus showing an increase in number in that direction. The axials are crossed by 8 primary, narrow, revolving ridges which are a little more widely spaced on the posterior than on the anterior half of the whorl; three secondaries occupy each of the interspaces, and on the larger whorls tertiaries appear between the other ridges where the spacing between the primaries is widest: all of the revolving ridges override the axials; under the microscope the numerous axials and

the densely crowded spirals produce an elegant sculptural pattern. The periphery as shown by the paratype is obtusely subangular and weakly carinated, and the base descends abruptly to the columella; the axials on the body whorl end abruptly at the periphery; the base is at least partly if not wholly covered with narrow, closely spaced revolving ridges; there is a narrow spiral furrow just in front of the periphcral carina. These features suggest generic relationship with *Drepanochilus*.

Dimensions of the incomplete holotype: Height 26+ mm., diameter 13+ mm. The dimensions of the one incomplete paratype, which may not be an adult, are: Height 23+ mm., diameter 13 mm.

The axial ribs on this species are more numerous than on any Coastal Plain species heretofore described; the ornamentation is in this respect comparable to that of the type species, *Drepanochilus evansi* Cossmann, from the Fox Hills sandstone (Upper Cretaceous) of the Western Interior.

Compared with *Drepanochilus? davisi*, this species is less slender, has more numerous axials and spirals, and a less deeply impressed suture.

*Types.*—Holotype, U.S.N.M. no. 76956; 1 unfigured paratype, U.S.N.M. no. 76957. Named for Capt. Hermán Martín, who led an expedition (entrada) to the Tejas tribe of Indians in 1650.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.);  $2\frac{1}{2}$  miles north of Corsicana (14114),  $2\frac{1}{2}$  miles west by south of Corsicana (17368).

# DREPANOCHILUS? DAVISI Stephenson, n.sp.

## Pl. 57, figs. 13, 14

Shell of moderate size, turreted, apical angle about 25 degrees. Whorls 8 in the incomplete holotype, broadly convex on the sides. Suture closely appressed, moderately impressed. Protoconch not preserved. The 4 larger whorls of the holotype are ornamented with moderately prominent axial ribs whose trend describes a curve broadly concave toward the aperture; the ribs number about 20 on the largest whorl, are round-crested and are much narrower than the interspaces. The shell is further ornamented with numerous spiral ridges which override the axials and

which consist of 8 relatively strong primaries, and 2 or 3 much smaller, somewhat uneven secondaries between each of the primaries. The sculpture is not well preserved on several of the smaller whorls at and near the apex. One incomplete fragment of a body whorl shows the axial ribs ending at the periphery which is sharply rounded; on the abruptly constricted base are 4 or 5 major, broadly rounded spiral ridges, the two outer ones of which are the largest and the three inner ones of which become progressively smaller toward the columella; both the ribs and interspaces are covered with numerous, somewhat uneven spiral threads. The outer lip and anterior canal are broken away; the inner lip is broadly excavated and forms a thin callus on the base.

Dimensions of the incomplete holotype: Height 24+ mm., diameter 9 mm. The paratype, an incomplete body whorl, has a diameter of 14.5 mm.

The species is placed questionably in the genus *Drepanochilus* because of the two largest major ribs on the base. The shell is more slender and the sculpture is coarser than are the corresponding features of *D. evansi* Cossmann, the type species of the subgenus. Compared with *D.? martini*, the shell is more slender, the suture more deeply impressed, and the sculpture coarser.

Types.—Holotype, U.S.N.M. no. 76958; 1 unfigured paratype, U.S.N.M. no. 76959. Named for the Hon. Edmund J. Davis, Governor of Texas, 1870-1874.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); 3/5 to 4/5 mile northeast of Chatfield (7572).

#### DREPANOCHILUS? CORBETENSIS Stephenson, n.sp.

#### Pl. 57, figs. 6-8

Shell small. Spiral angle about 32 degrees. Whorls 6 or 7, sides evenly rounded and of only moderate plumpness. Protoconch small, trochoid. Axials numerous, prominent, irregular in strength and spacing, but in general narrower than the interspaces; varices widely and irregularly spaced, averaging about two to the whorl; on some specimens there is a tendency for the varices to occur, one below, or nearly below the other, or they may drop back a little from whorl to whorl. The axials number 20 or 21 on the body whorl and decrease gradually to 15 or 16 on the smaller whorls near the apex; they are somewhat irregular in their trend, but in general are nearly direct, with a very broad curve concave toward the aperture; on the body whorl the axials end against a moderately prominent, round-topped carina which marks the obtusely angular peripherv. The spiral ornamentation consists of very fine ridges much narrower than the interspaces, and numbering 15 or more on the larger whorls: these override the axials and produce tiny tubercles on their crests: still finer secondaries begin to appear between the primaries on the larger whorls. The base is flattened and strongly constricted, curving rather sharply below into the columella; the base is ornamented with 10 or 12 narrow, low, smooth, relatively widely spaced spirals, between some of which are still smaller secondaries.

Aperture subovate, angular posteriorly, and passing anteriorly into a narrow straight, beak-like canal of moderate length. The three available specimens are apparently immature and give no clue as to the character of the outer lip.

Dimensions of the holotype: Height 11.5+ mm., diameter 5 mm.

Although the character of the outer lip is not known, the carinated periphery and flattened base seem to ally these species with *Drepanochilus* Meek.

Types.—Holotype, U.S.N.M. no. 76960; 1 figured paratype, U.S.N.M. no. 76961; 1 unfigured paratype, U.S.N.M. no. 76962.

Distribution in Texas.—Navarro group, Neylandville marl: 21/2 miles north of Corbet (16170, type lot; 17365).

## DREPANOCHILUS TRILIRATUS Stephenson, n.sp.

#### Pl. 57, figs. 9, 10

Shell small, turreted, with spiral angle of 32°. Whorls about 6, regularly convex on the sides. Suture compressed, deeply impressed. Protoconch broken away. Body whorl inflated above, sharply constricted on the base; periphery marked with a prominent, narrow primary spiral which rises a little as it approaches the broken outer lip; below on the base are 2 successively weaker, widely spaced spirals; the lower of the two interspaces bears 2 weak secondaries, the upper one the weaker; the rest of the base below and the anterior extension are covered with about a dozen closely spaced fairly regular, small ribs which become successively somewhat weaker from above downward. Above the peripheral ridge the body whorl is ornamented with 19 narrow axials which are broadly concave in trend toward the aperture, and are much narrower than the interspaces. About a dozen fine, fairly regular, spiral threads override the axials; the axials override the peripheral ridge, producing nodes thereon, but die out in the first interspace below, some of them reaching the next spiral below. The peripheral ridge becomes weaker posteriorly and fades out on the penultimate whorl, and on the whorls of the spire the axials extend to the second basal spiral which forms the bottom of the sutural depression. The axials number 16 on the penultimate whorl and about the same number on the antepenulwhorl: occasional. timate irregularly spaced axials are enlarged to form varices. The expanded outer lip is badly broken away, but the aperture is lanceolate, with an acute posterior angle, and converges to a short narrow canal in front. The columella is slender, smooth and straight.

Dimensions of the incomplete holotype: Height 17+ mm., diameter 7.5+ mm.

The species is closely allied to *Drepanochilus quadriliratus* (Wade),<sup>357</sup> but has 3 instead of 4 primary spirals on the base and has fewer axials on the whorls.

Holotype.- U.S.N.M. no. 76963.

Distribution in Texas.—Navarro group, Neylandville marl: Corsicana road 21/2 miles north of Corbet (17365).

Navarro group, Nacatoch sand: State Highway 22,  $2\frac{1}{2}$  miles west of the courthouse at Corsicana (17368, type loc.).

# Unidentified specimens of DREPANOCHILUS

Two specimens of *Drepanochilus* from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet (16170, U.S.N.M. no. 76964, pl. 57, figs. 11, 12; 17365, U.S.N.M. no. 76965) are closely analogous to *Drepanochilus triliratus*. The figured specimen includes parts of the body whorl and of the penultimate whorl and

<sup>&</sup>lt;sup>357</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 151, pl. 53, figs. 3, 4, 1926.

appears to be an adult with the outer lip broken away. The axials are numerous and strong and are overriden by fine spirals; an occasional axial is swollen to the form of a varix. On the penultimate whorl, approaching the body whorl, obscure nodes begin to appear on successive axials a little above the suture; passing forward these nodes grow in strength and gradually become connected with each other by an intercostal spiral ridge which in turn increases in strength and on the body whorl becomes a prominent noded peripheral carina; on a complete shell this carina would be seen to pass forward onto an expanded spur-like labrum like that possessed by Drepanochilus quadriliratus (Wade).358 On the base below the peripheral carina are two spiral lirae and in addition the base is covered with numerous fine, spiral ridges. The anterior canal is broken away, but appears to be of the short, narrow beak-like type. This form has a shorter spire and more numerous axials than has D. triliratus.

Three immature specimens of Drepanochilus, from the Neylandville marl, on the Corsicana road,  $2\frac{1}{2}$  miles due north of Corbet, Navarro County (16170), resemble D. ?corbetensis from the same locality, but they are less slender and the protoconch is larger and has a wider apical angle. They seem to represent a different species, but this can not be certainly ascertained without a larger suite of specimens for comparison, U.S.N.M. no. 76966.

A nearly complete whorl (pl. 57, fig. 15) from the same locality (16170), having a diameter of 8 mm., is similar in sculpture and in the character of its periphery and base, to *D.? martini*, but the sculpture is a little coarser. The specimen is inadequate for determination. U.S.N.M. no. 76967.

Another specimen from the same locality (16170) has a maximum diameter of 5.5 mm., and includes about two and a half whorls. Its sculpture is similar to that of D.? martini, but is finer, and it appears to be more slender in form; it is probably a distinct species. U.S.N.M. no. 76968.

#### Genus PTEROCERELLA Meek

Type species .--- Harpago tippana Conrad.

Pterocerella Meek<sup>359</sup> is a good genus in its own right, and need not be linked with the living *Chenopus* Philippi as a subgenus, as was done by Cossmann.<sup>360</sup> It is certainly generically distinct from the Jurassic *Phyllochilus* Gabb (1868).

## PTEROCERELLA POINSETTIFORMIS Stephenson, n.sp.

Pl. 58, figs. 9-12

1907. Pterocerella tippana (Conrad). Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 718 (in part), pl. 83, fig. 1 (not fig. 2).

Shell of moderate size, thin, conical, apical angle 54 degrees. Protoconch small, trochoid, smooth, dextral, coiled about 3 times, and rather sharply distinguishable from the first whorl of the conch. The whorls are 6 in number on adults, are moderately convex on the sides, and have no axial ornamentation. Suture closely appressed, moderately impressed. A narrow, prominent sharply roundcrested revolving carina traverses each whorl a little below the middle, and extends back to the junction of the conch with the protoconch. A similar narrow carina, a little less prominent, marks the periphery of the body whorl; this carina is not quite overridden by the posterior margin of the growing conch, so that its crest appears as a narrow, sharply defined band just above the suture. The base is abruptly constricted, and is smooth with the exception of 2 gentle revolving swells which divide the base into 3 bands of nearly equal width. The outer lip is fantastically expanded and subdivided into a series of 6 long, widely flaring, paddlelike wings of more or less irregular outline, separated by deep, wide indentations. The two carinae on the body whorl and the two revolving swells on the base pass forward onto the outer lip, following respectively the centers of the 4 inner wings, on which they all appear as sharp, narrow, prominent carinae; the two outer

<sup>&</sup>lt;sup>355</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 151, pl. 53, figs. 3, 4, 1926.

<sup>&</sup>lt;sup>350</sup>Meck, F. B., Check list of the invertebrate fossils of North America, Cretaceeus and Jurassic: Smithsonian Misc, Coll., vol. 7, no. 177, p. 36, 1864.

<sup>360</sup> Cossmann, M., Essais Paléo. Comp., 6th Liv., p. 70, 1904.

wings, that is the posterior and anterior of the 6 wings, are also marked centrally by similar carinae; these 2 outer wings appear as having forked off from the nearest adjacent wings. The under side of each wing is cut longitudinally by a channel which opposes the carina on the outside of the wing, and this channel is closely bordered on each side by a narrow prominent carina; these channels connect with the aperture, which is somewhat elongated though fairly wide open. The inner lip of adults is thick and stands out prominently away from the base of the shell.

Dimensions of the holotype: Height, disregarding the downward expansion of the wings, 34 mm.; diameter measured to the base of the wings, about 22 mm. The maximum wing spread is 70 mm. or more.

This species exhibits the most fantas:ic wing expansion of any known gastropod species in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain.

Weller figured the holotype of this species as an example of *P. tippana* (Conrad). The type of the latter is lost, but on typical specimens from the Owl Creek formation, on Owl Creek,  $2\frac{1}{2}$  miles northcast of Ripley, Mississippi, in the National Museum collection, the whorls of the spire are smooth, or have only a weakly developed revolving carina, the spire is more slender and the wings are less widely separated; these differences are sufficiently marked to justify specific separation.

The specimens from the Coon Creek tongue of the Ripley formation, at Coon Creek, Tenneseee, which Wade<sup>361</sup> referred to *P. tippana* (Conrad), resemble the Texas species, in that the whorls of the spire bear a prominent, narrow carina, but the spire is markedly more slender and the wings are less widely separated; the presence of the carina and other differences warrant the recognition of the Coon Creek shells as belonging to a species distinct from *P. tippana*.

The internal mold from the Wenonah sand, New Jersey, which Weller referred to *P. tippana* (Conrad), is too incompletely preserved to warrant its reference to any species. One specimen in the National Museum (no. 20530), from a locality  $2\frac{1}{2}$  miles south of Dumas, Tippah County, Mississippi, though not completely preserved, is essentially like *P. poinsettiformis*, and the stratigraphic position of this locality, as interpreted, is approximately the same as that of the Nacatoch sand of Texas.

*Types.*—Holotype, U.S.N.M. no. 76969; 1 paratype, U.S.N.M. no. 20994; 1 paratype. U.S.N.M. no. 21061; 1 paratype, U. S.N.M. no. 76970.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); field 3/5 mile west of Kaufman (14103); vicinity of Chatfield (762, 1 figured paratype); Hervey Lake road, 2 1/10 miles northeast of Chatfield (Tex. Bur. 17302, 1 figured paratype).

Outside distribution.—Mississippi at one locality in the Ripley formation, near Dumas, Tippah County (709).

# Family STROMBIDAE

#### Genus PUGNELLUS Conrad

# PUGNELLUS DENSATUS NACATOCHANUS Stephenson, n.var.

## Pl. 58, figs. 5-8

- 1901. Pregnellus [sic] densatus Conrad. Hill, U. S. Geol. Survey 21st Ann Rept., pt. 7, pl. 48 (p. 342), fig. 2. (Figure only.)
- 1906. Pugnellus densatus Conrad. Veatch, U.S. Geol. Survey Prof. Paper 46, pl. 10, fig. 3. (Figure only.)
- 1924. Pugnellus densatus Conrad. Deussen, U.S. Geol. Survey Prof. Paper 126, pl. 11, fig. 1. (Figure only.)

Shell of adult large, thick, and completely covered with callus; outline and form very irregular due to the uneven distribution of heavy deposits of callus, and to the thick expanded outer lip; on the prominently ribbed portion of the body whorl the covering of callus is thin. The stage of growth just preceding that in which the shell begins to take on its old age characters is without a covering of callus and presents a plump, smooth conch of about 5 whorls, the spire of which is shorter than the body whorl; the apical angle is about 67 degrees. The protoconch is a small, simple, dextral, slightly tilted shell having about two volutions. Suture closely appressed, not deeply impressed, bordered by a very narrow, flat, regular

<sup>&</sup>lt;sup>361</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 152, pl. 53, figs. 6, 7, 1926.

shoulder. The whorls are very broadly and evenly convex, and the growth lines extend from the shoulder obliquely downward and forward in a broad curve concave toward the aperture. At this stage the periphery of the body whorl is broadly and evenly rounded; at an earlier stage it presents a broad, subobtuse angle; the base slopes off rather gently, becoming more sharply constricted toward the columella, and the growth lines become markedly sinuous as they cross from the periphery down over the base. The surface is apparently smooth but under a lens exhibits fine, more or less obscure revolving lines or ridges which number 14 or 15 from suture to suture; lines of this kind can barely be detected on the base of some specimens. The aperture is elongated, acutely angular posteriorly and channelled anteriorly; the outer lip is thin and simple. The shell at this stage is about 40 mm. high (estimated) and 20 mm. in diameter.

As the shell advances to maturity coarse axial folds or ribs begin to form on the upper half of the body whorl and at the stage where the outer lip begins to thicken these ribs number 8 or 9 and are present on the most mature half of the body whorl; they reflect the sinuosity of the growth lines and at the periphery are noticeably swollen into elongated nodes; they die out on the slope below. The last stage in the growth of the animal is marked by a backward reflection of the mantle from the aperture over the outer surface of the shell, and an excessive secretion of callus which enormously thickens the expanded outer lip, and also the inner lip which forms a broad, heavy, elongated mass extending from well down on the base, upward to and more or less completely enveloping the tip of the spire; eventually callus is deposited over the entire shell, even covering though not obscuring the axial ribs. The outer lip is expanded both downward and upward into dull, heavy projections, the latter the more prominent; these projections are set off from the main lip margin by distinct notches; on the inner surface of the outer lip a thick, moderately prominent ridge of callus parallels the outer margin, from which it is separated by a space of 7 or 8 mm. At this adult stage the anal canal occupies a posterior, broad round-bottomed channel, and anteriorly there is a well developed, slightly sinuous siphonal canal of only moderate length. At the final stage of growth the aperture is greatly elongated, with the sides nearly parallel and only 5 to 7 mm. apart.

Dimensions of the holotype: Height 44.5 mm.; greatest diameter, including the expanded lip, 44 mm.; diameter, not including the expanded lip, 27 mm.

Compared with *Pugnellus densatus* Conrad, from the upper part of the Ripley formation at Owl Creek, Tippah County, Mississippi,<sup>362</sup> this variety averages larger and is more massive, has coarser and a little more widely separated ribs, and the ribs are less sharply noded on the peripheral angle.

The example of *Pugnellus densatus* Conrad, figured by Hill (see synonymy) was obviously this variety and probably came from either Navarro County or Kaufman County, but its exact locality is not recorded, and the specimen is apparently lost. Hill's figure was repeated by Veatch and Deussen (see synoynmy).

*Pugnellus pauciplicatus* Stephenson from the Snow Hill member of the Black Creek formation, North Carolina,<sup>363</sup> is a nearly related species with, however, fewer plications on the body whorl.

The specimen from Coon Creek, Tennessee referred by Wade<sup>364</sup> to *Pugnellus densatus* Conrad, has ribs similar to Conrad's species except that they lack the peripheral nodes. It begins to assume old age characters at a much younger stage than either the Owl Creek species or the Texas variety, and should probably be treated as a separate variety.

Types.—Holotype, U.S.N.M. no. 76971; 1 figured paratype, U.S.N.M. no. 76973; 1 figured paratype, U.S.N.M. no. 76974; 7 unfigured paratypes, U.S.N.M. no. 76972.

<sup>303</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 330, pl. 35, fig. 14, 1858.

3031Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, p. 373, pl. 92, figs. 10-12, 1923.

<sup>304</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 148, pl. 52, figs. 4, 5, 1926. Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, loc. of holotype and 7 unfigured paratypes); north edge of Corsicana (518, loc. of 2 unfigured paratypes); vicinity of Corsicana (763); 2½ miles north of Corsicana (14114); vicinity of Kaufman (761); vicinity of Terrell (12246).

## PUGNELLUS ROBUSTUS Stephenson, n.sp.

# Pl. 58, figs. 1-4

Shell of adult large, thick, robust, irregular. largely covered with callus of uneven thickness; on the outer surface of the body whorl back of the thickened outer lip the covering of callus is thin, and on different individuals is more or less completely scaled off. The stage of growth just preceding that in which old age characters begin to form is a smooth, plump shell similar to, though considerably larger than, that of Pugnellus densatus nacatochana. The apical angle is about 65 degrees. There is a flat narrow shoulder just below the suture; the side of the whorl is very broadly rounded, but is modified above just below the shoulder by a shallow excavated band about one-fourth the width of the whorl. The growth lines extend first nearly vertically downward from the suture and then curve strongly forward becoming slightly sinuous as they approach the suture below; on the body whorl the growth lines are markedly sinuous as they pass downward over the broadly rounded periphery and the base below. The surface is nearly smooth except that on some specimens 4 or 5 faint revolving lines appear on the penultimate whorl between the excavated band and the suture below. On mature shells 4 or 5 obscure, but coarse, rather widely spaced longitudinal ribs are present on the upper part of the body whorl back of the aperture; these ribs are sinuous, following the trend of the growth lines. The uncallused surface of this part of the body whorl also shows a dozen or more very faint, fine spiral lines diverging from the convex part of the whorl toward the margins of the lip; apparently new lines are intercalated as the interspaces widen.

The aperture of the adult is elongated, with almost parallel sides about 10 mm. apart in the upper three-fourths of its length; the anal channel is broad and wide open with a broadly rounded bottom; the siphonal channel is of moderate length and nearly straight. The outer lip is very thick and widely expanded; its upper, outer extremity is formed by a heavy, blunt node which projects upward 10 mm. or more, but which is incompletely preserved in the available material; on the margin a little more than halfway between this large node and the anterior extremity of the shell is another curious, smaller, but prominent, blunt node which projects 6 or 7 mm. forward, a little downward and a little inward; this node is clongated in the direction of the margin, has a length of about 8 mm., and a thickness of 4 or 5 mm. The base just in front of the aperture is made plump by a deposit of callus which spreads away from the aperture in a progressively thinning sheet, and the spire is completely callused over in such a manner as to present a twisted appearance.

Dimensions of the holotype: Height 68 mm.: diameter, not including the expanded lip 32 mm.; diameter, including the expanded lip, 55 mm.

This species is not apt to be confused with any other North American species of *Pugnellus*.

*Types.*—Holotype, U.S.N.M. no. 76975; 1 figured paratype, U.S.N.M. no. 76976; 1 figured paratype, U.S.N.M. no. 76977; 9 unfigured paratypes, U.S.N.M. no. 20995.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, holotype and 9 unfigured paratypes); field 2 miles southwest of Kaufman (7547, 1 figured paratype); road 2 miles southwest of Kaufman (7546, 1 figured paratype).

# Unidentified specimens of PUGNELLUS

Internal molds of *Pugnellus* having the general form of the younger stages of *P. densatus* Conrad, though a little more slender, have been collected from the Corsicana marl of the Navarro group at the following localities: Public road, 11/4

miles south by east of Oak Grove, Bowie County (16160, U.S.N.M. no. 76978); road ditch westward-facing slope of Lynne Creek valley, 3 7/10 miles southwest of Campbell, Hunt County (15547, U.S.N.M. no. 76979); the E. R. Ridley 30-acre tract, northwest corner of W. G. Lee Survey, about 3 miles southwest of Campbell (12927, U.S.N.M. no. 76980); Dallas road at west edge of Kaufman, Kaufman County (7548, U.S.N.M. no. 76981); pit of Standard Fuller's Earth Company, 4/5 mile north of Castroville road, 14 miles west of San Antonio, Bexar County (15520, U.S.N.M. no. 76982).

The Kemp clay has yielded one imperfect mold of the body whorl of an indeterminate *Pugnellus*, from a public road, 3/5 mile west of Elm Creek School, 4½ miles northwest of Lockhart, Caldwell County (16151). U.S.N.M. no. 76983.

# Genus TUNDORA Stephenson, n.gen.

## Type species.—*Tundora tuberculata* Stephenson. Etymology.- By anagram from *rotunda*. Gender, feminine.

This new genus is a small, rotund shell with a low spire, a small, low protoconch, and a rapidly expanding conch. The ornamentation on the uncallused shell consists of narrow to sharp spirals separated by proportionately wide flat-bottomed interspaces in which the incrementals appear as sharp, closely spaced lines. Axials are wanting. In the adult the entire shell is covered with a proportionately thick coating of callus consisting of 2 or more lavers. A remarkable peculiarity of this coating is the development over much of its surface of low, round-topped tubercles, most of which are aligned in rows surmounting the concealed spirals; however, scattered nodes are present in the interspaces and nodes are absent on the parietal wall in the vicinity of the aperture, and also on the higher parts of the spire. In one meridian of the spire the callus is folded up to form a narrow, prominent axial ridge which extends up to and over the apex, somewhat as in Calyptraphorus. The four available shells of Tundora tuberculata are all incomplete but the holotype reveals the beginning of an

expanded outer lip of undetermined extent. The columella is smooth and the aperture is elongated and terminates acutely at the rear; one of the paratypes shows a narrow anal canal impressed in the callus and extending well up on the side of the penultimate whorl. The anterior canal is narrow, recurved and is probably short. The family relationship of this species is not certainly known, but it appears to be a member of the Strombidae.

# TUNDORA TUBERCULATA Stephenson, n.sp.

## Pl. 59, figs. 1-4

Shell small, rotund. Spire low; spiral angle 106 degrees at the apex, decreasing rapidly to 55 degrees on the larger whorls below. Protoconch small forming a low, simple, dextral spiral of about 11/2 volutions. Whorls 4 or 5, rapidly expanding, broadly rounded on the sides. Suture closely appressed, moderately impressed. Body whorl plump, broadly and regularly rounded from suture to base. The ornamentation on the uncallused body whorl consists of 13 or 14 narrow to sharp spirals separated by proportionately wide, flat-bottomed interspaces: the spirals are strongest on the inflated part of the shell, become weaker below, and nearly fade out on the lower part of the base. The fourth or fifth spiral below the suture is stronger than the others; it increases in strength toward the aperture and may become prominent on an expanded lip, only the beginnings of which are preserved on the three available incomplete specimens. The seventh or eighth spiral below the suture is a little stronger than the nearest adjacent spirals and it also increases in strength toward the aperture; it is slightly bifid on its crest.

The whole surface of the adult shell is covered with a proportionately thick callus consisting of 2 or more layers; the spirals are reflected through the callus in accentuated thickness. An unusual feature displayed over much of the callused surface is a series of low, round-topped tubercles, most of which are aligned in rows immediately above the spirals; a few isolated tubercles stand in the interspaces; tubercles are wanting on the parietal wall

at the aperture and on the smaller whorls of the spire. On portions of the shells from which the surficial layer of callus has been accidentally broken away the incrementals appear as sharp, closely spaced lines trending upward and obliquely backward somewhat beyond the line of greatest inflation, thence curving around and running obliquely forward and upward to the suture. On one meridian of the spire of the holotype the layer of callus is folded into a narrow, prominent, forward leaning ridge which passes upward over the apex and for at least 2 mm. down over the opposite side. Aperture elongated, of only moderate width, acutely angular at the rear; one paratype bears a remnant of callus showing the imprint of an anal canal extending upward two-thirds of the way across the penultimate whorl. At the anterior end of the aperture is an incomplete, narrow, recurved siphonal canal which is probably not very long in a complete shell. Outer lip partly broken away, but probably thin and more or less expanded. Inner lip forming a thin callus, broadly convex on the parietal wall, excavated low on the base. Columella without folds.

Dimensions of the holotype: Height 12.7+ mm., diameter just back of the beginning of the lip expansion 8.5 mm.

*Types.*—Holotype, U.S.N.M. no. 76984; 1 figured paratype, U.S.N.M. no. 76985; 1 unfigured paratype, U.S.N.M. no. 76986; 1 unfigured paratype, U.S.N.M. no. 76987.

Distribution in Texas.--Navarro group, Neylandville marl: Corsicana road, 2½ miles north of Corbet, Navarro County (17365, 1 unfigured paratype; Tex. Bu. 17300, holotype and 2 paratypes, 1 figured).

# Family CYPRAEIDAE

# Genus CYPRAEA Linné

## CYPRAEA NUCIFORMIS Stephenson, n.sp.

# Pl. 59, figs. 8-11

Shell of moderate size, thin in younger stages, becoming thick in adults. Spire small, low, conical, becoming completely covered with callus in adults; about three

whorls are exposed just preceding the adult stage. The protoconch is not well exposed. The exposed whorls of the spire are broadly rounded, the suture is closely appressed and the surface is ornamented with 8 or 9 fine, rather obscure revolving ridges which appear to alternate in size. The body whorl is relatively very large and plump, and there is no peripheral ridge or angle; the surface where not callused over exhibits rather widely separated, fine, obscure revolving ridges. The aperture is long, narrow, and extends the whole length of the shell; at the top it curves to the left, ending in a well defined, reflected anal channel. The siphonal channel is broken away on all the specimens but is probably short. The outer lip becomes very thick and rounded on the edge, due to the generous deposition of callus both within and The inner lip also becomes without. heavily callused and from both the inner and outer lips the mantle spreads over practically the whole shell, including the spire, covering the surface with polished callus. Both the inner and the outer lip are crenulated at the margin of the aperture.

Dimensions of the holotype: Height 24+ mm., diameter 18 mm.

The species differs from *Cypraea mor*toni Gabb,<sup>365</sup> and from specimens which have been referred to that species by authors, in that the spire is not completely enveloped except as it is covered by callus in the adult stage. The genus is rare in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain.

Types.—Holotype, U.S.N.M. no. 76988; 2 figured paratypes, U.S.N.M. no. 21007.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### CYPRAEA GRACILIS Stephenson, n.sp.

## Pl. 59, figs. 12, 13

Shell small, thin, relatively slender. Spire low, conical, partly covered by the reflected anal channel; the two partly exposed whorls of the spire are very broadly convex to almost flat on the side, and are ornamented with 5 or 6 fine spiral ridges; these are crossed by still finer, rather

<sup>&</sup>lt;sup>305</sup>Gabb, Wm. M., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 391, pl. 68, fig. 9, 1860.
closely spaced axial ridges which are present not only in the interspaces but override the spirals. The protoconch is a simple, dextral, broadly conical conch of about two and a half volutions. The large body whorl is broadly rounded and is ornamented with numerous fine, obscure spirals which apparently disappear toward the margin of the aperture. The aperture is long, narrow, and curved, being a little wider anteriorly than posteriorly, and extends the full length of the shell; it is reflected to the left posteriorly, ending in a wide open anal channel; anteriorly the siphonal channel is broken away. The outer lip is greatly thickened by the deposition of callus, and its inner margin is crenulated, the nodes numbering about 6 in a distance of 5 mm.; the inner lip is formed of a thin layer of callus which spreads for several millimeters over the shell; the inner lip is also finely crenulated, the nodes numbering about 9 in a distance of 5 mm.

Dimensions of the holotype: Height 15+ mm., diameter 10 mm.

This species is smaller, thinner and more slender than *Cypraea nuciformis*; in addition the ornamentation is distinctive and the marginal crenulations of the aperture are much finer.

Holotype.-U.S.N.M. no. 20894.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); 3/5 to 4/5 mile northeast of Chatfield (7572).

## Superfamily RACHIGLOSSA

#### Family PYROPSIDAE

#### Genus PYROPSIS Conrad

The genus *Pyropsis* is founded upon *Tudicla (Pyropsis) perlata* Conrad, from the Ripley formation of Tippah County, Mississippi. Conrad later raised the subgeneric name to the rank of genus. The type of Conrad's species is preserved in the Academy of Natural Sciences of Philadelphia.<sup>366</sup>

#### **PYROPSIS LANHAMI Stephenson**, n.sp.

#### Pl. 59, figs. 14–16

Shell of moderate size, rather thick, with about  $3\frac{1}{2}$  whorls. Spire very low and

flattish. Protoconch poorly preserved but apparently a simple, flattish, dextral conch, coiled  $1\frac{1}{2}$  or 2 times. The whorls expand rapidly and the body whorl is large and strongly inflated above. The suture is closely impressed, and is at the inner edge of a deep flat-bottomed groove which expands regularly toward the aperture. The periphery of the body whorl forms an approximate right angle, below which the base descends steeply with a broadly convex contour to a strong basal constriction. The upper flattish surface of each whorl is slightly excavated and is bordered on each side by a row of obscure nodes. This upper surface is smooth from the aperture back to and including more than half of the penultimate whorl; the posterior part of the penultimate whorl and the antepenultimate whorl are covered with numerous fine, obscure, spiral ridges. The body whorl between the periphery and the basal constriction is ornamented with 9 moderately strong, spiral, nodose ribs; the nodes are small and number 6 or 7 to the centimeter, the ones on the peripheral rib being a little coarser than those on the ribs below: the nodes are arranged in vertical rows which mark small, obscure axial ribs; the spiral ribbing is continued at least on the upper part of the siphonal extension, most of wihch is broken away on the holotype. The aperture is broadly subovate and slightly flaring in the adult; a faint anal channel and a more pronounced angulation at the terminus of the periphery give to the posterior part of the aperture a wide, squarish margin. The outer lip is thick and feebly notched at the ends of the spiral ribs; on the inner surface, paralleling the margin of the outer lip and about 3 mm. from it is a low, obscurely nodose ridge. The inner lip forms a layer of callus spreading forward several millimeters on the base of the body whorl; this layer is thin above, thicker below, and at the lower part of the aperture rises in a sharp fold from the main shell surface, forming a deep umbilical fissure. The aperture is continued forward in a deep, narrow siphonal channel most of which is broken away.

Dimensions of the incomplete holotype: Height 26+ mm., diameter 27 mm.

This elegant shell is smaller, and more regularly ornamented than *Pyropsis* 

<sup>&</sup>lt;sup>300</sup>Conrad, T. A., Acad. Nat. Sci. Ph'ladelphia Jour., 2d ser., vol. 4, p. 283, pl. 46, fig. 39, 1360.

perlata Conrad, the type species of the genus, from the Ripley formation in Tippah County, Mississippi; it also lacks the prominent peripheral keel of that species. Compared with *P. proxima* Wade, from Coon Creck, Tennessee, this species is smaller, more regularly ornamented, and less inflated, and has a more sharply reflected inner lip.

Holotype.—U.S.N.M. no. 76989. Named for the Hon. S. W. Lanham, Governor of Texas, 1903-1907.

Distribution in Texas.--Navarro group, Kemp clay: West of Zuehl (7721).

### Unidentified specimens of PYROPSIS

The Neylandville marl of the Navarro group has yielded one incomplete, poorly preserved specimen of *Pyropsis* (pl. 59, figs. 19, 20) from a field 1 3/5 miles east-northeast of Black Hills school,  $3\frac{1}{2}$ miles west-northwest of Corsicana, Navarro County (16166). In the form of its spire and body whorl the shell resembles P. lanhami, but there is evidence of stronger spiral ribs on the shoulder of the body whorl, and greater unevenness of ribbing is evident on the base, on the upper part of which several ribs are markedly larger than the others. The periphery is strongly carinated. The canal is broken away. Dimensions of the incomplete specimen: Height 18+ mm., diameter 20 mm. U.S.N.M. no. 76990.

Specimens of *Pyropsis* which are too poorly preserved for specific identification have been found in the Corsicana marl at the localities indicated in following paragraphs.

Cut in San Antonio road 6 miles east of Castroville, in Bexar County (15502); this species resembles *P. lanhami* in form, but is more finely ornamented (pl. 59, fig. 17). U.S.N.M. no. 76991.

Westward-facing bluff on Guadalupe River, 1.3 miles north of McQueeney, Guadalupe County (15524); this is a fragment of the body whorl showing a flat upper surface with fine spiral lines, a sharply angulated, carinated periphery, 4 fine, sharp, widely spaced spirals on the body whorl below, and with 4 or 5 fine threads in each of the interspaces between the main spirals (pl. 59, fig. 18). U.S.N.M. no. 76992.

San Marcos River, <sup>1</sup>/<sub>2</sub> mile below Martindale, Caldwell County (15526); two specimens, one a large, badly crushed, internal and external mold, apparently nearly smooth, and the other a fragment of a body whorl showing rather coarse ribbing. U.S.N.M. no. 76993.

Questionably on the W. H. Moore Survey, 100 yards south of the Missouri-Kansas & Texas R.R., 1/4 mile cast of the west line of the Survey, 5 miles east by north of Greenville, Hunt County (12924); this is an incomplete internal mold of a small, crushed individual, having a low, flattish spire, a sharply angular, carinated periphery with large, weak, widely spaced nodes, and with 4 spiral ridges on the body whorl below the periphery; the length and character of the siphonal channel are unknown. U.S.N.M. no. 76994.

A fragment of the internal mold of the body whorl, found in a public road,  $1\frac{1}{4}$ miles south by east of Oak Grove, Bowie County (16160), bears the impressions of 4 strong spiral ribs on the upper part of the base below the periphery; these are strongest on the side toward the aperture. and fade out apically to a smooth surface less than halfway around the volution. U.S.N.M. no. 76995.

## Genus MEDIONAPUS Stephenson, n.gen.

1926. Trochifusus Wade, U.S. Geol. Survey Prof. Paper 137, p. 140. (Not Trochifusus Gabb.)

Type species.- Medionapus elongatus Stephenson. Etymology.--Latin medius, medium [size]; Latin napus, a turnip.

Gabb<sup>367</sup> in 1876 suggested the generic name *Trochifusus* for a species of this family from Noxubee County, Mississippi, to which Tuomcy<sup>368</sup> had given the name *Pyrula trochiformis*. Wade,<sup>369</sup> in 1926, accepted Gabb's *Trochifusus* and referred three species from Coon Creek, Tennessee, to it. Tuomcy did not figure his *Pyrula trochiformis*, the type is lost, the exact

<sup>&</sup>lt;sup>307</sup>Gabb, Wm. M., Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 285, 1876.

<sup>&</sup>lt;sup>308</sup>Tuomey, M., Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 169, 1851.

<sup>309</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 140, 1926.

type locality is unknown, and the original description is inadequate to permit the safe identification of any material with it. There is no evidence that either Gabb or any subsequent reviewer saw Tuomey's type specimen. Wade's assignment of species to *Trochifusus* is not accepted, and the new generic name *Medionapus* is here proposed for shells like *M. elongatus* from Texas, and like the species referred to *Trochifusus* by Wade, of which the shell *Trochifusus spinosus*, shown in his plate 49, figure 3, is a good example.

Medionapus differs from Pyropsis in having a markedly higher spire, a much longer siphonal prolongation, a plumper body whorl below the shoulder angle, and a more completely sealed umbilical fissure; the protoconch is not quite so flat, is more slender and more regularly coiled, and has at least one more volution.

# MEDIONAPUS ELONGATUS Stephenson, n.sp.

### Pl. 60, figs. 9 11

Shell of moderate size, rather thick, with a long siphonal channel. Spire broadly conical, apical angle about 103 degrees: whorls of spire about 4. Sides of whorls broadly excavated, each whorl bordered on each side near the suture by a row of nodes of irregular strength; the nodes become more widely separated from each other away from the apex; a low, rather sharp ridge follows the excavation slightly above its middle, and between this and the suture below, on the penultimate and antepenultimate whorls, are 5 or 6 fine revolving ridges. The whorls expand rapidly and the body whorl is relatively large and plump above, becoming sharply constricted below, and continuing in a long siphonal extension. The continuation of the excavated band that forms the sides of the whorls of the spire becomes a broad, sloping excavated shoulder on the body whorl: the nodes which border this band become spinose toward the aperture, the spines being excavated toward the front. The inflated part of the body whorl is ornamented with 9 nodose spiral ribs with subequal interspaces; the uppermost rib bears the nodes and spines which border the shoulder excavation; just

in front of the inner lip these ribs alternate in size but around the whorl toward the outer lip they tend to become equal in size: the nodes are aligned in rows axially, and mark obscure axial ribs: toward the aperture the nodes tend to become The spiral ornamentation is spinose. continued out onto the siphonal extension. becoming weaker and fading out before the outer tip is reached: these ribs are of somewhat irregular strength and are obscurely noded; the inflated part of the body whorl is further ornamented with fine. almost microscopic spiral lines which cover both the ribs and interspaces. The main part of the aperture is elongate-ovate and ends posteriorly in an anal notch; anteriorly the aperture passes into a long straight siphonal channel. The outer lip is broken, but appears to be simple and uncallused; the inner lip forms a thin vencer of callus extending noticeably forward on the base; just above the posterior end of the siphonal channel the columella exhibits a broad axial swell which marks the position of the umbilical fissure of an earlier stage of growth, this fissure having become callused over in the adult.

Dimensions of the holotype: Height about 83 mm. diameter 35 mm.

This species has a close analogue in the shell from Coon Creek, Tennessee, which Wade called *Trochifusus spinosus*, but the Texas shell has a proportionately more inflated body whorl and a shorter and stouter siphonal channel.

Holotype.---U.S.N.M. no. 20945.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); ?vicinity of Chatfield (762); (?) vicinity Kaufman (761); ?4½ miles east by north of Rosali (14061).

#### Unidentified specimens of MEDIONAPUS

A young shell (pl. 60, figs. 12, 13), questionably referred to *Medionapus*, from the Nacatoch sand on Rock Branch on the Walton lease of the Houston Oil Company, 3 miles northeast of Corsicana, Navarro County (9545), has a flattish spire, with a roughly nodular carinated periphery. The most inflated part of the body whorl lies below the periphery and bears a prominent spiral ridge with low, widely spaced elongated nodes. The base of the shell descends steeply with a slight convexity and is ornamented with 2 major spirals. A pair of tiny spirals lie in the middle of the space between the periphery and the prominent spiral below; one faint spiral lies above the upper of the two basal spirals; 4 or 5 weak spirals occupy the constriction at the base of the body whorl. The siphonal extension is broken away, and its length is not known. U.S.N.M. no. 76996.

Incomplete internal and external molds of a specimen of *Medionapus?* sp. (pl. 60, fig. 14) were obtained from the basal sandy portion of the Corsicana marl, on the Frieze place, 2 3/5 miles north by cast of Malta, Bowie County (16159). The shell has the general form of *M. elongatus*, but appears to lack the angular shoulder of that species, and exhibits a more pronounced development of axials and weaker and less nodose spirals. It is too imperfect to serve as the type of a new species. U.S.N.M. no. 76997.

## Genus NAPULUS Stephenson, n.gen.

- 1858. Ficus Klein. Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 2, p. 332. (Ficus octoliratus Conrad.)
- 1860. Fusus Lamarck. Gabb, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 301. (Fusus retifer Gabb.)
- 1861. Perissolax Gabb, Synopsis of the Mollusca of the Cretaceous formation, p. 66. (Also in Am. Philos. Soc. Proc., vol. 8, p. 122, 1861.) Lists Ficus octolirata Conrad among the species referable to Perissolax.
- 1892. Pyropsis Conrad. Whitfield, U.S.Geol.
  Survey Mon., vol. 18, pp. 36, 38. (Geol.
  Survey New Jersey, Paleontology, vol. 2, pp. 36, 38, 1892.) (Pyropsis retifer (Gabb) and Pyropsis octolirata (Conrad).)
- 1892. Dolium Lamarck. Whitfield, idem., p. 121. (Dolium (Doliopsis?) multiliratum Whitfield.)
- 1892. Ficus Klein. Whitfield, idem., p. 122. (Ficus precedens Whitfield.)
- 1907. Pyropsis Conrad. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, pp. 749-752. (Pyropsis retifer (Gabb), Pyropsis whitfieldi Weller, Pyropsis octolirata (Conrad), Pyropsis lenolensis Weller.)
  1916. Pyropsis Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), pp. 451-454. (D
- 1916. Pyropsis Conrad. Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), pp. 451-454. (Pyropsis whitfieldi Weller, Pyropsis r et if er (Gabb), Pyropsis lenolensis Weller.)
- 1926. Perissolax Gabb. Wade, U.S.Geol. Survey, Prof. Paper 137, p. 141. (Perissolax whitfieldi (Weller), pl. 49, figs. 6, 9.)

- Type species.--The species from Coon Creek, Tennessee, identified by Wade as Perissolax whitfieldi (Weller), is here designated genotype.
- Etymology.—Diminutive of *napus* (Latin), a turnip.

According to Whitfield370 and Stewart,371 Fusus trivolvus Gabb, from the Vincentown sand of New Jersey, must be taken as the type species of *Perissolax*, a genus proposed by Gabb<sup>372</sup> in 1861. The Vincentown sand, supposed by Gabb to be Cretaceous, is now known to be Eocene. Gabb referred the Cretaceous species Ficus octolirata Conrad to Perissolax, and Wade referred Pyropsis whitfieldi Weller, also Cretaceous, to that genus. Although these species resemble *Perissolax* in form, they are much smaller and their protoconchs, compared with the Eocene species, Fulgur eocense Aldrich.<sup>373</sup> which Stewart believes to be congeneric with *Perissolax*, are much smaller and not so clearly differentiated from the main shell; in both, however, the protoconch is erect, a feature which clearly distinguishes Perissolax and Napulus from Pyropsis and Medionapus, whose protoconchs are nearly flat.

The species here referred to Napulus are all small, not exceeding 32 mm. in height, have plumper body whorls than that of *Pyropsis*, and lack the prominent peripheral angle of that genus. The siphonal canal is long and slightly curved. The body whorl is strongly constricted below, and its main inflated part bears 6 to 9, nearly evenly spaced, spiral ribs which may be prominently or only obscurely noded. The protoconch is small, strongly elevated, and is not sharply separated from the main conch. There is no umbilical fissure. The columella is without folds, but is slightly swollen at the upper end of the siphonal canal.

<sup>870</sup>Whitfield, R. P., U. S. Geol. Survey Mon., vol. 18, pp. 34, 46, and 172, 1892. (Geol. Survey New Jersey, Paleontelogy, vol. 2, pp. 34, 46, and 172, i892.)

<sup>&</sup>lt;sup>371</sup>Stewart, Ralph B., Acad, Nat. Sci. Philadelphia Proc., vol. 78, p. 427, 1927; Acad. Nat. Sci. Philadelphia Special Pub. No. 3, p. 41, 1930.

<sup>&</sup>lt;sup>372</sup>Gabb, Wm. M., Synopsis of the Mollusca of the Cretaceous formation, p. 66. (Also in Proc. Amer. Philos. Soc., vol. 3, p. 122, 1861.)

<sup>&</sup>lt;sup>373</sup>Aldrich, T. H., Bull, Am. Paleontology, vol. 1, No. 2, p. 62, pl. 3, figs. 7, 7a, 1395. See also Harris, G. D., Bull, Am. Paleontology, vol. 3, no. 11, p. 65, pl. 8, fig. 13, 1899.

The genus is based on the species represented by the shell from the Coon Creek tongue of the Ripley formation, at Coon Creek, McNairy County, Tennessee, which Wade<sup>374</sup> described and figured as *Perissolax whitfieldi* (Weller). There is reason to doubt the correctness of Wade's specific identification, but whatever name may eventually be applied to it, the Coon Creek species is designated the genotype of *Napulus. Napulus whitfieldi* (Weller), of Wade, is the largest of the species referred to this new genus; its height is 32 mm. and its diameter 19 mm.

following previously described The species are regarded as belonging to this Ficus octolirata Conrad, Fusus genus. retifer Gabb, Dolium (Doliopsis?) multiliratum Whitfield, Pyropsis lenolensis Weller. and Pyropsis whitfieldi Weller. With the exception of Ficus octolirata Conrad, these species are based on poor material and some of them may be synonyms. The several species referred to this genus appear to form a compact group of gastropods in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain; with one or two exceptions these species are in the Exogyra costata zone.

A relatively large species from near Chatfield, Navarro County, Texas, described by Shumard<sup>375</sup> under the name *Ficus (Pyri/usus) granosus*, probably belongs to *Napulus*, but the type is lost and the species has not been identified in collections subsequently made in the vicinity of Chatfield.

# NAPULUS TUBERCULATUS Stephenson, n.sp.

## Pl. 60, figs. 3-6

Shell small, thin, pyriform, with about two and a half whorls. Spire low with plump whorls. Protoconch small, elevated, coiled one and a half or two times. The whorls expand rapidly and the body whorl is plumply inflated above, becoming sharply constricted below, passing into a long siphonal extension. Suture closely appressed, moderately impressed, bordered below by a flattish band, which forms a

shoulder of moderate width. The penultimate and antepenultimate whorls are ornamented with 2 moderately prominent spiral ribs, which divide the surface into three nearly equal bands, the upper one of which forms the flattish shoulder; both ribs are obscurely tuberculated. The inflated part of the body whorl bears 8 spiral ribs, which decrease in promincnce from above downward; all these ribs are tuberculated, but the one bordering the shoulder band has the strongest tubercles and the tubercles on the successive ribs below become progressively less pronounced; the tubercles on the different ribs are arranged in vertical rows and are faintly connected across the interspaces, thus giving rise to fine, obscure axials; fine, obscure spiral lines can be detected on the shoulder band; spiral ribbing continues out onto the siphonal extension of the body whorl; the ribs are reflected on the inner surface of the body whorl as shallow spiral chan-The aperture is subovate, squarish nels. posteriorly at the end of the shoulder band, and extends anteriorly in a long, narrow, slightly curved siphonal channel. The outer lip is thin and simple, except for the notching produced by the channels on the inner surface; the inner lip is broadly excavated and forms a thin callus extending somewhat forward on the base of the shell.

Dimensions of the incomplete holotype: Height 12 + mm., diameter 9.6 mm. The figured paratype measures: Height 14.3 mm., diameter 8.7 mm.

The tuberculated spiral ribs of this species distinguish it from *Napulus octoliratus* (Conrad), from the Owl Creek formation at Owl Creek, Mississippi; the ribs on Conrad's species are also a little wider and more squarish in cross section. *Napulus whitfieldi* (Weller)?, from Coon Creek, Tennessee, is a larger species with fewer spirals.

Types.--Holotype, U.S.N.M. no. 76998; 1 figured paratype, U.S.N.M. no. 20911.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); vicinity of Chatfield (762); 3/5 to 4/5 mile northeast of Chatfield (14117).

<sup>374</sup>Wade, Brace, U. S. Geol, Survey Prof, Paper 137, p. 141, pl. 49, figs. 6, 9, 1926.

<sup>&</sup>lt;sup>375</sup>Shumard, B. F., Descriptions of new Cretaceous fossils from Texas: Boston Soc. Nat. Hist. Proc., vol. 8, p. 196.

### NAPULUS OCTOLIRATUS (Conrad)?

## Pl. 60, figs. 7, 8

#### 1858. Ficus octoliratus Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 2, p. 332, pl. 35, fig. 6.

Shell small, thin, pyriform, with two and a half or three whorls. In size and form this species is very much like *Napulus tuberculatus*, but the spiral ribs are a little wider and more squarish in cross section, and tubercles are wanting or very obscure. Fine, obscure to moderately distinct riblets occupy the interspaces between the main ribs. The growth lines are fine and sharp. The one available specimen from Texas is poorly preserved.

Dimensions: Height 21+ mm., diameter 12.5 mm.

Tubercles such as characterize *N. tuber*culatus are wanting on this species. Compared with the typical *N. octoliratus* (Conrad) from Owl Creek, Mississippi, this Texas shell has a plainer development of riblets between the main spirals, and the latter are a little more closely spaced on the base of the shell, but these features may be variable on different individuals; until more and better specimens are available the Texas shell is tentatively referred to the Mississippi species.

Types.—The holotype is not listed among Conrad's types in the Academy of Natural Sciences of Philadelphia, and is apparently lost. Four imperfectly preserved specimens (topotypes) from the Owl Creek formation at Owl Creek, Tippah County, Mississippi, the type locality of the species, are in the collection of the National Museum (U.S.N.M. no. 20413). One plesiotype(?) from Texas, U.S.N.M. no. 76999.

Distribution in Texas.—Navarro group, Kemp clay: ?Branch 6½ miles southwest of Currie (14139).

Outside distribution.—Mississippi: Owl Creek formation.

Range.—The species occurs in the Owl Creek formation of Mississippi and questionably in the Kemp clay of the Navarro group in Texas. Reported occurrences elsewhere in the Coastal Plain, based on poor material, have not been confirmed.

# Unidentified specimens of NAPULUS

Two internal molds from the Corsicana marl in a public road,  $1\frac{1}{4}$  miles south by cast of Oak Grove, Bowie County (13568, U.S.N.M. no. 77000; 16160, U.S. N.M. no. 77001), have the typical form of *Napulus*, with, however, only 5 spiral ribs impressed upon the mold.

A similar internal mold from the Corsicana marl in a public road, 1 4/5 miles N. 20° W. of Tona siding, in Hunt County (15545), also has 5 spiral ribs (pl. 59, fig. 6). U.S.N.M. no. 77002.

An internal mold from the Corsicana marl in a westward-facing bluff on Guadalupe River, 1 3/10 miles north of Mc-Queeney, Guadalupe County (15521), reflects 7 rather sharp spiral ribs, with faint axial ribs spaced in such a manner as to divide the surface into small squares and rectangles; the spirals are tuberculated at the intersections of the axials, the nodes on the two upper spirals being distinct, and those on the others below obscure. The two lower spirals are smaller than the others (pl. 59, fig. 7). U.S.N.M. no. 77003.

An internal mold found with the preceding (15524) has 8 or 9 spirals and appears to lack the axials and tubercles. U.S.N.M. no. 77004.

An internal mold which may be the same species as the preceding was found in the Corsicana marl on San Marcos River,  $\frac{1}{2}$  mile below Martindale, Caldwell County (15526). U.S.N.M. no. 77005.

A badly crushed internal mold from the Corsicana marl on the Mexia road, 23/4 miles east of Cooledge, Limestone County (13832), has 10 or 11 spiral ribs which appear to be finely tuberculated (pl. 59, fig. 5). U.S.N.M. no. 77006.

One imperfect shell from the Kemp clay in a field east of the Austin-Elgin road,  $3\frac{1}{4}$  miles east by north of Manor, Travis County (13861), appears to be a Napulus. It is about as large as the large species of Napulus which Wade<sup>376</sup> described under the name Perissolax whitfieldi (Weller). Compared with the Coon Creek species this one has a more pronounced shoulder, and the spirals on the body whorl, which are similarly spaced, are thicker and more

<sup>376</sup>Wade, Brace, U. S. Geol. Survey Prof. Paper 137, p. 141, pl. 49, figs. 6, 9, 1926. prominent; they are, however, similarly noded. U.S.N.M. no. 77007.

## Genus HERCORHYNCUS Conrad

1860. Fusus Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 286. (= Fusus tippana Conrad.)

1869. Hercorhyncus Conrad, Amer. Jour. Conch., vol. 4, p. 247.

Type species .- Fusus tippana Conrad.

The type species of this genus, *Hercorhyncus tippanum* Conrad, is from Tippah County, Mississippi, but the exact locality was not stated by Conrad. A similar, but apparently more slender, unnamed species occurs at Owl Creek, 2½ miles northeast of Ripley, Tippah County.

The shell which Wade<sup>377</sup> described under the name Serrifusus tennesseensis appears to be congeneric with Hercorhyncus tippanum Conrad; it has a shorter spire, the excavated band below the shoulder is nearly smooth, and the canal appears to be more strongly bent. Serrifusus Meek, though closely related, appears to be generically distinct.

Haplovoluta Wade<sup>378</sup> from Coon Creek, Tennessee, is closely allied to *Hercorhyncus* Conrad, but the presence of a distinct sulcus at the base of the body whorl, and much more numerous spinose nodes on the periphery, seem to justify a generic separation.

The Texas species, *H. malleiforme*, is more closely related to the genotype, *Hercorhyncus tippanum* Conrad, than it is to either the Owl Creek or the Coon Creek species.

## HERCORHYNCUS MALLEIFORME Stephenson, n.sp.

#### Pl. 61, figs. 10, 11

Shell of medium size, rather thick, mallet-shaped, with 4 or 5 volutions. Spire of moderate height; the whorls increase rapidly in size, and the anal fasciole on the penultimate and smaller whorls is broadly excavated below the suture. Protoconch broken away. Suture closely appressed and distinctly impressed, bordered below by a well developed collar which forms the upper slope of the excavated band. Bordering the excavated band below is a row of coarse, rounded nodes of somewhat irregular size and spacing, numbering 11 on the penultimate and 9 on the antepenultimate whorl. The continuation of the excavated band becomes a pronounced shoulder on the body whorl where the nodes number 11 and are quite prominent and coarse, forming blunt axials which die out a few millimeters below the periphery. The anal fasciole bears 6 small, closely crowded, spiral ridges, the 3 lower ones of which override the nodes, the lowest one passing over the crests of the nodes. The body whorl below the shoulder angle is ornamented with spiral ribs of moderate size; the fifth one below the shoulder is more than twice as large as the others and forms a peripheral ridge, below which the base descends steeply and rounds broadly into the anterior extension: the primary spiral ribs below the peripheral ridge are larger and more widely spaced than those above it. and 2 or 3 small minor ribs, poorly preserved, are present in each of the interspaces; the ribbing dies out about halfway out on the canal. Aperture subovate, squarish posteriorly at the end of the anal fasciole; the anal channel forms a distinct, narrow notch at the end of the collar; siphonal channel slightly curved and about as long as the main aperture, separated from the columella by a narrow fissure. The outer lip is partly broken away. The inner lip forms a broadly excavated, moderately thick callus.

Dimensions of the holotype: Height 45+ mm., diameter 24 mm.

Closely allied species are *H. vadosum*, *H. tippanum* Conrad (the genotype) from the upper part of the Ripley formation at Owl Creek, Tippah County, Mississippi, and *H. tennesseense* (Wade) from the lower part of the Ripley formation (Coon Creek tongue), from Coon Creek, McNairy County, Tennessee. On *H. tippanum*, a smaller shell, the excavated shoulder band lacks revolving ribs, and its anterior canal is proportionally shorter and a little more twisted than that of *H. malleiforme*, but the two are very closely related.

Holotype.-U.S.N.M. no. 77008.

Distribution in Texas.---Navarro group, Kemp clay: West of Zuehl (7721, type

<sup>377</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 143, pl. 50, figs. 3, 4, 1926.

<sup>378</sup>Op. cit., p. 138.

loc.); Webberville (7601); near Deatsville (764, 14125); Littig (765); 2 2/5 miles southeast of Manor (18196).

# HERCORHYNCUS VADOSUM Stephenson, n.sp.

## Pl. 61, figs. 18-20

This shell is closely related to *H. mallei*forme, but differs in several details. The general form and size are about the same, but vadosum is somewhat more finely sculptured and the shoulder band is markedly more shallow, and therefore more gently sloping; the shoulder is a little more obtuse and the shoulder nodes more numerous (14 on the body whorl) and not quite so prominent; the nodes may be somewhat waterworn. Spiral ribs are wanting on the anal fasciole, but several weak spirals appear on the upper flanks of the shoulder nodes; four or five spirals appear on the body whorl between the shoulder angle and the periphery; the peripheral ridge bears three obscure minor spirals; the spirals on the base are more closely crowded and number seven or eight. The inner lip forms a thick callus on the parietal wall. On the two available shells the apical whorls and the anterior canals are both broken away.

Dimensions of the holotype: Height 38+ mm., diameter 27.

*Types.*—Holotype, U.S.N.M. no. 77009; 1 paratype, U.S.N.M. no. 77010.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

# HERCORHYNCUS NODOSUM Stephenson, n.sp.

# Pl. 61, figs. 14, 15

Shell of medium size, pyriform, with about 4 volutions. Spire of moderate height increasing rapidly in size; spiral angle about 75 degrees; anal fasciole broadly excavated. Protoconch not preserved. Suture closely appressed, deeply impressed, bordered below by a well defined collar of moderate width. On the shoulder is a row of prominent, thick nodes slightly elongated axially; these number 10 on the body whorl and 8 or 9 on the penultimate and on the antepenultimate whorls; on the body whorl the nodes end almost abruptly a little below the shoulder. The body whorl is covered on its side and base with numerous, well developed, narrow, roughly round-crested spirals which are narrower than the interspaces; a pair of these form a broadly obtuse peripheral ridge a little below the ends of the large axial nodes; five of the spirals are above this shoulder and the upper two or three of them override the large nodes; ten of them are below the pair on the base and on the upper part of the canal. The anal fasciole bears numerous small and very obscure spirals. Aperture elongate-lanceolate with the widest part just below the shoulder angle; anal channel acute; anteriorly the aperture becomes narrow and passes into the siphonal canal which is broken off in the holotype. The outer lip, which is incomplete, is angulated at the shoulder and broadly arched below. The inner lip is broadly excavated above and forms a thin callus over the parietal wall; below the callus it is slightly separated from the wall of the siphonal canal by a long. narrow fissure. Columella apparently smooth.

Dimensions of the incomplete holotype: Height 25+ mm., diameter about \* 16 mm.

The species differs from *Hercorhyncus* malleiforme in the fewer, more widely separated and more prominent axial nodes, and in its finer spiral sculpture; *H.* vadosum exhibits a similar spiral sculpture but has more numerous, more closely spaced, and less prominent axial nodes.

Holotype.---U.S.N.M. no. 77011.

Distribution in Texas.--Navarro group, Neylandville marl: 2<sup>1</sup>/<sub>2</sub> miles north of Corbet (Tex. Bu. 17300).

## HERCORHYNCUS MUNDUM Stephenson, n.sp.

Pl. 61, figs. 16, 17

Shell of medium size and elegant contour. Spire of moderate height; apical angle about 65 degrees, spreading to 80 degrees on the larger whorls below. Suture closely appressed, deeply impressed. Anal fasciole broadly and rather deeply excavated, forming a pronounced collar below the suture. The axials number 11 or 12 on each of the three larger whorls and are about coequal in width with the interspaces; the axials are rather

thick, of only moderate prominence and on the body whorl extend from the shoulder down the side, fading out high on the base. The spirals are rather weak and widely spaced on the upper part of the body whorl and override the axials; the two upper ones are closer together than the others and form a pair on the shoulder; on the base are 5 or 6 more prominent spirals which increase in size and width of spacing from above downward, but appear to fade out on the upper part of the incomplete siphonal canal; spirals are wanting on the anal fasciole. The incrementals appear rather coarse as the shell is preserved; they are sinuous in trend and bend markedly forward as they cross the anal fasciole. Aperture wide above but narrowing abruptly to an acute anal channel; below the aperture narrows to an elongated siphonal canal which is incomplete in the holotype. Outer lip partly broken away; it is broadly arched outward above becoming slightly concave below. Inner lip broadly excavated above where it forms a thin callus over the parietal wall; below the callus is slightly separated from the wall of the siphonal channel, forming a narrow fissure. The columella appears to be smooth.

Dimension of the incomplete holotype: Height 24-+ mm., diameter 14 mm.

This shell differs in detail of sculpture and form from the other three species and is easily recognized as a separate species. The axials are more numerous, more clongated, and much less prominent than those of *Hercorhyncus nodosum* in the same formation.

*Types.*—Holotype, U.S.N.M. no. 77012; 1 unfigured paratype, U.S.N.M. no. 77013.

Distribution in Texas.- Navarro group, Neylandville marl: 2<sup>1</sup>/<sub>2</sub> miles north of Corbet (17365; Tex. Bu. 17300, type lot).

# HERCORHYNCUS CORONALE Stephenson, n.sp.

# Pl. 61, figs. 12, 13

Shell of medium size, ventricose. Spire about half the total height of the shell, spiral angle 70°. Protoconch and one or two coils of spire broken away. Whorls 4 or 5, closely appressed, rapidly expand-

Suture deeply impressed. Body ing. whorl clongated, inflated above, sharply compressed below. Shoulder wide, steeply sloping, broadly excavated. Axial sculpture consisting of regularly spaced, prominent, pointed nodes on the shoulder angle, numbering 9 on the body whorl, and 8 on the penultimate whorl. The body whorl below the shoulder nodes is ornamented with spirals distributed as follows: Just below the nodes are 3 small spirals, narrower than the interspaces; on the perimeter is a strong broad, slightly bifid rib; on the base are 7 or 8 flattishtopped spirals which are narrower than the interspaces; 4 or 5 of the upper ones are moderately strong, the others below becoming successively weaker and fading out about halfway out on the anterior prolongation. Spirals are wanting on the shoulder of the body whorl, but on the penultimate whorl, numerous fine, microscopic threads override the shoulder nodes. The trend of the growth lines is broadly convex forward as they pass up over the base; as they cross the shoulder they bend first backward and then forward to the suture. Aperture wide above, acutely angular at the rear, narrowing quickly to a long, narrow siphonal canal in front. Outer lip thin, nearly rectangular at the intersection of the shoulder angle. Inner lip broadly excavated on the sharply constricted base.

Dimensions of the incomplete holotype: Height 22.5 mm., diameter 13 mm.

The species differs from the other species of the genus in its more elevated shoulder and in the sharpness and wider spacing of the nodes on its shoulder angle. The species appears to be most closely related to *H. nodosum* Stephenson.

Holotype.-U.S.N.M. no. 77014.

Distribution in Texas.—Navarro group, Nacatoch sand:  $2\frac{1}{2}$  miles west by south of the courthouse at Corsicana (17368).

# Unidentified specimens of HERCORHYNCUS

Imperfectly preserved specimens probably belonging to *Hercorhyncus* have been found at localities in the Corsicana marl as enumerated below. These are all closely similar in form and sculpture to *H. malleiforme* but they lack the deeply excavated shoulder and the strongly developed collar below the suture, and should probably be treated as one or more distinct species. The localities are: Guadalupe River, 1 3/10 miles above Mc-Queenev, Guadalupe County (7637, U.S.N.M. no. 77015; 15524, U.S.N.M. no. 77016): 2 miles south of Marion, Guadalupe County (13389, U.S.N.M. no. (77017); public road, 4/5 mile south of the Castroville road, just east of the old fuller's earth pits, 14 miles west by south of San Antonio, Bexar County (15623, U.S.N.M. no. 77018); pit of Standard Fuller's Earth Company, 4/5 mile north of Castroville road, 14 miles west of San Antonio (15520, U.S.N.M. no. 77019).

# Family BUSYCONIDAE

# Genus BUSYCON Bolten

# BUSYCON? sp.

# Pl. 62, fig. 10

The incomplete internal and external molds of a large gastropod, found in the Nacatoch sand on land of E. A. Stevens, 1 4/5 miles northcast of Quinlan, Hunt County (16162), is similar in form to Busycon (Protobusycon) cretaceum Wade<sup>379</sup> from Coon Creek, Tennessee, but lacks a spiral sulcus at the base of the body whorl, a feature which served as the basis for Wade's subgenus, Protobusycon. The growth lines over the part preserved are vigorous and closely crowded. Numerous fine spiral lirac are only faintly discernible, but their obscurity may be due to imperfection of preservation. The angular shoulder or periphery bears irregular, elongated protuberances as in Wade's species. The second obscure keel outlining the base of the body, described by Wade, is scarcely defined but the Texas shell is larger and more mature and even on the younger stage represented by the Tennessee shell this feature is already tending to smooth out and disappear toward the aperture. The general similarity of the Texas shell to the one from Tennessee suggests the possibility that the sulcus at the base of the body whorl on the latter may be a pathologic feature due to a mantle injury, but this possibility can not be checked until more shells of this kind are obtained from the Coon Creek locality. U.S.N.M. no. 77070.

#### Genus PINELLA Stephenson, n.gen.

Type species.—*Pinella reticulata* Stephenson. Etymology.—Diminutive of *pinea* (Latin), a pine cone.

Shell small, moderately thick. Spire low, with angle of about 80 degrees. Whorls three, increasing rapidly in size; body whorl very large, more than twice as high as the spire. Shoulder moderately wide, sloping, slightly excavated, making an obtuse angle with the side below. Surface reticulated by numerous, narrow, closely spaced axials, and fewer, thicker, more prominent, and more widely spaced spirals. Aperture somewhat deformed by mechanical pressure, but evidently rather widely gaping with an obtuse notch at the shoulder angle; anal canal shallow; siphonal canal short, deep, moderately wide, and markedly twisted; this canal is bordered above by a distinct, oblique columellar fold. The inner lip forms a very thin wash of callus on the parietal wall and columella. In form this shell resembles Busycon, but it is very much smaller and the anterior canal is shorter and is decidedly twisted; the sculpture is also much more strongly accentuated.

## PINELLA RETICULATA Stephenson, n.sp.

### Pl. 60, figs. 1, 2

The species is based on one individual. Shell small, moderately thick. Spire low with an apical angle of about 80 degrees. Protoconch broken away, but small as indicated by the scar. Whorls three, increasing rapidly in size. Body whorl relatively very large, being more than twice as high as the spire. Shoulder of medium width, sloping, slightly excavated, meeting the side of the whorl at an obtuse angle. Surface finely reticulated with axial and spiral ribs. The axials are narrow, closely spaced and number about 48 on the body whorl and 30 on the penultimate; they override the spirals, bend forward above where they cross the

<sup>&</sup>lt;sup>379</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 136, pl. 47, figs. 1, 4, 1926.

shoulder which is without spirals, and extend below to the base of the body. The spirals are much broader and more widely spaced than the axials, and number about a dozen on the body whorl between the shoulder angle and the base of the body. The external surface on the pillar in front of the siphonal canal is covered with small, closely spaced, rather obscure spirals. Aperture elongate-subovate, with a shallow anal canal at the rear, which produces an angle a little less than a right angle at the junction of the outer lip with the body; the siphonal canal in front is rather short, but deep and moderately wide and is markedly twisted. The outer lip is broken and irregular but it is broadly notched at the shoulder angle; inner lip broadly excavated and forming a thin callus over the parietal wall and columella. The columella is twisted and bears a distinct fold below at the upper border of the anterior canal.

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Dimensions: Height about 11 mm., diameter about 6.5 mm.

Holotype.-U.S.N.M. no. 77020.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7721).

## Family SARGANIDAE

## Genus SARGANA Stephenson

- 1907. Rapana Schumacher. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 754, pl. 89, figs. 1-3.
- 1923. Sargana Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 377, pl. 93, figs. 1-5.

Type species .-- Rapana stantoni Weller.

The type species of this genus, Sargana stantoni (Weller), is from the Nacatoch sand, near Chatfield, Navarro County, Texas. Weller placed the genus in the family Purpuridae and Wade<sup>380</sup> in the family Muricidae, but the low spire, the presence of a columellar fold, and the absence of prominent spines and varices, serve to distinguish the genus from these families and warrant the recognition of the family Sarganidae to include it and related species. Wade's genus Schizobasis should be classed either in this family, or in a closely parallel family, instead of in the Turbinidae to which he referred it. This is indicated by the presence of a narrow, deep siphonal canal like that in *Sargana*, the presence of two columellar folds, and by the flaring, coarsely and irregularly notched margin of the umbilical fissure.

The genus is represented in the Cretaceous of Pondoland, southeast Africa, by *Pyropsis geversi* Rennie,<sup>331</sup> a species which, judged by the published figures, is remarkably close to Sargana stantoni.

## SARGANA STANTONI (Weller)

Pl. 60, figs. 15-17

- 1907. Rapana stantoni Weller, New Jersey Geol. Survey, Palcontology, vol. 4, p. 754, pl. 89, figs. 1-3.
- 1923. Sargana stantoni (Weller). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 377, pl. 93, figs. 1-5.
- vol. 5, p. 377, pl. 93, figs. 1-5. 1926. Sargana stantoni (Weller). Wade, U.S. Geol. Survey Prof. Paper 137, p. 136, pl. 46, figs. 7, 8.

Shell of moderate size, thick, subpyriform, with 3 or 4 rapidly expanding volutions. Protoconch small, simple, slightly elevated, not sharply separated from the conch. Spire very low, the exposed surface of the whorls being almost flat. Suture closely appressed. Body whorl sharply angular at the periphery in young individuals, becoming subangular in Body whorl sharply constricted adults. at the base. The upper surface of the conch is smooth at its small end, but within 10 or 12 mm. 3 rows of small spinose nodes appear, one on the inner and one on the outer border, and one in the middle; these nodes gradually increase in prominence and gradually come to occupy the crests of ill-defined spiral ribs; longitudinally the nodes are aligned in oblique rows which mark obscure axials. The flattish exposed surface of the whorls of the spire becomes a slightly sloping shoulder on the body whorl, and the spinose nodes become continuously more pronounced toward the aperture, the

<sup>&</sup>lt;sup>380</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 136, 1926.

<sup>&</sup>lt;sup>3st</sup>Rennie, John V. L., New Lamellibranchia and Gastropoda from the Upper Cretaceous of Pondoland (with an appendix on some species from the Cretaceous of Zululand): Annals of the South African Museum, vol. 28, pt. 2, p. 229, pl. 27, figs. 17-19, 1930.

outer row forming the subangular periphery; 4 additional spinose spirals adorn the body whorl below the periphery, making 7 spirals in all; the nodes mark the intersection of moderately pronounced axials of irregular strength and spacing, with the spiral ribs. Resting stages in the growth of the shell are indicated by broader and deeper axial depressions between rows of nodes. The constriction at the base of the body whorl is emphasized by a rather broad rugose sulcus, below which is another row of irregular spines, marking an ill-defined spiral. The spines are formed by sharp upfolds of growth lamellae concave toward the aperture. The aperture is subcircular or broadly subovate; the margin is modified posteriorly by a distinct anal notch, and anteriorly is slit by its junction with a narrow, deep, twisted siphonal channel; the inner lip forms a thick callus. The shell is characterized by a deep, expanding umbilicus, the outer margin of which is coarsely notched and becomes progressively more attenuated anteriorly; the inner surface of the umbilicus is marked by radiating grooves which intersect the margin at the bottoms of the notches. A broken shell from Mississippi shows a narrow, sharp columellar fold bordering the inner margin of the siphonal slit.

Dimensions of the holotype: Height 24 mm., diameter 24.5 mm.

The reported occurrence of the species in the Marshalltown formation (*Exogyra ponderosa* zone) of New Jersey, by Weller, has not been confirmed.

*Types.*—Holotype, U.S.N.M. no. 21070; 3 paratypes, U.S.N.M. no. 77021.

Distribution in Texas.--Navarro group, Neylandville marl: ?<sup>1</sup>/<sub>2</sub> mile north of Cooper (4064).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); 4/5 mile north of Hester (Tex. Bu. 17306); vicinity of Corsicana (763).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Ripley formation.

Chattahoochee region (Alabama-Georgia): Upper part of Ripley formation. North Carolina: Peedee formation (upper part).

Range.—So far as definitely known this species is limited in its stratigraphic range to the Exogyra costata zone. Poorly preserved shells belonging to the genus, but probably to different species, are known in the Exogyra ponderosa zone in North Carolina and New Jersey.

## Family MOREIDAE

## Genus MOREA Conrad

The genus *Morea* has been assigned by different authors to the families Cancellariidae, Purpuridae, and Buccinidae, all of which are based on Recent genera. Morea differs from Purpura Bruguière not only in contour and the sculpture of the shell, but in having a sharply defined fold on the columella. Morea differs from Cancellaria Lamarck in contour, in the character of the sculpture, and in having only one fold low on the columella, bordering the siphonal channel, instead of several folds well above the siphonal channel. Buccinum Linné has a higher spire and a different type of sculpture. These differences seem to justify the recognition of a separate family to include the Cretaceous shells. The genus Morea is represented in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain by 5 or 6 closely related species, and is herewith proposed as the type genus of the new family. The type species of the genus is Morea cancellaria Conrad from the Ripley formation at Eufaula, Alabama.

# MOREA CANCELLARIA CORSICANENSIS Stephenson, n.var.

# Pl. 61, figs. 7-9

Shell of moderate size, thick, subpyriform, with 4 whorls. Spire low with plumply rounded volutions. Protoconch poorly preserved, but apparently small, smooth, and moderately elevated. Suture deeply impressed, closely appressed in the young and intermediate stages, opening out in adults. Body whorl proportionately very large, broadly rounded in contour, slightly constricted anteriorly. Surface of body whorl ornamented with 8 or 9

prominent, square-topped spiral ribs, crossed by less prominent, slightly wider, but a little more closely spaced axial ribs; the intersection of the two types of ribs is marked by moderately prominent square or rectangular nodes. The upper or posterior spiral rib is a little wider than the others, and the interspace just below it is a little wider and deeper than the other interspaces. Three of the spiral ribs are exposed on the penultimate whorl. The aperture is elongate-ovate, with a distinct anal notch at the rear, and with a short twisted siphonal canal forming a deep wide notch in front; the upper margin of the canal is bordered by a pronounced columellar fold which follows the twist of the canal back into the shell. Anteriorly there is a broad, deep, twisted false umbilicus bordered on the side of the columella by the sharp edge of the inner lip, and on the other side by a rough, twisted, convex, spirally striated band; both this band and the inner surface of the umbilicus are roughened by fine, sharp, closely spaced growth ridges. The outer lip is beveled to a rather thin edge which is notched at the intersection of the spiral ribs; the inner lip forms a thin callus over the base of the shell above the false umbilicus.

Dimensions of the incomplete holotype: Height 35+ mm., diameter 28 mm. Dimensions of the accompanying paratype: Height 25.5+ mm., diameter 20 mm.

The typical Morea cancellaria Conrad was reported by Conrad<sup>382</sup> to have been found at Eufaula, Alabama, and in Tippah County, Mississippi, but he did not state at which of these places the figured specimen was obtained. Specimens from Eufaula agree well with the published figure but the type specimen is lost. In the absence of knowledge to the contrary the first named place, Eufaula, may be accepted as the type locality. The typical M. cancellaria has a higher spire, and is proportionately more slender than the variety corsicanensis; in addition the axial ribs are narrower and more closely spaced in the Eufaula shells and the prominent spiral rib just below the suture is less distinctly nodose, the nodes showing a tendency to become narrower and to assume a lamellar form in the adult stage. The variety corsicanensis has a shorter spire and is plumper than the variety crassa described below. M. reticulata Stephenson, from the Snow Hill member of the Black Creek formation, Snow Hill, North Carolina, is a more slender and more finely ornamented shell.

Types.--Holotype, U.S.N.M. no. 77022; 1 figured paratype, U.S.N.M. no. 77023.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518).

# MOREA CANCELLARIA CRASSA Stephenson, n.var.

# Pl. 61, figs. 5, 6

In form and in type of sculpture this variety is very much like the typical *Morea cancellaria* Conrad, but the spiral and axial ribs are thicker and the latter are more widely spaced, thus producing a coarser cancellation. In addition the first interspace below the upper or posterior spiral in *crassa* is narrower and shallower than is the corresponding interspace in the typical *cancellaria*. Compared with the variety *corsicanensis* the variety *crassa* is more slender and has a higher spire. Four of the spiral ribs are exposed on the penultimate whorl.

Dimensions of the incomplete holotype: Height 29+ mm., diameter 18+ mm.

Holotype .-- U.S.N.M. no. 77024.

Distribution in Texas.—Navarro group, Nacatoch sand: 2½ miles north of Corsicana (14114, holotype); north edge of Corsicana (518); 4/5 mile north of Hester (Tex. Bu. 17306); vicinity of Chatfield (762); ?vicinity of Kaufman (761).

### MOREA MARYLANDICA BELLA Stephenson, n.var.

# Pl. 61, figs. 1, 2

Shell of moderate size and thickness, subpyriform, with 3 or 4 whorls. Whorls of the spire plumply rounded; spiral angle 80 to 85 degrees. The protoconch is small, simple and moderately elevated, but is not

<sup>&</sup>lt;sup>252</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 24 scr., vol. 4, p. 290, pl. 46, fig. 30, 1860.

well preserved in the types. Suture deeply impressed. Body whorl large, moderately plump, broadly rounded in contour; the upper part of the whorl curves in rather sharply; in the larger of the two paratypes this curvature is strong enough to form a subangular shoulder, a feature which may be sexual. The base of the body whorl is bounded by a pronounced spiral sulcus which extends from the middle of the inner lip to the margin on the inner side of the outer terminus of the canal. Body whorl ornamented with 12 narrow, square-topped spiral ribs; the interspace between the two upper spirals is deeper and much wider than the other interspaces, which range in width from a little narrower to a little wider than the spirals; crossing the spirals are numerous rather closely spaced axial ribs which are a little less prominent than the spirals; the intersections of the spirals and axials are marked by squarish nodes. Four or five of the spirals are exposed the penultimate whorl. Aperture on elongate-ovate with a distinct anal notch and a short deep canal; upper edge of canal bordered by a narrow, prominent fold. Outer lip broadly arched and notched at the intersection of the ribs; inner lip broadly excavated, and forming a thin callus on the base of the shell. False umbilicus deep above, flaring out rather broadly below, bordered on the columellar side by a narrow, sharp ridge, and on the other side by a plumply rounded, twisted ridge; both this ridge and the inner surface of the umbilicus are spirally striated.

Dimensions of the holotype: Height 19 mm., diameter 12.5 mm.

The volutions of this varietal form are a little more plumply rounded, and the upper part of the body whorl exhibits a very much less pronounced shoulder than does the typical Morea marylandica The sculpture is much finer Gardner. than that of *M. cancellaria* and its varieties.

Cossmann<sup>383</sup> has proposed the subgeneric name Pseudomorea, with Morea marylandica Gardner as type, but a careful comparison of the Maryland species with Morea cancellaria fails to reveal differences that would seem to justify the erection of the subgenus.

Types.- -Holotype, U.S.N.M. no. 77025; unfigured paratypes, U.S.N.M. no. 20916; 1 unfigured paratype, U.S.N.M. no. 77026.

Distribution in Texas .-- Navarro group, Neylandville marl: ?1/2 mile north of Cooper (4064).

Navarro group, Nacatoch sand: North edge of Corsicana (518, holotype and 2 paratypes); vicinity of Corsicana (763, loc. of 1 paratype); vicinity of Kaufman (761).

Range .--- Questionably from the Neylandville marl upward into the Nacatoch sand of the Navarro group.

## MOREA MARYLANDICA LANGUIDA Stephenson, n.var.

## Pl. 61, figs. 3, 4

This variety resembles the species marylandica but has 9 instead of 11 spiral ribs, and has a decidedly more drooping shoulder, with scarcely a suggestion of a shoulder angle; these features produce a relatively coarser sculpture and a more slender contour. The shoulder of M. marylandica bella is narrower and less drooping and the sculpture is finer, the spiral ribs numbering 12.

Dimensions of the incomplete holotype: Height 14.4+ mm., diameter 9.7 mm.

Types.—Holotype, U.S.N.M. no. 77027; 1 unfigured paratype, U.S.N.M. no. 77028.

Distribution in Texas.-Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

### Family BUCCINIDAE?

#### Genus SEMINOLA Wade

1917. Seminola Wade, Acad. Nat. Sci. Philadelphia Proc., vol. 69, p. 290.

1920. Ripleya Cossmann, Revue géologie anneé 1, no. 9, p. 376. 1926. Seminola Wade, U.S.Geol. Survey Prof.

Paper 137, p. 144.

Type species .-- Seminola crassa Wade.

If the recommendation of the International Commission of Zoological Nomenclature is to be followed, Wade is within his rights in retaining the name Seminola, since the name with which this one is supposed to be synonomous is Seminolus.

<sup>353</sup>Cossmann, M., Essais Paléoc. Comp., Liv. 13, p. 265, 1925.

The genus is represented in the Navarro group by two species, S. crassa Wade, from the Nacatoch sand, and S. sp. from the Exogyra cancellata zone. Wade described two species, S. crassa and S. solida, from Coon Creck, Tennessee. One or two undescribed species are known in the Ripley formation in Mississippi, and at least one species in the upper part of the Ripley formation near Eufaula, Alabama. Two species, S. globosa (Gabb) and S. greenensis Stephenson.384 have been recorded from the Snow Hill marl member of the Black Creek formation, North Carolina. Fasciolaria crassicosta Gabb.<sup>385</sup> the type of which is a small crushed shell in the collection of the Academy of Natural Sciences of Philadelphia, has the form and the basal groove of Seminola and appears to belong to that genus.

## SEMINOLA CRASSA Wade

#### Pl. 63, figs. 1-4

- 1917. Seminola crassa Wade, Acad. Nat. Sci. Philadelphia Proc., vol. 69, p. 291, pl. 19, figs. 6, 7.
- 1918. Seminola crassa Wade. Cossmann, Revue critique paléozoologie année 22, nos. 1--2, p. 21.
- 1926. Seminola crassa Wade, U.S. Geol. Survey Prof. Paper 137, p. 145, pl. 50, figs. 9-12.

Shell large, thick, semiglobose. Apical angle about 68 degrees; spiral angle increasing below to 85 or 90 degrees in medium stages, decreasing again to 65 or 70 degrees in adults where the body whorl begins to droop on the shoulder. Whorls 5 or 6, increasing rapidly in size, plumply rounded on the sides, with a pronounced shoulder above. Body whorl moderately elongated, rounding down broadly to a deeply impressed spiral sulcus at the base; the shoulder on the body whorl tends to droop and smooth off toward the aperture on adults. The suture is undulating and in young stages is closely appressed and moderately impressed; in later stages it tends to become less closely impressed and in some individuals opens out markedly. Protoconch not preserved but evidently The surface sculpture is very small.

elaborate and markedly variable on different individuals referred to the species. On the spire and the posterior part of the body whorl the dominant characters are the strong, coarse axial undulations which number about 12 on each whorl; posteriorly each rib is swollen into a coarse. node-like protuberance, the series of which produces the shoulder of the shell; posteriorly toward the suture the axials bend forward and tend to smooth off into thickened, undulating, narrow collar which closely borders the suture; on this collar are 2 or 3 small obscure spirals. On the body whorl the coarse axials fade out less than halfway to the basal sinus, and on some large shells show a tendency to fade out toward the aperture.

On the younger stages the conspicuous spiral sculpture consists of moderately strong, squarish-topped ribs, generally narrower than the interspaces; these ribs override the axials without diminution in strength; 7 or 8 spirals are exposed on the penultimate whorl. On the body whorl of adults the interspaces tend to widen out and small secondary ribs appear between the primaries, but this feature is irregular and variable on different individuals; on some shells the secondaries become as strong as the primaries before reaching the lip. The surface is further covered with numerous more or less obscure, fine spiral threads which cover both the spiral ribs and interspaces. Aperture elongate-subovate, with a pronounced anal channel, and with a short, deep, moderately wide twisted anterior canal. Outer lip thin below and thin or thick above, depending on its relation to the coarse axials, crenulated on the inner margin; inner lip broadly excavated, becoming thickly callused in adults. Umbilical fissure shallow. The area between the umbilical fissure and the spiral sulcus at the base of the body whorl is a broad, nearly flat-topped twisted ridge, crossed by rugose incrementals; on young shells this area is covered with 7 or 8 low spiral ridges. The columella bears a pronounced, round-crested oblique fold below, which borders the upper margin of the anterior canal.

Dimensions of the incomplete, nearly adult shell shown in plate 63, figure 1: Height 77+ mm., diameter 56 mm. Dimensions of a young shell (pl. 63, figs.

<sup>&</sup>lt;sup>884</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, pp. 375-376, pl. 93, figs. 8-11, 1923.

<sup>&</sup>lt;sup>385</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 282, 1876.

3, 4) whose apex is broken away: Height 27+ mm., diameter 21 mm. The largest shell in the collection is 37+ mm. high and 58 mm. in diameter.

The Texas shells referred to this species, about 16 individuals from three localitics, show considerable variation in form, ornamentation, and closeness of coiling, and in this respect they agree with the shells from the type locality at Coon Creck, Tennessee.

One adult shell from near Corsicana, Navarro County (763), exhibits a deep, wide sutural channel on the body whorl and an obscure development of shoulder nodes on the axials. Several young shells in the same lot are a little more finely sculptured than the shells of the same stage from the type locality, and they also show drooping shoulders. In view of the known individual variation within the species it seems best at present to refer these shells to *Seminola crassa*, but a better suite of specimens might justify their separation as a distinct variety.

*Types.*—Holotype and paratype, U.S.N. M. no. 32911.

Three plesiotypes from Texas, U.S.N.M. no. 77029.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, loc. of 3 plesiotypes);  $21\frac{1}{2}$  miles north of Corsicana (14114); ?vicinity of Corsicana (763).

Outside distribution.--Tennessee: Coon Creek tongue of Ripley formation at Coon Creek, McNairy County (holotype and paratype).

Range.—The species appears to be restricted to the lower half of the *Exogyra* costata zone of the Gulf region.

## SEMINOLA? sp.

# Pl. 62, figs. 6, 7

One incomplete body whorl of a small, probably juvenile, shell of *Seminola*, was obtained from the Neylandville marl on the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170). The body whorl indicates a much more slender form than that of *S. crassa* Wade. In profile the body is broadly and acentrically rounded, the greatest inflation being above the midheight of the whorl; the surface, however, droops away from the suture with only an obscurely developed shoulder; a shallow, spiral sulcus on the upper part of the whorl produces a narrow, obscure collar. The spiral sulcus at the base of the body, which characterizes the genus, is sharply incised. The axials, though similar to those of S. crassa, lack the shoulder nodes, and extend down over the body nearly to the basal sulcus. The spirals are similar to those of S. crassa, but even at this apparently young stage they alternate in size except as noted below; the primary spirals are narrow, with a subsquarish top, and number about 13 on the body whorl; one small secondary spiral is present in each of the interspaces, with the exception of one on the most inflated part of the shell, and two higher on the shoulder. The aperture is elongated, with a shallow anal channel above, and a rather wide, deep, twisted, siphonal channel in front. Outer lip thin and crenulated on its inner margin; inner lip poorly preserved but apparently broadly excavated and thinly callused. Anterior fasciole broadly rounded and rather obscurely striated. Dimensions of the one incomplete shell: Height 9+ mm., diameter 5 mm. U.S.N.M. no. 77030.

# SEMINOLA sp.

An internal mold belonging to Seminola, from the Kemp clay of the Navarro group, in a ditch along a public road 2 7/8 miles west-southwest of Staples, Guadalupe County (10878), is too poorly preserved for specific identification, but it shows the characteristic spiral sulcus at the base of the body whorl; numerous short axials ornament the upper part of the body whorl and the penultimate whorl. U.S.N.M. no. 77031.

# Genus HYDROTRIBULUS Wade

### HYDROTRIBULUS ASPER Stephenson, n.sp.

### Pl. 63, figs. 9, 10

Shell large, thick, rugged. Spire moderately high; the holotype is slightly deformed mechanically but the spiral angle appears to be 55 or 60 degrees. The protoconch and about two of the succeeding whorls are broken away on the holotype. Whorls 4 (estimated), increasing rapidly in size; shoulder sloping, broadly excavated, forming a marked angle with the side below. Suture undulating, closely

appressed, deeply impressed. Periphery scarcely subangular; below the periphery the base becomes rather sharply constricted, but rounds broadly into the canal The surface sculpture is coarse below. and vigorous. The axials are broad and round-crested, but are very irregular in width especially on the body whorl; the interspaces are also very irregular in width, ranging from narrower to wider than the axials; the axials number 15 or 16 on the body whorl and on the penultimate whorl; each axial is coarsely nodose on the shoulder angle, but becomes very faint where it crosses the shoulder above; both the axials and the growth lines bend strongly forward as they cross the shoulder to the suture: the axials extend well down over the base, fading out gradually as they reach the upper end of the anterior canal; toward the outer lip of the holotype the axial sculpture passes into a broad band marked by vigorous growth lamellae. The spiral sculpture consists of faintly bifid, squarish-topped ribs of only moderate strength, which override the axials and which are separated by much wider interspaces; a small secondary rib appears in one of the interspaces on the base of the type; 12 or 13 primary spirals appear on the body whorl, the four uppermost of which are exposed above the anterior suture on the penultimate whorl; very fine, obscure spiral lines appear over most of the shell.

Aperture broadly subovate; anal canal shallow, bordered in front by a broad, low, obscure ridge; anterior canal deep, rather narrow, strongly twisted. Outer lip thick, coarsely lamellose; inner lip broadly excavated, forming a thick polished callus over the base and columella, but thinning out abruptly in front. In the adult a prominent oblique fold borders the anterior canal near the aperture, but this fold becomes less prominent as it passes back into the shell. Umbilical fissure glazed over, but reflected as a shallow depression.

Dimensions of the incomplete holotype: Height 67+ mm., diameter 47 mm.

On the available material both the apex and the anterior canal are incomplete. Compared with *H. nodosus* Wade,<sup>386</sup> this species is much larger and has a proportionately higher spire and longer body whorl; the sculpture is also much less nodose at the intersections of the axial and spiral ribs.

Types.—Holotype, U.S.N.M. no. 77032; 2 unfigured paratypes, U.S.N.M. no. 77033.

Distribution in Texas.—Navarro group, Kemp clay: Branch 6½ miles southwest of Currie (14139, 17377; type loc.); ?west of Zuehl (7720, 7721).

# Genus TRYONIA Stephenson, n.gen.

Type species .-- Tryonia valida Stephenson.

Etymology.—In honor of the distinguished conchologist, George W. Tryon, Jr.

Shell large, thick, rugged. Spiral angle 65 to 70 degrees. Height of spire less than the length of the aperture. Suture deeply impressed. Whorls 5 or 6, rapidly increasing in size, each with a narrow, but conspicuous squarish shoulder, and a tumid, rugose collar; sides of whorls broadly convex, subvertical; body whorl broadly rounded on the periphery, broadly excavated at the base. Axials rather subdued, irregular and numerous; they are noded at the shoulder angle and cross the shoulder to the suture in an obscure and irregular fashion; they become weaker downward and die out on the lower slope of the base. The surface of the body whorl from the shoulder angle downward to the base bears 10 or 11 strong, squarishcrested spirals, separated by interspaces of equal or greater width; several narrow, obscure spirals appear on the anterior canal. The growth lines are vigorous, and indicate a narrow, shallow notch at the shoulder angle; they bend strongly forward and cross the shoulder to the suture in a sinuous manner. Aperture lenticular, with a deep, acute anal sinus at the rear and a short, profound, anterior canal, bent strongly to the observer's left. The inner lip is broadly excavated centrally, and forms a thin callus over the middle and lower parietal wall and a thick ridge of callus just below the anal canal. Columella sturdy, twisted, broadly swollen at the upper margin of the anterior canal.

<sup>&</sup>lt;sup>286</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 147, pl. 51, figs. 6, 7, 1926.

This genus appears to have a family relationship with *Hydrotribulus* Wade<sup>387</sup> and *Stantonella* Wade.<sup>388</sup>

#### TRYONIA VALIDA Stephenson, n.sp.

# Pl. 62, figs. 8, 9

Shell large, thick, rugged. Protoconch and 2 or 3 apical whorls broken away. Spiral angle about 67 degrees. Whorls 5 or 6, the body whorl large and noticeably longer than the height of the spire. The body whorl exhibits a narrow, squarish shoulder, surmounted by a broad, subvertical, tumid, rugose collar, and these features extend with gradually lessening distinctness to the apex. Suture deeply impressed. In contour the body whorl is subvertical above just below the shoulder and rounds down very broadly to the broadly excavated base. Axials nonprominent and irregular in strength, especially on the body whorl; they bear dull, elongated nodes at the shoulder angle and cross the shoulder above as obscure. low ridges of irregular strength; the axials become gradually weaker as they pass from the shoulder angle down over the base and practically disappear as they reach the bottom of the basal excavation; the axials number 20 on the body whorl, 18 on the penultimate, and 15 on the antepenultimate. From the shoulder angle down to the base the body whorl bears 10 or 11 strong, squarish-topped spirals, separated by interspaces of equal or greater width, and several narrow, obscure spirals appear on the anterior canal; the spirals override the axials; 4 of the spirals are exposed on the penultimate whorl; spirals are wanting on the shoulder and collar. The vigorous growth lines cross the body whorl in a broad curve convex toward the aperture but bend sharply forward at the shoulder angle and cross the shoulder and collar in a sinuous trend; they indicate a shallow, narrow notch at the intersection of the shoulder angle with the outer lip. The aperture is lenticular and ends posteriorly in a deep, narrow anal canal; anteriorly the aperture is extended in a short, profound canal of moderate width

which is bent sharply to the left as viewed from the front. The outer lip is broadly convex and is slightly notched at the shoulder angle. Inner lip broadly excavated at the base of the shell; it forms a thin callus over the parietal wall, except near the anal canal where the callus thickens to a low, round ridge. Columella stout, twisted, and broadly swollen at the border of the anterior canal.

Dimensions of the holotype: Height 73 + mm., diameter 42 mm.

This fine sturdy shell is known only from one slightly incomplete individual and another fragment of a spire.

Types.—Holotype, U.S.N.M. no. 20890; 1 unfigured paratype, U.S.N.M. no. 77034.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, holotype); 2½ miles north of Corsicana (14114, paratype).

# Genus DEUSSENIA Stephenson, n.gen.

Type species.—Deussenia ciboloensis Stephenson. Etymology.—In honor of Mr. Alexander Deussen, the Texas geologist who discovered the locality of the type species on Cibolo Creek.

Shell of medium size, thick. Spire of medium height; spiral angle about 55 degrees. Collar well differentiated, bordered below by a narrow shoulder. A notch is wanting at the extreme posterior part of the outer lip, but a broad shoulder notch marks the intersection of the shoulder bench with the outer lip. Axial and spiral ribs numerous and of medium to prominent development, the axials dying out on the middle or lower part of the base. Columella apparently smooth but with a broad swell bordering the anterior canal. In general form this shell resembles Volutomorpha but it has a shorter body, is more densely ornamented, has a more prominent shoulder, an apparently smooth columella, and lacks a notch at the suture. All four of the named species of this genus occur in the Kemp clay of the Navarro group.

# DEUSSENIA CIBOLOENSIS Stephenson, n.sp.

# Pl. 64, figs. 13, 14

Shell of medium size, thick. Spire of medium height, about two-fifths the total height of the shell; spiral angle about 55

<sup>&</sup>lt;sup>387</sup>Wade, Bruce, U. S. Ceol. Survey Prof. Paper 137, p. 146, 1926.

<sup>&</sup>lt;sup>358</sup>Op. cit., p. 127.

degrees. Protoconch not preserved. Suture deeply impressed. Whorls 5 or 6; body whorl elongated, moderately plump, with the greatest inflation at the shoulder angle; the surface slopes gently from the shoulder to the periphery, below which it descends more steeply to a very broadly excavated base; the upper part of the body whorl is sharply constricted, to form a steeply sloping, tumid collar 4 to 5 mm. wide, bordered below by a narrow, prominent shoulder formed by the upper ends of the axials.

The body whorl bears 18 thick, roundcrested, nearly direct axials separated by slightly narrower interspaces; the axials end at the shoulder in pronounced, coarse nodes, but each axial is reflected in a low swell across the collar above; the axials are most prominent above, at and just below the shoulder, and die out rather quickly on the base below the periphery. Eleven rather thick, moderately prominent, closely spaced spirals ornament the body whorl from the shoulder down to the basal excavation; these override the axials; these spirals are followed in the basal excavation below by 3 or 4 weaker, more widely spaced spirals with small obscure secondary ribs in the interspaces; small, closely spaced spirals cover the outer surface of the anterior canal: the collar bears 3 or 4 relatively weak spirals; on the penultimate whorl 5 or 6 spirals are exposed between the shoulder angle and the suture below.

Aperture elongate-lenticular, with an acute posterior sinus and a narrow, deep, slightly twisted siphonal canal of medium length at the front. Outer lip broadly arched with a shallow notch marking the intersection of the shoulder bench with the outer lip; inner lip very broadly excavated and forming a callus which is very thin over the parietal wall except in the vicinity of the anal canal above, where it becomes noticeably thicker. The lower part of the columella is swollen, but no pronounced fold is visible from the aperture.

Dimensions of the holotype which is slightly defective at each extremity: Height 70-- mm., diameter 35 mm.

Holotype.--- U.S.N.M. no. 77036.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7721, type loc.); ?near Deatsville (764).

## DEUSSENIA TRAVISANA Stephenson, n.sp.

## Pl. 63, figs. 5-8

This species is based on one slightly crushed specimen which is incomplete at its anterior extremity. It is similar to D. ciboloensis but differs in the following features: The axial ribs are more numerous and more crowded, a little more prominent and irregular, and extend farther down over the base of the body whorl, and lack the prominently developed nodes at their upper extremities; the axials number about 20 on the body whorl; the spiral ribs are thicker and more prominent, and are more coarsely developed in the basal excavation of the body whorl; the body whorl is not quite so elongated; the collar stands more nearly vertical and is more coarsely sculptured. One small secondary spiral is present in each interspace between the primary spirals on the basal slope of the body whorl.

Dimensions of the incomplete holotype: Height 50+ mm., diameter (estimated) 30 mm.

*Types*—Holotype, U.S.N.M. no. 77037; 1 paratype, U.S.N.M. no. 77035.

Distribution in Texas. --Navarro group, Kemp clay: 134 miles north-northwest of Deatsville (14126).

## DEUSSENIA MULTILIRAE Stephenson, n.sp.

# Pl. 62, figs. 3-5

This species is also similar in form and sculpture to Deussenia ciboloensis, but differs in the lesser prominence of the shoulder bench, and in the greater number of both axial and spiral ribs; the spire is also shorter, the spiral angle being about 70 degrees near the apex, decreasing to 60 degrees on the larger whorls. The axials are irregular in their development nd number about 27 on the body whorl; they die out rather quickly on the base of the body whorl and lack prominent nodes at their upper ends. The steeply sloping collar bears 4 spirals, and the body below bears 18 rather closely

crowded, round-topped spirals of medium strength; the spirals override the axials and produce a cancellated appearance.

Dimensions of the incomplete holotype: Height 52+ mm., diameter 34 mm.

*Types.*—Holotype, U.S.N.M. no. 77038; one young paratype, U.S.N.M. no. 77039.

Distribution in Texas.—Navarro group, Kemp clay: Near Deatsville (764, type loc.); 2 2/5 miles southeast of Manor (18196).

## DEUSSENIA CORBIS Stephenson, n.sp.

### Pl. 62, figs. 1, 2

This species is more like Deussenia multilirae in form and sculpture than it is like *D. ciboloensis*. The axial sculpture is, however, not so dense, the ribs numbering only 21 on the body whorl. The collar is narrower and more convex in cross section, the exposed portion of the penultimate whorl is wider, and the suture is more deeply impressed. The principal spiral ribs override the axials, are moderately thick, and are round-topped; the interspaces are as wide or narrower than the ribs: the collar bears 4 small spiral ribs and the body whorl below the collar about 20 spirals, the anterior 5 or 6 of which are small and closely spaced; 4 spirals are exposed between the suture below and the collar above on the penultimate whorl. The columella is smooth and is straight as far forward as it is preserved in the holotype.

Dimensions of the incomplete holotype: Height 42+ mm., diameter 30 mm.

Holotype .--- U.S.N.M. no. 77040.

Distribution in Texas.—Navarro group, Kemp clay: 2 miles northwest of Deatsville (14128).

### Family FUSIDAE

#### Genus FUSUS Lamarck

# FUSUS? ROBERTSI Stephenson, n.sp.

# Pl. 64, figs. 15, 16

This species is based on one incomplete shell the spire of which is well preserved with the exception of the protoconch and one or two apical whorls which are broken away; part of the body whorl and the anterior canal are also broken away. Shell of medium size, turreted, slender. Spiral angle about 25 degrees. Whorls 7 or 8, gradually increasing in size, broadly rounded on the sides. Suture closely appressed, moderately impressed. Each whorl is constricted above to form a narrow, slightly tumid collar, below which is a narrow unobtrusive shoulder; the periphery of the body whorl is broadly rounded, below which the base is sharply The axials are broad, low constricted. and broadly rounded on their crests; they do not extend across the collar above; on the body whorl they die out as they pass down over the base, and tend to smooth out toward the outer lip of the aperture; the interspaces are narrower than the axials; the axials number 12 on the penultimate whorl and 11 on the smaller whorls on which they can be The body whorl from the counted. shoulder down is ornamented with 15 or more distinct squarish-topped spirals which override the axials, and differ in width and spacing; those on the inflated part of the shell are widest and are slightly narrower than the interspaces; those on the base are much narrower, and about as wide as the interspaces; 5 or 6 of the main spirals are exposed on each whorl of the spire between the shoulder and the suture below; the collar is adorned with 4 still smaller, squarishtopped, sharply differentiated spirals which are slightly narrower than the interspaces. The columella appears to be smooth.

Dimensions of the incomplete holotype: Height 29+ mm., diameter 11.5 mm.

Holotype.--U.S.N.M. no. 77041. Named for the Hon. Oran M. Roberts, Governor of Texas, 1879-1883.

Distribution in Texas.—Navarro group, Nacatoch sand: Field 3/5 mile west of Kaufman (14103).

# Unidentified specimens of FUSUS

Impressions of badly crushed shells, questionably referred to *Fusus*, have been found in the Corsicana marl as follows:

Pit of Corsicana Brick Company, 2 miles south of the courthouse at Corsicana, Navarro County (16167); this is a slender fusoid shell about 34 mm. high and 9 mm. in diameter, having a long anterior canal, and both axial and spiral sculpture well developed. U.S.N.M. no. 77012.

Mexia highway at forks of Wortham road 2 4/5 miles east-southeast of Cooledge, Limestone County (14137); this shell is 21-4- mm. high and 6 mm. in diameter, with a moderately long anterior canal, rather coarse axial ribs, and finer spiral ribs. U.S.N.M. no. 77043.

## Genus ANOMALOFUSUS Wade

This genus is questionably referred to the Fusidae.

## ANOMALOFUSUS BELLULUS Stephenson, n.sp.

### Pl. 64, figs. 5-7

Shell of moderate size, fusiform. Spiral angle about 45 degrees in the holotype, but ranging from 38 to 50 degrees in other shells referred to the species. Protoconch trochoid, smooth, coiled  $2\frac{1}{2}$  or 3 times; the first half is quite small and flattish, beyond which the shell expands rapidly. Whorls 5 in adults, broadly rounded on the sides, with a shallow spiral constriction (anal fasciole) just below the suture; body whorl of moderate size, aperture about equal in length to the spire. Periphery broadly rounded. Suture closely appressed, deeply impressed. The sculpture consists of relatively coarse axials, and fine overriding spirals. The axials number 17 on the body whorl of the holotype, and 22 on the penultimate whorl; they are moderately prominent though very irregular in strength, round to subangular on the crest, and in general are about equal in width to the round-bottomed intercostal spaces; they trend first upward and a little backward, but bend sharply forward where they cross the anal fasciole above; on the fasciole they vary greatly in strength on different individuals; on the body whorl they die out irregularly as they pass down over the base; at wide and irregular intervals intercostals are swollen to form varices which range in prominence from weak to strong. The spiral sculpture consists of relatively large widely spaced primaries and numerous small secondaries and tertiaries; there are at least 10 primaries on the body whorl and 4 are exposed on the penultimate whorl; the uppermost one marks the shoulder. On many specimens the secondaries and tertiaries show a tendency to become coequal in strength on the upper parts of the whorls of the spire, a feature which, however, is exceedingly variable on different individuals; the spiral sculpture is well developed down over the base of the body whorl and out onto the beak; the anal fasciole is covered with small spirals which, on the larger whorls, tend to alternate in strength: the first primary below this band is a little stronger than the succeeding ones below it, and tends to produce a faint shoulder angle. Aperture lenticular, acutely angular at the rear, and produced anteriorly into a slightly twisted canal which, though not complete in the available material, is probably of only moderate length. Outer lip thin, with a broadly curved shoulder notch which varies in depth on different individuals and at different stages of growth on the same individual, as shown by the incrementals. Inner lip broadly excavated and forming a thin callus over the parietal wall and pillar. Columella slightly twisted and apparently without folds.

Dimensions of the incomplete holotype: Height 23+ mm., diameter 2 mm.

Compared with Anomalofusus substriatus Wade,350 this species is less slender, and more finely sculptured; the two species are, however, very closely related. One specimen in the collection is larger than Wade's largest specimen. The individuals referred to the species exhibit considerable variation in form and sculpture, but no satisfactory basis for subdividing them is afforded by the available material. Anomalofusus appears to be closely allied to Trachytriton Meek from the Pierre shale of the Western Interior, but it is probably distinct. Meek generically included Trachytriton in the family Tritonidae (= Nyctilochidae Dall).

*Types.*—Holotype, U.S.N.M. no. 77044; 1 figured paratype, U.S.N.M. no. 77045; 2 unfigured paratypes, U.S.N.M. no. 77047; 2 unfigured paratypes, U.S.N.M. no. 77016.

Distribution in Texas.—Navarro group, Neylandville marl: Corsicana road,  $2\frac{1}{2}$ miles north of Corbet (17365, Tex. Bu. 17300).

<sup>&</sup>lt;sup>389</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 126, pl. 44, figs. 5-7, 1926.

Navarro group, Nacatoch sand: North edge of Corsicana (518); vicinity of Corsicana (763); 4 miles north of Corsicana (17366); vicinity of Chatfield (762, type loc.); vicinity of Kaufman (761); road 2 miles southwest of Kaufman (7546); 3/5 mile west of Kaufman (7545).

## ANOMALOFUSUS sp.

A fragment of a rather small specimen of Anomalofusus, from the Neylandville marl on the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (16170), includes the lower part of the body whorl and the canal. The latter is moderately long and slightly twisted, and the sculpture is similar to that of A. substriatus Wade, but the shell is too incomplete for specific identification. U.S.N.M. no. 77048.

#### ANOMALOFUSUS? sp.

An incomplete crushed internal mold with the sculpture impressed upon it, from the Corsicana marl, in a westwardfacing bluff on Guadalupe River, 1 3/10 miles north of McQueency, Guadalupe County (7637), is questionably assigned to the genus Anomalojusus Wade. The cast exhibits rather narrow, widely spaced axial ribs, overridden by very fine spirals which tend to alternate in size over most of the surface; a few widely spaced ribs are a little larger than any of the intermediate ones. In form and sculpture the specimen bears some resemblance to A. substriatus Wade from Coon Creek, Tennessee.390 The dimensions of the incomplete specimen are: Height 22+ mm., approximate diameter 13 mm. U.S.N.M. no. 77049.

#### Genus ALIOFUSUS Stephenson, n.gen.

# Type species.—Aliofusus reagani Stephenson. Etymology.—Latin alius, another; Fusus.

Shells like those here referred to the new genus *Aliofusus*, and related shells which should doubtless be treated as closely allied genera, have been referred to Conrad's genus *Pyrifusus* by several authors. *Pyrifusus subdensatus* Conrad, the genotype of Conrad's genus, has a much lower spire, a different type of shoulder, a more expanded body, and much stronger spiral sculpture.

Aliofusus is subfusiform with spire shorter than the length of the aperture. Whorls probably about 5. The body whorl is moderately expanded and has a well developed sloping shoulder with a shallow spiral sulcus above, and a narrow slightly tumid collar bordering the suture. The axials are numerous, moderately prominent, and subnodose on the shoulder angle: from this angle the axials trend in a broad curve, down over the body, convex toward the aperture, gradually becoming weaker and dying out in a broad constriction at the base. The uppermost prominent part of each axial is well exposed on the penultimate whorl. The whole shell is covered with fine spirals which are relatively coarser on the base than elsewhere. The aperture is elongate-ovate with an acute anal canal at the rear and a moderately long, somewhat twisted siphonal canal at The outer lip is thin with a the front. broad notch at the shoulder; the inner lip is broadly excavated and forms a thin callus on the parietal wall. The columella is smooth, slightly twisted and slightly swollen just above the anterior canal.

The shell from Brightseat, Maryland, which Gardner<sup>391</sup> named *Pyrifusus monmouthensis*, appears to be congeneric with *Aliofusus*. It has a narrower and deeper constriction on the shoulder, and is more distinctly nodose on the collar bordering the suture.

Specimens in the collections of the U.S. National Museum from the Ripley formation, Eufaula, Alabama, and from Union County, Mississippi, labelled *Strepsidura interrupta* Conrad and *Fusus* sp., probably belong to this genus; they also have distinctly noded collars.

# ALIOFUSUS REAGANI Stephenson, n.sp.

### Pl. 64, figs. 8, 9

Shell of medium size, subfusiform, somewhat stout. Protoconch and one or two apical whorls broken away. Spire of medium height, but shorter than the length of the aperture; spiral angle about 60 degrees. Whorls 4 or 5, increasing in size with moderate rapidity; a distinct

<sup>301</sup>Gardner, Julia, Maryland Geol, Survey, Upper Cretaceous (2 vols.), p. 459, pl. 16, figs. 5, 6, 1916.

<sup>&</sup>lt;sup>300</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 126, pl. 44, figs. 5-7, 1926.

shoulder is formed by a broadly excavated band below the suture; a narrow, obscurely developed, slightly tumid collar bordering the suture bears weak nodes which appear to be independent of the axials; the suture is sharply impressed along the upper border of this collar; the body whorl is very broadly rounded on the periphery and becomes broadly constricted at the base. The body whorl bears 17 axials which are most prominent at the shoulder angle where they are coarsely subnodose; they trend a little backward from below upward; the axials die out abruptly above along the lower border of the shoulder but they fade out gradually as they pass down over the base, being still faintly visible in the basal constriction; the axials decrease in number on the successively smaller whorls, numbering 15 on the penultimate and 13 on the antepenultimate. The entire surface is covered with fine spiral lirae of irregular strength which tend to alternate in size; the lirae are coarsest on the lower slope of the body whorl. The aperture is elongate-subovate, ending posteriorly in a deep acute anal channel and anteriorly in a narrow, slightly twisted, siphonal channel of medium length, which is incomplete in the holotype. The outer lip is broken away, but is broadly notched at the shoulder as shown by the growth lines. The inner lip forms a thin callus over the parietal wall. Columella smooth and slightly twisted.

Dimensions of the holotype: Height 29+ mm., diameter 17 mm.

The two varieties, *subtilis* and *tumidus*, described below, from the same locality as *reagani* (761), present differences which seem to justify their recognition under separate names; however, the typical form and the two varieties are each represented only by single specimens and it is possible that, with large suites of specimens available for comparison, sufficient individual variation might be found to render their separation unnecessary.

Holotype.- -U.S.N.M. no. 77050. Named for the Hon. John H. Reagan, a former Congressman who assisted Major J. W. Powell in founding the United States Geological Survey.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

### ALIOFUSUS REAGANI SUBTILIS Stephenson, n.var.

## Pl. 64, figs. 11, 12

This variety is very much like the typical *A. reagani*, but is noticeably less slender, and has finer axial sculpture; the axials are more closely spaced and number 23 on the body whorl and about 19 on the penultimate whorl. The shoulder nodes are a little more prominent, thus producing a more pronounced shoulder angulation. The columella is more swollen just above the anterior canal. The fine spiral sculpture appears to be essentially identical with that on the typical *reagani*.

Dimensions of the incomplete holotype: Height 27-+ mm., diameter 17.5 mm.

Holotype.--U.S.N.M. no. 77051.

Distribution in Texas.- Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

## ALIOFUSUS REAGANI TUMIDUS Stephenson, n.var

#### Pl. 64, fig. 10

One imperfect individual from near Kaufman is similar in axial sculpture to the typical *A. reagani*, but it has a lower spire, is more tumid, and has a broader and more steeply sloping shoulder, the collar of which appears to rise higher on the sides of the whorls of the spire.

Dimensions of the incomplete holotype: Height 25+ mm., diameter 18 mm.

Holotype.-U.S.N.M. no. 77052.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### ALIOFUSUS sp.

Two incomplete internal molds with the exterior sculpture imperfectly impressed upon them, from the Corsicana marl in a branch on the Wm. H. Moore Survey, 1/4 mile cast of the west line of the Survey, 100 yards south of the Missouri-Kansas & Texas R.R., about 5 miles east by north of Greenville, Hunt County (12924), are questionably referred to *Aliofusus*. Compared with the genotype they have much lower spires, coarser and stronger revolving sculpture, and thicker axials which

well preserved in the types. Suture deeply impressed. Body whorl large, moderately plump, broadly rounded in contour; the upper part of the whorl curves in rather sharply; in the larger of the two paratypes this curvature is strong enough to form a subangular shoulder, a feature which may be sexual. The base of the body whorl is bounded by a pronounced spiral sulcus which extends from the middle of the inner lip to the margin on the inner side of the outer terminus of the canal. Body whorl ornamented with 12 narrow, square-topped spiral ribs; the interspace between the two upper spirals is deeper and much wider than the other interspaces, which range in width from a little narrower to a little wider than the spirals; crossing the spirals are numerous rather closely spaced axial ribs which are a little less prominent than the spirals; the intersections of the spirals and axials are marked by squarish nodes. Four or five of the spirals are exposed the penultimate whorl. Aperture on elongate-ovate with a distinct anal notch and a short deep canal; upper edge of canal bordered by a narrow, prominent fold. Outer lip broadly arched and notched at the intersection of the ribs; inner lip broadly excavated, and forming a thin callus on the base of the shell. False umbilicus deep above, flaring out rather broadly below, bordered on the columellar side by a narrow, sharp ridge, and on the other side by a plumply rounded, twisted ridge; both this ridge and the inner surface of the umbilicus are spirally striated.

Dimensions of the holotype: Height 19 mm., diameter 12.5 mm.

The volutions of this varietal form are a little more plumply rounded, and the upper part of the body whorl exhibits a very much less pronounced shoulder than does the typical Morea marylandica The sculpture is much finer Gardner. than that of M. cancellaria and its varieties.

Cossmann<sup>383</sup> has proposed the subgeneric name Pseudomorea, with Morea marylandica Gardner as type, but a careful comparison of the Maryland species with Morea cancellaria fails to reveal differences that would seem to justify the erection of the subgenus.

Types.-Holotype, U.S.N.M. no. 77025; unfigured paratypes, U.S.N.M. no. 2 20916; 1 unfigured paratype, U.S.N.M. no. 77026.

Distribution in Texas.--Navarro group, Neylandville marl:  $?\frac{1}{2}$  mile north of Cooper (4064).

Navarro group, Nacatoch sand: North edge of Corsicana (518, holotype and 2 paratypes); vicinity of Corsicana (763, loc. of 1 paratype); vicinity of Kaufman (761).

Range.—Questionably from the Nevlandville marl upward into the Nacatoch sand of the Navarro group.

## MOREA MARYLANDICA LANGUIDA Stephenson, n.var.

## Pl. 61, figs. 3, 4

This variety resembles the species marylandica but has 9 instead of 11 spiral ribs, and has a decidedly more drooping shoulder, with scarcely a suggestion of a shoulder angle; these features produce a relatively coarser sculpture and a more slender contour. The shoulder of M. marylandica bella is narrower and less drooping and the sculpture is finer, the spiral ribs numbering 12.

Dimensions of the incomplete holotype: Height 14.4+ mm., diameter 9.7 mm.

Types.—Holotype, U.S.N.M. no. 77027; 1 unfigured paratype, U.S.N.M. no. 77028.

Distribution in Texas.-Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

## Family BUCCINIDAE?

## Genus SEMINOLA Wade

1917. Seminola Wade, Acad. Nat. Sci. Philadelphia Proc., vol. 69, p. 290.

1920. Ripleya Cossmann, Revue géologie anneé 1,

no. 9, p. 376. 1926. Seminola Wade, U.S.Geol. Survey Prof. Paper 137, p. 144. Type species.—Seminola crassa Wade.

If the recommendation of the International Commission of Zoological Nomenclature is to be followed, Wade is within his rights in retaining the name Seminola, since the name with which this one is supposed to be synonomous is Seminolus.

<sup>383</sup>Cossmann, M., Essais Paléoc. Comp., Liv. 13, p. 265, 1925.

13 on the penultimate whorl, and 11 on the antepenultimate whorl. Several of the earliest axials to appear on the whorl following the protoconch are simple and oblique. On the upper part of the body whorl fine obscure spirals can barely be detected: these grade downward into coarser but numerous spirals, which are most prominent and widely spaced about midway of the base, and become progressively finer and more obscure as they pass out toward the tip of the siphonal canal. Aperture elongate, sublanceolate, squarish above, with a small, narrow anal channel near the suture, passing anteriorly into a narrow siphonal channel of moderate length. Outer lip broadly arched above, becoming slightly concave below. Inner lip broadly excavated, forming a thin callus over the parietal wall. Columella bearing one moderately prominent, narrow oblique fold just above the siphonal channel, paralleled above by a small, weak fold.

Dimensions of the incomplete holotype: Height 36 + mm., diameter 16 + mm.

Because of its very narrow anal fasciole the species is referred questionably to *Bellifusus*. It is easily distinguishable from the other species of the genus by the pronounced tubercles terminating the upper ends of the axials.

Types.---Holotype, U.S.N.M. no. 77055; 1 figured paratype, U.S.N.M. no. 77056; 1 unfigured paratype, U.S.N.M. no. 77057.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (17365, 2 paratypes; Tex. Bu. 17300, holotype).

# BELLIFUSUS ROBUSTUS Stephenson, n.sp.

# Pl. 65, figs. 19, 20

Shell of medium size, fusiform, robust. Spire a little shorter than the length of the aperture; spiral angle about 55 degrees. Protoconch broken away in all specimens, but obviously small. Whorls 5, gently convex on the side, shouldered above. Suture undulating, closely appressed, deeply impressed. Shoulder narrow, deeply excavated, bordered above by a narrow, tumid, finely wrinkled collar, and below by a row of coarse axial

shoulder nodes. Axials prominent, thick, somewhat sinuous, and about equal in width to the interspaces; they terminate abruptly above in coarse, blunt shoulder nodes, and die out below about halfway down the base; they number 12 on the body whorl of the holotype, and decrease to 10 on the smallest whorl. On the upper part of the body whorl the spiral sculpture is relatively fine and obscure; the base below the ends of the axials is covered with 7 or 8 moderately prominent, flattish-topped spiral ribs separated by interspaces of about the same width; these ribs are not exposed on the whorls of the spire. Aperture elongate-lenticular, with a subacute anal canal at the rear and a moderately long, open, siphonal canal which is very slightly twisted and which narrows to the anterior tip. Outer lip broken away, but the growth lines indicate a broad shoulder notch. Inner lip broadly excavated at the base of the parietal wall; this lip forms a callus so thin that it does not conceal the spiral Columella slightly twisted and ribs. bearing one fold of medium strength and at least one additional weak fold above.

Dimensions of the holotype: Height 33 mm., diameter 15.5 mm.; the largest specimen in the collection has a diameter of 22.5 mm.

Compared with *Bellifusus curvicostatus* (Wade), this species has a slightly shorter spire and a higher, more angular, more distinctly noded shoulder; the axials are thicker and coarser and the posterior fasciole is more tumid.

*Types.*—Holotype, U.S.N.M. no. 77058; 10 unfigured paratypes, U.S.N.M. nos. 77059; 3 unfigured paratypes, U.S.N.M. no. 20948.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, holotype and 10 unfigured paratypes); vicinity of Corsicana (763, 3 unfigured paratypes).

# BELLIFUSUS TENUISTRIATUS Stephenson, n.sp.

### Pl. 65, figs. 7-9

Shell similar in size, form, and sculpture to *B. robustus*, with the following differences: The axials are not quite so thick and are scarcely noded on the shoulder, which is therefore less prominent and less angular; the collar is less tumid and is more finely striated; the spiral sculpture on the shoulder and on the inflated part of the shell is finer but is a little more sharply and distinctly developed, and the spirals on the base are finer, less prominent and more numerous; the principal fold on the columella is narrower and more prominent.

Dimensions of the holotype, which is partly broken away both at the apex and at the anterior extremity: Height 24 + mm., diameter 12.5 mm. A larger paratype is 15 mm. in diameter.

*Types.*—Holotype, U.S.N.M. no. 77060; 1 figured paratype, U.S.N.M. no. 77061; 2 unfigured paratypes, U.S.N.M. no. 77062.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

## BELLIFUSUS? DEATSVILLENSIS Stephenson, n.sp.

# Pl. 65, figs. 17, 18

In size and general form this species is similar to B. robustus, but it differs in details of sculpture and in other features. The holotype is mechanically somewhat deformed. The axials are more numerous (15 on the body whorl) and are narrower and more sharply angular on their The collar is less tumid and is crests. much less sharply differentiated from the shoulder slope below. There is a mere suggestion of nodes on the shoulder. The spirals are fine and as preserved are obscure on the shoulder and inflated part of the shell; they grade into coarser but still rather obscure spirals on the base. The columella is not sufficiently exposed to reveal a plait which, however, is probably present. The protoconch is gone and the shell is not quite complete on the anterior extremity.

Dimensions of the holotype: Height 36 + mm., diameter 16 mm. (estimated). *Holotype.*--U.S.N.M. no. 77063.

Distribution in Texas.—Navarro group, Kemp clay: Near Deatsville (764, type loc.); ?west of Zuehl (7721).

#### BELLIFUSUS? MULTICOSTATUS Stephenson, n.sp.

### Pl. 65, figs. 10, 11

Shell small, fusiform. Spire shorter than length of aperture; spiral angle about 50 degrees. Protoconch not preserved. Suture deeply impressed, bordered below by a narrow anal fasciole. The whorls number about 5 and are ornamented with closely spaced axials as follows: Body whorl about 25; penultimate whorl 16; antepenultimate whorl 12. Body whorl plump and broadly rounded above, broadly excavated on the basal slope. Nine or 10 obscure spirals are present on the middle and lower part of the basal slope; no spirals detected on the whorls of the spire as preserved. Aperture elongate, wide open above, narrow below, passing into a moderately long, narrow siphonal channel. Outer lip broadly arched above becoming broadly excavated below. Inner lip broadly excavated, most deeply above the middle, forming a thin callus on the parietal wall. Columella with one rather weak fold.

Dimensions of the incomplete holotype: Height 18 + mm., diameter 9.2 mm.

This species differs from B.? deatsvillensis, with which it is associated, in its smaller size and the greater number of its axial ribs.

*Type.*--Holotype, U.S.N.M. no. 77064. *Distribution in Texas.*--Navarro group, Kemp clay: Near Deatsville (764).

#### BELLIFUSUS? CRASSICOSTATUS Stephenson, n.sp.

# Pl. 65, figs. 5, 6

This species is based on one shell which consists of the body whorl with the anterior canal broken away, and about half of the penultimate whorl. This shell is similar in form to B.? deatsvillensis, but exhibits much coarser axial sculpture; there are only 10 axials on the body whorl and although these axials are thicker and less angular, the interspaces between them are wide. The spirals, as preserved, are obscure, but those on the base are relatively coarse. The collar is apparently not as sharply differentiated as on *B. robustus*, but it is not well preserved. The columella bears one moderately prominent fold.

Dimensions of the incomplete holotype: Height 27 + mm., diameter 17.5 mm.

Holotype .--- U.S.N.M. no. 21185.

Distribution in Texas.—Navarro group, Kemp clay: Near Deatsville (764).

# BELLIFUSUS BUFFALOENSIS Stephenson, n.sp.

# Pl. 65, figs. 12, 13

The one available specimen is of medium size and is incomplete at both ends; the anterior canal is wanting and the outer lip partly broken away. The shell includes the incomplete body whorl, the penultimate and the antepenultimate whorls. Spiral angle 42 degrees. Suture deeply impressed, undulating, bordered below by a collar of moderate width; collar gently undulating on the smaller whorls, passing below into distinct rounded nodes of irregular size on the body whorl; the nodes number about twice as many as the axials below. Axials moderately prominent, thick, round-crested, numbering 10 or 11 on each whorl; on the body whorl the upper end of each axial bears a nonprominent, narrow node elongated spirally; the axials fade out rather high on the basal slope. The spiral sculpture is obscure except on the basal slope which bears 5 or 6 weak, flattish ribs. Growth lines sinuous, broadly concave in trend toward the aperture on the upper part of the whorl. Aperture lanceolate, outer lip broadly arched, inner lip broadly excavated, thinly callused. Columella slightly twisted, bearing one narrow, nonprominent fold, with a much weaker fold above it.

Dimensions: Height 22.3 mm., diameter 13 mm.

Among the Navarro species of *Bellifusus* this one seems to be nearest to *B. crassicostatus* but its axial ribs are more numerous and less prominent.

Holotype.-U.S.N.M. no. 77065.

Distribution in Texas.—Navarro group. Kemp clay: 3½ miles north-northwest of Bazette, Navarro County (17375).

## BELLIFUSUS? sp.

## Pl. 64, fig. 4

A fragment which includes the imperfectly preserved protoconch and four additional whorls, found in the Neylandville marl on the Corsicana road,  $2\frac{1}{2}$  miles north of Corbet, Navarro County (17365), is similar in form and ornamentation to *Bellijusus curvicostatus* (Wade), the genotype of the species, from Coon Creek, Tennessee. The axials are prominent and slightly more numerous than in Wade's species, and five spirals can barely be detected in places. U.S.N.M. no. 77066.

#### BELLIFUSUS? sp.

## Pl. 65, figs. 15, 16

One small, incomplete shell, probably juvenile, found in the Nacatoch sand near Chatfield (762), has the sculpture well preserved, but is difficultly assignable either specifically or generically. The spire is relatively short and if complete at its present stage would exhibit 4 or 5 plump whorls. The protoconch and one or two apical whorls are broken away. The suture is closely appressed and deeply impressed. There is no well defined shoulder. The axials are thick and prominent and number about 10 on the largest whorl; they curve forward a little above and extend to the suture without interruption by an anal fasciole, and die out below well down on the base. The spirals are very fine and numerous on the upper part of each whorl but become relatively coarse on the lower part of the base and on the upper part of the anterior canal. No well defined fold is present on the exposed part of the columella, a fact which throws doubt on the assignment of this shell to Bellifusus. U.S.N.M. no. 77067.

## BELLIFUSUS sp.

## Pl. 65, fig. 14

Small internal molds of Bellifusus, with the external sculpture partly impressed upon them, were collected from two localities in the Corsicana marl, as follows: Branch below road,  $2\frac{1}{2}$  miles north of Tona siding, 5 miles southwest of Quinlan in Hunt County (15546, U.S.N.M. no. 77068); and Mexia road 23/4 miles east of Cooledge, Limestone County (13832, figured, U.S.N.M. no. 77069). The shells represent a species with a moderately high spire, which is a little shorter than the length of the aperture. The axials are narrow and sharp-crested and number 9 or 10 on a half turn of the body whorl; they fade out before reaching the base of the body whorl. The spirals on the main part of the body whorl are numerous, fine, and show a tendency to alternate in size; on the lower portion of the body whorl the spirals are markedly coarser and are more equal in size, but they again become small and crowded as they pass out onto the anterior canal.

### Genus ORNOPSIS Wade

The genotype of Ornopsis is O. glenni Wade.<sup>395</sup> The determinable Texas species here referred to this genus fall within the range of species included by Wade in the genus. They all possess a single fold situated low on the columella and a more or less bent or twisted siphonal canal, but compared with the genotype they are smaller, more slender, have thinner shells, and have less deeply excavated shoulders. Their striking difference in form from O. glenni suggests the possible desirability of erecting a new subgenus or even a new genus to contain them. They are, however, closely congeneric with Wade's species clevata and digressa.

#### **ORNOPSIS PULCHRA Stephenson**, n.sp.

#### Pl. 66, figs. 7-9

Shell of medium size and of elegant form and ornamentation. Spire elevated, its altitude being a little less than the length of the aperture; spiral angle about Protoconch broken away. 45 degrees. Whorls 6, moderately inflated on the side, gradually expanding. Suture deeply impressed. Posteriorly the body whorl presents a broad, steeply sloping shoulder which meets the main surface below at a wide obtuse angle; the posterior fasciole forms a narrow collar below the suture and is bordered below by a shallow, spiral excavation, which becomes a little more pronounced toward the aperture; the shoulder continues well developed on the penultimate and antepenultimate whorls, but gradually becomes obscure on the apical whorls. The periphery is represented only by a broadly rounded, obscurely defined swell, below which the base is noticeably constricted. The body whorl of the holotype bears 13 short, strong axials on its most inflated part, each axial

being bluntly noded on the shoulder angle; the axials continue well developed on the whorls of the spire, but decrease in number posteriorly, there being only 8 on the smallest whorl on which they can be counted; on the whorls of the spire all but the small, lower end of each axial is uncovered. The whole surface of the shell is covered with small, narrow, nearly flat-topped spiral costae; on the shoulder these are smaller than elsewhere and tend to alternate in size; the coarsest spirals appear on the most inflated part of the body whorl where they override the axials and tend to alternate in size; in a broad band on the base the spirals are of subequal size, but lower on the constricted part of the shell and out on the long canal they again tend to alternate in size.

Aperturc subovate, with a narrow, deep anal canal at the rear, and a long, narrow, slightly curved siphonal canal at the front. Outer lip thin and broadly notched at the shoulder margin; this notch is reflected in the strongly curved trend of the growth lines where they cross the shoulder band. Inner lip broadly excavated and forming a thin callus over the parietal wall and pillar. Columella smooth above, and bearing a sharp, prominent, oblique plait at the upper border of the anterior canal.

Dimensions of the holotype, which lacks the protoconch and the tip of the anterior canal: Height 44 + mm., diameter 18 mm.

The genotype of Ornopsis is O. glenni Wade.<sup>396</sup> In its essential generic characters O. pulchra agrees well with the genotype, except that it is much more slender and in this respect agrees more closely with O. elevata Wade,<sup>397</sup> which, however, has a narrower and more deeply excavated shoulder and differs in other details.

*Types.*—Holotype, U.S.N.M. no. 77071; 1 figured paratype, U.S.N.M. no. 77072; 2 unfigured paratypes, U.S.N.M. no. 20950.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); 4 miles north of Corsicana (17366); vicinity of Chatfield (762).

<sup>&</sup>lt;sup>305</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 126, 1926.

<sup>&</sup>lt;sup>200</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 126, pl. 44, figs. 8, 9, 12, 13, 1926.

<sup>&</sup>lt;sup>307</sup>Wade, Bruce, op. cit., p. 127, pl. 44, figs. 10, 11; pl. 45, figs. 1, 2.

## ORNOPSIS SOLISTELLA Stephenson, n.sp.

## Pl. 66, figs. 5, 6

This species is similar in form and ornamentation to O. pulchra, but differs in The shoulder is narrower and details. more deeply excavated; the axials are fewer, thicker, a little more prominent and extended upward nearly across the shoulder; they number 10 on the body whorl. The spirals, though similar in kind, are somewhat finer and less prominent; the alternation in the size of the spirals extends over the entire base. The apical whorls are poorly preserved and the protoconch is gone. The columella is badly crushed, but the characteristic plait at the upper border of the anterior canal is distinguishable.

Dimensions of the imperfect holotype: Height 31 + mm., diameter about 15 mm.

Types.—Holotype, U.S.N.M. no. 77073; 1 unfigured paratype, U.S.N.M. no. 77074.

Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637, type loc.); ?1/2 mile below Martindale (15526); ?1 4/5 miles N. 20° W. of Tona siding (15545); ?3 7/10 miles southwest of Campbell (15547).

# ORNOPSIS? MAXEYI Stephenson, n.sp.

#### Pl. 66, figs. 3, 4

Shell small, fusiform. Spire elevated, spiral angle about 45 degrees; height of spire a little less than the length of the aperture. Protoconch broken away. Whorls 5 or 6, broadly convex on the side; body whorl moderately inflated; shoulder steeply sloping, broadly excavated, with an ill-defined shoulder angle; periphery very broadly rounded, base gently sloping. Suture closely appressed, moderately impressed. Axials strong on the body inflation, becoming weak where they cross the shoulder above, and dying out well down on the base below; the axials are sinuous, being broadly concave toward the aperture above, and broadly convex in the same direction below on the base; the axials are rather wide apart, numbering 11 on the body whorl, 11 on the penultimate, and 9 on the antepenultimate. The spiral sculpture is exceedingly weak, being barely discernible on the base of the holotype and slightly stronger on the paratype. Aperture elongate-subovate; anal canal subacute, siphonal canal moderately long, narrow, slightly twisted. Outer lip broken away; inner lip broadly excavated, forming a callus of medium thickness over the parietal wall. Columella slightly twisted, bearing a pronounced, oblique plait just above the canal.

Dimensions of the incomplete holotype: Height 17 + mm, diameter 8 mm.

This species is even more slender than O. pulchra and its spiral sculpture is more subdued than that of any other species referred to Ornopsis. The shoulder is steeper and the growth lines cross it more directly than in other species. The pronounced plait on the columella seems to ally the species rather closely with Ornopsis, but the other differences noted probably justify its recognition as a subgenus, or perhaps even as a distinct genus.

Types.—Holotype, U.S.N.M. no. 77075; 2 unfigured paratypes, U.S.N.M. no. 77076. Named for the Hon. Samuel Bell Maxey, a former United States Senator from Texas, whose influence aided in the establishment of the U.S. Geological Survey.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### Unidentified specimens of ORNOPSIS

Specimens questionably referred to Ornopsis have been found in the Nacatoch sand at the localities indicated below; they are too incompletely or too poorly preserved to serve as types of new species.

Two incomplete specimens from a field north of the Dallas road, 3/5 mile west of Kaufman, Kaufman County (14103), are similar to O. pulchra but differ from it in details of sculpture. One of the specimens (pl. 66, fig. 2), which includes parts of the body and penultimate whorls, has 12 somewhat elongated axials and very fine spirals which, on the body whorl, cover the surface from the suture down over the shoulder angle nearly to the base of the axials; on parts of the surface these fine spirals tend to alternate in size; the rest of the base exhibits relatively much coarser primary spirals, between each two of which is one fine secondary; on the penultimate whorl only the uppermost one of the larger primaries is left uncovered by the inclosing upper margin of the body

whorl. The other specimen, which includes only part of the body whorl, is similar to the first, except that the spiral sculpture is much more weakly developed, the upper part of the whorl being nearly smooth. U.S.N.M. no. 77077, 77078.

A fragment (pl. 66, fig. 10) from near Kaufman (761), which includes most of the body whorl, has small short axials which are little more than a row of nodes on the shoulder angle; weak obscure spirals appear over the rest of the surface which has a nearly smooth appearance; the columella is noticeably twisted and hears one moderately prominent fold at the upper border of the anterior canal; this appears to be a distinct species. U.S. N.M. no. 21014.

A specimen from the Corsicana marl, on San Marcos River, ½ mile below Martindale, Caldwell County (15526, U.S.N.M. no. 77079), is similar in form to O. solistella, except that the shoulder is higher and more prominent; it is an internal mold with the sculpture obscurely impressed upon it. A similar internal mold was found in the same formation in a public road, 14% miles N. 20° W. of Tona siding, in Hunt County (15545, U.S.N.M. no. 77080); it does not show the sculpture.

A fragment (pl. 66, fig. 1) consisting of the well preserved protoconch and 41/2 whorls of the spire of Ornopsis? was obtained in the Kemp clay on Colorado River at Webberville, Travis County (7601).The protoconch is a small, smooth conical shell of 3 volutions having an apical angle of about 55 degrees. The larger whorls of the spire present 12 strong axials similar to those of Ornopsis; these are reduced to 10 or 11 on the smaller whorls. The spiral sculpture is finer than that of the other Texas species of the genus, but resembles that of O. digressa Wade<sup>398</sup> from Coon Creek, Tennessee. The spirals increase in number from the smaller to the larger whorls, the new ones first appearing as secondaries between the primaries, but gradually increasing in size until they become as large as the primaries. On the largest whorl -----

18 or 20 spirals can be counted between the sutures. U.S.N.M. no. 77081.

## Genus REMERA Stephenson, n.gen.

Type species.—*Remera microstriata* Stephenson. Etymology.—By anagram from *reamer*. Gender, feminine.

This new genus is characterized by an clongated, turreted spire, with an aperture shorter than the spire. The axials are numerous. nearly direct on the whorls of the spire, becoming gently sinuous with a broad curve convex toward the front on the base of the body whorl. The spirals are numerous and subdued; they override the axials on whose crests they become weaker. The aperture is elongated, acutely angular at the rear, and extends anteriorly into a siphonal canal of moderate length. The columella is without folds. There is no indication of an expanded lip, as in Anchura, to which genus Johnson,<sup>359</sup> Wade<sup>400</sup> and other authors have provisionally assigned closely related shells of this kind.

The protoconch is not preserved on the Texas material, but among 17 unnamed shells of this genus, probably representing 2 or more species, in the Wade collection from Coon Creek, Tennessee, one young shell has the protoconch nearly perfectly preserved; it is a small, smooth, rather high, trochoid shell of 2½ volutions.

## REMERA MICROSTRIATA Stephenson, n.sp.

## Pl. 65, figs. 3, 4

Shell small, turreted, slender, with spiral angle of about 20 degrees. Protoconch not preserved. Whorls 9 (estimated), very broadly rounded to nearly straight on the sides. Suture moderately impressed, rather loosely compressed. Body whorl elongated, very broadly rounded from the suture above to the broadly excavated base below. The shell is ornamented with numerous, nearly direct or broadly curved, narrow axials, subangular to sharply rounded on the crests, separated by wider interspaces. On the

<sup>&</sup>lt;sup>308</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 127, pl. 45, figs. 3, 4, 1926.

<sup>&</sup>lt;sup>309</sup>Johnson, C. W., Acad. Nat. Sci. Philadelphia Proc., for 1898, vol. 50, p. 463, text fig. 2, 1899.

<sup>&</sup>lt;sup>400</sup>Wade, Bruce, op cit., p. 151, pl. 53, figs. 1, 2, 1926.

body whorl the axials number 15; down over the base they become sinuous with a broad curve convex toward the front; they fade out as they approach the broad excavation at the base. The axials number 14 each on the penultimate and antepenultimate whorls. The whole surface is covered with fine, subdued, closely packed spirals which become weaker as they override the axials; they differ somewhat in strength, being coarsest low on the base and finest on the anterior canal; over much of the surface of the larger whorls the spirals show a tendency to slight bifurcation on their crests. Aperture elongated, but shorter than the spire, lanceolate, acutely angular at the rear, with an clongated, narrow, slightly recurved siphonal canal at the front. Outer lip thin, broadly arched in the upper twothirds, becoming broadly concave below. Inner lip forming a thin callus on the parietal wall, broadly excavated below. Columella smooth, slightly twisted.

Dimensions of the holotype: Height 24.2 + mm., diameter 6.8 mm.

This species is congeneric with the shell from Coon Creek, McNairy County, Tennessee, which Wade401 described under the name Anchura? pergracilis Johnson. The spiral sculpture on the Texas shell is, however, noticeably finer and the axials are more subdued. The original of Johnson's species is recorded as having come from the Woodbury clay at a depth of 150 to 160 feet in a well located at the foot of Mount Laurel, Burlington County, New Jersey. The Woodbury clay is at or below the middle of the Exogyra ponderosa zone and is therefore stratigraphically lower than the Coon Creek tongue and the Neylandville marl. Johnson's types are preserved in the Academy of Natural Sciences of Philadelphia and include 1 mature shell (figured) and two small This species is congeneric with shells. Remera microstriata, but is slightly less slender and has more strongly curved axials on the body whorl. The protoconch is small, smooth and rather openly coiled.

Types.—Holotype, U.S.N.M. no. 77082; 2 unfigured paratypes, U.S.N.M. no. 77083. Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, paratypes; Tex. Bu. 17300, holotype).

#### **REMERA DECORA Stephenson**, n.sp.

# Pl. 65, figs. 1, 2

Shell small, slender, elegant. Spiral angle 26 degrees. Protoconch small, smooth, rather high trochoid. Whorls 6, broadly rounded on the sides. Suture deeply and sharply impressed. Body whorl moderately long, broadly rounded on the perimeter, constricted at the base, anterior canal broken away. Shell neatly ornamented with numerous narrow, nearly straight axials of medium strength; collar and anal sulcus wanting. On the body whorl the axials number 18 and are slightly sinuous; they fade out low down on the base; the axials number about one less on each successively smaller whorl. Surface covered all over with fine, low, closely packed spirals; these are a little coarser on the lower basal slope than elsewhere. The outer lip is broken away, but the aperture is obviously lanceolate in outline, acutely angular at the rear, passing into a narrow siphonal canal in Outer lip broadly arched, inner front. lip broadly excavated and forming a thin Columella smooth, slightly recallus. curved.

Dimensions: Height 12.7 + mm., diameter 4.6 mm.

Compared with *Remera microstriata* the spire of this shell is less slender, the sides of the whorls are a little more plumply rounded, and the axial sculpture is finer.

Holotype.--U.S.N.M. no. 77084.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (17365).

### Family GRAPHIDULIDAE

## Genus GRAPHIDULA Stephenson, n.gen.

Type species.—Graphidula terebriformis Stephenson.

Etymology.—Diminutive of graphis (Latin), a pencil.

Shell of moderate size. Spire long and tapering, spiral angle of the genotype about 25 degrees. Protoconch small and

<sup>401</sup>Wade, Bruce, op. ot., p. 151, pl. 53, figs. 1, 2, 1926.

proportionately high, not sharply differentiated, but apparently with 2 or  $2\frac{1}{2}$ smooth volutions. Whorls 7 or 8, slightly convex on the sides. Body whorl elongated, slender, aperture approximately as long as the spire. Sculpture consisting of numerous, closely spaced, nearly vertical axials which bend a little forward above toward the suture, crossed by flat-topped spirals of differing width, separated by narrow interspaces; on the body whorl the axials die out toward the lower slope of the base, but the spirals continue well developed out onto the canal nearly to the terminus. The aperture is elongate-lenticular, with an acute anal canal at the rear, and a long narrow anterior canal which becomes slightly bent toward the terminus. Columella smooth at the aperture, but bearing farther back two narrow, weak, rather widely separated folds which are best seen on Wade's types of two species from Coon Creek, Tennessee (see below); finer columellar striations may also be seen on some specimens. Outer lip thin; inner lip broadly excavated and forming a thin polished callus over the base.

Two species from Coon Creek, Tennessee, described by Wade,<sup>402</sup> under the names *Piestochilus cancellatus* and *Mesorhytis obscura*, are referable to this genus.

# GRAPHIDULA TEREBRIFORMIS Stephenson, n.sp.

Pl. 66, figs. 13, 14

Shell of medium size, slender. Spire high with angle of about 25 degrees. The protoconch is not perfectly preserved but is small, high, with 2 or  $2\frac{1}{2}$  volutions. Whorls 7 or 8, slightly and evenly convex on the sides; body whorl slender, with broadly rounded periphery; base broadly excavated below; aperture about coequal in length with the spire. Suture closely appressed, slightly impressed. Axials numerous, narrow, irregular in strength, numbering 30 or more on the body whorl, and 25 each on the penultimate and antepenultimate whorls; medially the trend of

the axials is nearly vertical, but above they bend broadly forward and extend to the suture; on the body whorl the axials fade out gradually as they pass down over the base and out onto the canal; between and on the axials are numerous uneven striae of growth. The spirals are flat-topped, override the axials, and differ markedly in strength and width on different parts of the whorl; on the body whorl the two uppermost spirals are relatively narrow and prominent, and form obscure nodes on the axials; below these and extending down partly over the base is a series of quite broad, obscure spirals, separated by narrow, faint interspaces; on the middle and lower parts of the base are a series of narrow, though very irregular, spirals which become most prominent in the broad excavation between the base and the canal; the outer surface of the canal is covered with small, distinct spirals. Five or six of the spirals are exposed between the sutures on each of the whorls of the spire. Aperture elongate-lenticular with an acutely angular anal canal at the rear, and a long, narrow, slightly twisted siphonal canal in front. Outer lip thin; the holotype suffered an injury while yet alive and the resulting break was healed by a growth of shell which exhibits rugged growth ridges but no well developed axials. Inner lip broadly excavated, and forming a thin vencer of callus over the base. Near the aperture the columella appears smooth, but a broken paratype reveals two narrow weak folds somewhat separated; this feature is better shown on the types of two species from Coon Creek, Tennessee, described by Wade (see below); still fainter striae can also be faintly seen on the columella.

Dimensions of the nearly complete holotype: Height 34 + mm., diameter about 9 mm.

Compared with *Graphidula cancellata* (Wade),<sup>403</sup> from Coon Creek, Tennessee, the spiral ribs of this species are much less regular in width, and lack sharpness of definition and prominence. Compared

<sup>&</sup>lt;sup>402</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, pp. 131, 132, pl. 45, figs. 9, 10, and pl. 46, figs. 2, 6, 1926.

<sup>403</sup>Wade, Bruce, op. cit., p. 131, pl. 45, figs. 15, 16, 1926.

with *Graphidula obscura* (Wade),<sup>404</sup> this species is more slender and has more subdued and less elaborate sculpture. The two columellar folds on the Texas species are not quite as distinct as the similar ones on the two Coon Creek species, but they are identical in character and position.

*Types.*—Holotype, U.S.N.M. no. 77085; 7 unfigured paratypes, U.S.N.M. no. 21076.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); vicinity of Corsicana (763); road 5 miles south-southwest of Corsicana (7573); 3 miles northeast of Corsicana (9545); vicinity of Kaufman (761).

# GRAPHIDULA? MULTICOSTATA Stephenson, n.sp.

# Pl. 66, figs. 11, 12

Shell large, turreted, with spiral angle of about 25 degrees. Five or 6 apical whorls and the anterior canal are broken Total number of whorls 8 or 9 away. (estimated); sides of whorls nearly flat. Whorls closely appressed, suture slightly impressed. Body whorl elongated; periphery very broadly rounded with a faint suggestion of a peripheral angle; base gently sloping. Axials numerous, of moderate thickness, low, round-crested, those on the body whorl numbering about 24: the axials are nearly direct, but are very gently sinuous on the body whorl. The spiral ribs override the axials and are moderately wide, flat-topped, widest and most widely spaced above, becoming narrower and more closely spaced on the middle slope of the base of the body whorl, and again becoming a little larger and more widely spaced on the lower part of the base. Aperture elongate, lenticular, with a subacute angle at the rear. Outer lip very broadly arched; inner lip broadly excavated and forming a thin callus over the parietal wall. Columella apparently smooth.

Dimensions of the incomplete holotype, the only available specimen: Height 53 + mm, diameter 24 mm. In form and ornamentation this species resembles the genus *Graphidula*, but it is much larger than the type species, *G. terebriformis*. In view of the incompleteness of the one available specimen its assignment to the genus *Graphidula* is questioned.

Holotype.-U.S.N.M. no. 77086.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7721).

# GRAPHIDULA? GABRIELENSIS Stephenson, n.sp.

### Pl. 66, figs. 15, 16

This species is based on one incomplete, partly flattened shell several of whose apical whorls and whose anterior canal are broken away.

Shell of medium size, turreted; apical angle about 25 degrees (estimated). Five and part of a sixth whorl are preserved. Whorls closely appressed, suture moderately impressed. Sides of whorls broadly and evenly convex. The axial sculpture consists of numerous, sharp-crested, nearly direct ribs which number 26 on the body whorl, 25, 22, 22, and 22 on successively smaller whorls. Generally, though not invariably, the ends of the ribs on adjacent whorls abut against each other. Each axial bears a row of small, closely spaced, poorly preserved nodes on its crest; these nodes represent the overriding of obscurely developed spirals. The body whorl is elongated, very broadly rounded, and lacks a peripheral angle. The aperture is elongated, lenticular with an acute angle at the rear; anteriorly the aperture passes forward into a siphonal channel which is probably long and straight. Inner lip very broadly excavated, forming a callus of only moderate thickness on the parietal wall. Columella apparently smooth.

Dimensions of the incomplete holotype: Height 40 + mm., estimated diameter 13.5 mm.

This specimen was found in a bed just above water level, which contained only a few poorly preserved fossils. Its generic relations are uncertain.

Holotype.---U.S.N.M. no. 77087.

<sup>404</sup> Wade, Bruce, cp. cit., p. 132, pl. 46, figs. 2, 6, 1926.

Distribution in Texas.--Navarro group, Kemp clay: San Gabriel River, 2/5 mile above San Gabriel (14130).

# GRAPHIDULA sp.

## Pl. 66, figs. 17, 18

A small, incomplete shell, perhaps juvenile, from the Nacatoch sand near Terrell, Kaufman County, is referred to Graphidula. The spiral angle is 30 degrees. The axial sculpture is dominant, the ribs on the body whorl numbering The axials are nearly vertical, are 19. regularly spaced close together, and are round-topped; they extend down to the base of the body whorl, and are continued strongly developed on the smaller whorls Two relatively wide and deep above. sulci parallel the deeply impressed suture on the upper part of each whorl, the lower one being the weaker. Spiral ribs are numerous and of medium strength on the base and on the anterior canal; the spirals become weak above and are only faintly present on the upper part of the body whorl and on the whorls of the spire. There is no anal notch and apparently a weak fold is present on the columella. Dimensions: Height 8 mm., diameter 3.5 mm. (U.S.N.M. no. 77121, replacing old no. 12246).

#### Genus LOMIROSA Stephenson, n.gen.

Type species .- Lirosoma cretacea Wade.

Etymology.- By anagram from Lirosoma. Gender, feminine.

Shell of medium size, thin, plump, fusiform. Length of aperture a little greater than height of spire; spiral angle 60 to 65 degrees. Protoconch small, smooth, flattish, coiled 21/2 times. Suture deeply impressed. Whorls strongly and regularly convex on the sides. Axial sculpture weakly and irregularly developed with moderately strong varices at wide and irregular intervals. Spirals narrow, flattish-topped, relatively widely spaced. Aperture pyriform in outline, angulated at the rear, with a fairly wide, deep, short canal in front. Outer lip thin, strongly arched, marked on the inner surface with channels corresponding to the external spiral ribs. Inner lip broadly excavated, thinly callused on the parietal wall. Columella and anterior canal twisted. Anterior canal bordered above by a thin, projecting lamella which forms a sort of narrow umbilical fissure below and above is bent over against the columella in the form of an arch, producing a strong, hollow, pseudofold; on the available specimens this hollow is filled with matrix.

Wade<sup>405</sup> referred his species cretacea to the Miocene genus Lirosoma Conrad, from which it differs in possessing an umbilical slit and a hollow umbilical fold instead of a solid one; in having a more strongly twisted columella, and a more strongly recurved anterior canal; and in possessing strong varices and relatively strong but irregular axials in the adult stage, both of which are weak or wanting on *Lirosoma*.

# LOMIROSA CRETACEA (Wade)

## Pl. 67, figs. 18, 19

- 1917. Lirosoma cretacea Wade, Acad. Nat. Sci. Philadelphia Proc., vol. 69, p. 288, pl. 18, figs. 5, 6.
- 1918. Lirosoma cretacea Wade. Cossmann, Revue critique paléozoologie, année 22, nos. 1-2, p. 21.
- 1926. Lirosoma cretacea Wade, U.S.Geol. Survey Prof. Paper 137, p. 139, pl. 47, figs. 2, 11.

Shell of medium size, thin, plump fusiform. Height of spire less than length of aperture; spiral angle about 60 degrees. Protoconch small, smooth, coiled two and one-half times, flattish at apex. Whorls 5, plump, closely appressed, suture deeply impressed; body whorl large, inflated, with a broad, steeply sloping shoulder which is limited below by a wide subobtuse angle; the shoulder becomes narrower and less clearly defined backward toward the apex; the body whorl bears a mere suggestion of a peripheral angle or swell, below which the lower part of the base becomes strongly constricted. Axials are represented on the body whorl by a row of 14 low, dull nodes on the shoulder angle; these are weakly extended in the axial direction but quickly die out on the shoulder above and on the side of the whorl below; this row

<sup>&</sup>lt;sup>405</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 139, pl. 47, figs. 2, 11, 1926.

continues backward, but the nodes grow fainter and disappear about the middle of the penultimate whorl; 2 or 3 widely spaced plump varices of unequal strength are present on the Texas specimen and 8 or 9 on the much larger holotype from Coon Creek, Tennessee. The spirals consist of narrow, widely spaced, squarishtopped ribs which number about a dozen from the suture above down to the basal constriction, beyond which numerous, small, more closely spaced spirals continue out onto the anterior canal; 5 of the spirals are exposed on each of the whorls of the spire and, due to a slight undulation of the suture, the upper edge of the sixth spiral may or may not show. The growth lines appear as sharp, closely spaced threads which are slightly sinuous on the side of the whorl, and bend forward a little on the shoulder. The aperture is subpyriform in outline, with a wide acute angle at the rear, and a wide, short, profound, slightly twisted siphonal canal at the front. The outer lip is thin and notched, the notches marking the outer ends of shallow internal channels which correspond to the spirals; these channels die out posteriorly on the inner surface at less than half a turn of the body whorl. The inner lip is broadly excavated and forms only a thin vencer of callus on the parietal wall. The columella is twisted and bears at its base a hollow pseudoplait which appears to consist of a thin upturned lamella bordering the anterior canal and folded back against and cemented to the columella above; in the available material the tunnel formed by this fold is filled with matrix which, in the figured specimen, is partly exposed by the peeling away of the thin shell layer.

Dimensions of the Texas specimen: Height 34 mm., diameter 20.5 mm.

There appears to be no essential difference between this Texas shell and the holotype of *L. cretacea* described by Wade from Coon Creek, Tennessee; the latter is, however, a little more rugose with respect to the axial sculpture, a difference which, if shown to be constant in numerous specimens, might warrant varietal separation. Types.—Holotype, U.S.N.M. no. 32898; from the Coon Creek tongue of the Ripley formation at Coon Creek on the Dave Weeks farm in the northeastern part of McNairy County, Tennessee, Plesiotype from Texas, U.S.N.M. no. 77088.

Distribution in Texas.- Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

Outside distribution. -Tennessee: Coon Creek tongue of Ripley formation.

Range.- Known only from the lower part of the Ripley formation (Coon Creck tongue) and from the Nacatoch sand memher of the Navarro formation.

# LOMIROSA? sp.

# Pl. 67, figs. 20, 21

A large gastropod preserved as slightly flattened, incomplete, imperfectly preserved internal and external molds, and less complete molds of two smaller individuals, from the Nacatoch sand in a cut of the Clarksville road, northwardfacing slope of Cuthand Creek valley, 412 miles east by north of Rosali, Red River County (14061), are questionably referred to Lomirosa. The material indicates a shell with a proportionately higher spire, a sharper shoulder angle, and more strongly developed axial nodes than the corresponding features on Wade's species. The spiral sculpture is similar to that of Wade's species. Sharp growth lines are present, but are only obscurely preserved. There is also an obtuse peripheral angle and a broadly concave band between this angle and the shoulder angle above. Approximate dimensions of the largest speci-Height 45 -+- mm., men: diameter  $30 \pm \text{mm}.$ There is a suggestion of a spiral sulcus at the base of the body whorl, but this may have been caused by a mechanical deformation during the process of fossilization. Figured specimen, U.S.N.M. no. 77089; unfigured specimens, U.S.N.M. no. 77090.

#### LOMIROSA? sp.

An incomplete internal mold of the body whorl of a *Lomirosa?*, with the external sculpture impressed upon it, was found in the Corsicana marl, in a westward-facing bluff on Guadalupe River, 1 3/10 miles above McQueeney, Guadalupe County (7637). The specimen exhibits a type of sculpture similar to that on *L. cretacea* (Wade), with apparently stronger axials, and somewhat stronger, more closely spaced spirals. It is probably a distinct species, but is too imperfect to serve as a type. U.S.N.M. no. 77091.

# Genus PIESTOCHILUS Meek106

Type species.—Fusus scarboroughi Meek and Hayden.<sup>407</sup>

# PIESTOCHILUS? LEVIS Stephenson, n.sp.

## Pl. 67, figs. 15-17

Shell of medium size and thickness. Spiral angle about 46 degrees. Protoconch not preserved. Whorls 6 or 7, gently convex on the sides, closely appressed. Suture sharply but not deeply impressed. Body whorl large, moderately inflated, broadly convex, broadly excavated at the base. The surface is nearly smooth, but the growth lines are distinct, and weak, irregular growth undulations are present on the body whorl; the growth lines are nearly vertical but are gently sinuous, with a curve concave toward the aperture just above the most inflated part of the body whorl; a few very faint, spiral grooves can be seen on the base of the body whorl of the holotype. Aperture elongate-lanceolate, acutely angular at the rear, narrowing down to a short, moderately deep, slightly twisted canal in front. Outer lip thin, broadly arched. Inner lip broadly excavated at the midheight; parietal wall covered with callus which becomes thicker above. The columella appears smooth, but a fold may be present well back on the unexposed portion. On the genotype the fold can not be seen at the aperture, but is well exposed farther back on a broken specimen; it is narrow and weak.

Dimensions of the incomplete holotype: Height 37 + mm., diameter 18 mm. A larger incomplete specimen is 42 + mm.high and 21 mm. in diameter. This species is similar in size and form to *Piestochilus scarboroughi* (Meek and Hayden), the type species of the genus, but is much smoother, lacks the shallow constriction on the upper parts of the whorls, has a more slender spire in the apical portion, a shorter anterior canal, and the growth lines are more nearly vertical toward their upper ends. The species is questionably referred to *Piestochilus*.

The shells from Coon Creek, Tennessee that Wade<sup>408</sup> referred to *Piestochilus* do not belong to that genus.

*Types.*—Holotype, U.S.N.M. no. 77092; one figured paratype, U.S.N.M. no. 77093.

Distribution in Texas.—Navarro group, Kemp clay: West of Zuehl (7721, type locality); near Deatsville (764).

# PIESTOCHILUS? sp.

An incomplete shell of Piestochilus? sp. was obtained from the Kemp clay on a hillside by a road about 2 2/5 miles southeast of Manor, Travis County (18196). In size and form the shell is similar to P. levis, but the spiral angle is a little less, being approximately 40 degrees, and the axial sculpture is more pronounced and more regular on the upper part of the body whorl and on the penultimate whorl; obscure, closely spaced spiral ribbing is present on the middle and lower parts of the body whorl. U.S.N.M. no. 77094.

# Family VOLUTIDAE

#### Genus LIOPEPLUM Dall

#### LIOPEPLUM LEIODERMA LONGUM Stephenson, n.var.

## Pl. 67, figs. 11, 12

Shell medium to large, thick, subconiform, polished. Whorls 5; body whorl greatly elongated; spire about one-third the total length of the shell; spiral angle near tip about 65 degrees, decreasing to about 50 degrees below. Protoconch small and imperfectly preserved in the available material. Whorls closely appressed; suture deeply impressed and covered with callus. The body whorl has its greatest

<sup>&</sup>lt;sup>405</sup>Meek, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, pp. 356, 359, pl. 32, figs. 4a-d, 1876.

<sup>&</sup>lt;sup>407</sup>Meek, F. B., and Hayden, F. V., Acad. Nat. Sci. Philadelphia Proc., vol. 9, p. 139, 1857.

<sup>408</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 131, pl. 45, figs. 9, 10, 15, 16, 1926.
inflation 3 to 5 mm. below its upper margin, above which it rounds over rather abruptly to the sutural depression, thus forming a sloping rounded shoulder without a distinct shoulder angle, below which the shell descends in a long gentle slope to the anterior extremity. The penultimate and antepenultimate whorls are covered with a prominent round-crested asymmetric spiral ridge of callus which has its longest slope above; this ridge extends forward 8 to 10 mm. out on the body whorl beyond the upper end of the aperture, and in the other direction fades out toward the apex, leaving 2 or 3 of the earlier whorls uncovered; the latter are ornamented with small, low, closely spaced slightly elongated axial nodes which number 15 or 16 on the largest exposed whorl. On some well preserved individuals very fine, obscure, spiral threads appear on the early costate whorls, and also on the anterior fasciole; otherwise the shell is smooth. The growth lines show clearly through the polish on the body whorl but are concealed by callus on the spire; they tend to become coarser toward the aperture and are especially coarse where they are reflected backward around the terminal margin of the anterior canal. The aperture is elongated and of medium width; it ends posteriorly in an acute sinus and anteriorly in a short, wide siphonal canal of moderate depth. The outer lip is very broadly arched, and bends backward at the shoulder to form a deep notch just below the suture. The inner lip is slightly excavated a little above the midlength of the aperture; it forms little or no callus on the parietal wall above, but the callus thickens up and spreads forward below partly enfolding the anterior fasciole. The columella is essentially straight and bears a group of folds which is variable on different individuals; generally there are two or more moderately prominent folds, and one or more minor obsolete folds.

Dimensions of the holotype: Height 48 mm., diameter 23 mm.

Compared with the type of *L. leioderma* (Conrad) from the Ripley formation, Tippah County, Mississippi, this varietal

form is less slender and has a more prominent and less steeply sloping shoulder, a thicker callus on the penultimate whorl, and is not so flat and not so straight on the side of the body whorl. It has a higher spire and more prominent shoulder than has the variety *breve*. This variety is represented by 22 more or less imperfect individuals from the type locality.

*Types.* -Holotype, U.S.N.M. no. 77095; 11 selected unfigured paratypes, U.S.N.M. no. 77096.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); field 3/5 mile west of Kaufman (14103); road 2 miles southwest of Kaufman (7546, 14099); field 2 miles southwest of Kaufman (7547); vicinity of Chatfield (762); ?field south of Chatfield (7569); ?¾ mile east of Chatfield (7571).

### LIOPEPLUM LEIODERMA BREVE Stephenson, n.var.

### Pl. 67, figs. 9, 10

Two specimens from near Kaufman have noticeably shorter spires, and proportionately plumper bodies than *L*. *leioderma longum*, but in other essential respects are like that variety. As there appear to be no intermediate forms the recognition of these specimens as a separate variety seems justified.

Dimensions of the holotype, the apex and anterior canal of which are partly broken away: Height 39 + mm., diameter 20 mm.

Types.—Holotype, U.S.N.M. no. 77097; 1 unfigured paratype, U.S.N.M. no. 77098.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### LIOPEPLUM LEIODERMA TABULATUM Stephenson, n.var.

### Pl. 67, figs. 13, 14

One specimen from Kaufman County differs from *L. leioderma* and its other varietal forms in having a tabulate or shelf-like shoulder with only a gentle slope away from the sutural depression, and with a sharply rounded to subangular outer border. The ridge of callus above the suture is prominently developed and extends 14 mm. forward beyond the aperture on the body whorl. The ends of two moderately prominent folds are uncovered on the columella. This variety is somewhat suggestive of *L. canalis* (Conrad), especially in the prominence of the ridges of callus, but its tabulate shoulder is in sharp contrast to the evenly rounded shoulder of *canalis*, which besides is a much more clongated shell.

Dimensions of the incomplete holotype: Height 49 + mm., diameter 26 mm.

Holotype .-- U.S.N.M. no. 77099.

Distribution in Texas.—Navarro group, Nacatoch sand: road 2 miles southwest of Kaufman (14099).

Outside distribution.—Internal molds of Liopeplum, which probably represent this variety of L. leioderma, occur in the Nacatoch sand of Arkansas.

### Genus DRILLUTA Wade

## DRILLUTA CRASSICOSTATA Stephenson, n.sp.

## Pl. 67, figs. 3, 4

Shell of medium size, thick, fusiform. Spire about equal in height to the length of the aperture; spiral angle about 40 degrees near the tip, increasing to 45 degrees at about the position of the antepenultimate whorl, decreasing again to 30 degrees on the large anterior whorls. Protoconch not preserved, but obviously very small. Whorls 7 or 8, closely appressed. Suture sharply but not deeply impressed, undulating over the axials. Body whorl elongated; periphery very broadly rounded, descending with moderately steep slope to a broadly rounded basal excavation. The species is characterized by coarse axial costae of somewhat variable thickness, spacing and trend; the costae are round-crested, and in general nearly direct, but many of them bend slightly forward above as they approach the anal fasciole; on the upper end of each costa just below the anal fasciole is a low node elongated in the spiral direction; the costae number 15 on the body whorl, 14 on the penultimate, and 12 on the antepenultimate whorl of the holotype: on the body whorl the costae are broadly sinuous and fade out and disappear well down on the base. The suture is bordered below by a corrugated, tumid, anal fasciole which forms a conspicuous collar having a maximum width of 4 mm. on the largest specimens; the costae of the whorl above the suture are reflected in the overriding collar as low humps or undulations. The base of the body whorl is ornamented with 10 or 12 distinct, low, squarish-topped spiral ribs, with interspaces as wide or wider than the ribs; on the upper part of the body whorl, and on the penultimate whorl, similar, but extremely obscure spirals may barely be detected; on the earlier whorls of some of the paratypes are spirals much finer than those on the base; the anterior canal is covered with fine, closely spaced clongate-lenticular; Aperture spirals. posterior sinus acutely angular; siphonal canal short, moderately wide and deep. Outer lip thin, broadly arched. The inner lip is broadly excavated a little above the midheight, and forms a thin callus over the parietal wall and pillar; the callus thickens inward away from the The columella is straight or only lip. slightly sinuous, and bears one moderately prominent fold and 2 or 3 minor more or less obscure folds, none of which reach the aperture of the holotype.

Dimensions of the incomplete holotype: Height 50 + mm., diameter 19 mm.; the largest specimen in the collection has a diameter of 27 mm.

The species is similar to *D. communis* Wade, the type species of the genus, but has a more rugged axial sculpture, coarser spirals on the base, and a straighter columella.

The shell from Eufaula, Alabama, which Conrad described under the name *Drillia? distans*,<sup>409</sup> probably belongs to this genus, but the type is lost, the figure, which is drawn as a sinistral shell, is poor, and no specimens are now available from the type locality; it is therefore impossible to refer material from other localities to that species with confidence. The shell referred to Conrad's species by Wade,<sup>410</sup> is probably incorrectly identified.

<sup>408</sup> Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 236, pl. 46, fig. 49, 1860.

<sup>410</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, 117, pl. 38, figs. 6, 7, 1926.

*Types.*—Holotype, U.S.N.M. no. 77100; 11 selected unfigured paratypes, U.S.N.M. no. 77102; 3 unfigured paratypes, U.S.N.M. no. 77101.

Distribution in Texas.-Navarro group, Nacatoch sand: North edge of Corsicana (518, holotype and 11 paratypes); vicinity of Corsicana (763, 3 paratypes); road 5 miles south-southwest of Corsicana (7573): 21/2 miles north of Corsicana (14114): north of Rock Branch, 3 miles northeast of Corsicana (9560); vicinity of Chatfield (762, locality of 16 paratypes): 23/1 miles north of Corsicana (Tex. Bu. 17304): 3/5 to 4/5 mile northeast of Chatfield (14117); vicinity of Kaufman (761); field 3/5 mile west of Kaufman (14103); vicinity of Terrell (U.S.N.M. no. 77233, replacing old no. 12246).

### DRILLUTA CRASSICOSTATA LONGA Stephenson, n.var.

## Pl. 67, figs. 5, 6

In the collections from near Corsicana are three incomplete shells which are essentially like D. crassicostata, except that they are noticeably more elongated in the direction of the height; the axial costae are fewer, there being 13 on the body whorl of the holotype, and the anterior canal is not quite so wide. The spiral angle decreases from about 40 degrees near the tip to a minimum of 25 or 30 The columella of the degrees below. holotype is crushed and no folds are visible at the aperture; one of the paratypes shows one well developed fold, but minor folds can not be detected on the exposed part of the columella.

The approximate dimensions of the incomplete holotype are: Height  $50 \pm \text{mm.}$ , diameter 17 mm.

*Types.*—Holotype, U.S.N.M. no. 77103; 2 unfigured paratypes, U.S.N.M. no. 77104.

Distribution in Texas. Navarro group, Nacatoch sand: Vicinity of Corsicana (763, holotype); north edge of Corsicana (518, 2 paratypes).

#### DRILLUTA PAUCICOSTATA Stephenson, n.sp.

## Pl. 67, figs. 1, 2

Shell thick, rather small. Spiral angle, measured on the larger whorls, about 40 degrees. Protoconch unknown. Whorls 5 or 6. broadly convex on the sides. Collar narrow and tumid, but weakly differentiated, becoming weaker toward the Body whorl only moderately apex. elongated, periphery broadly rounded, and base broadly excavated. Axials strong, round crested, widely and somewhat irregularly spaced, relatively few, numbering 11 each on the body and penultimate whorls; the axials are broadly sinuous with a broad, backward convexity in trend on the inflated part of the whorl; they die out as they pass down over the base of the shell. Nodes are weakly developed at the upper ends of the costae just below the collar. Five or 6 rather broad, nonprominent, flattish-topped spirals appear on the base of the body whorl, and these are succeeded on the anterior canal by 5 more closely spaced spirals; very obscure spirals can be detected on the upper surface of the body whorl; passing back onto the penultimate whorl these spirals become gradually a little more distinct and appear as fine, closely spaced ribs overriding the axials on the earlier whorls. Aperture lenticular; posterior sinus acute; siphonal canal partly broken away, but apparently narrow and somewhat twisted. The columella bears one fold of medium strength and one or more obscure minor folds.

Dimensions of the incomplete holotype: Height 19 + mm., diameter 12.5 mm.

Compared with the other forms of *Drilluta* in Texas, this one is characterized by the relatively small number and wide spacing of the axial costae, and by the weak differentiation of the collar bordering the suture. The two available specimens are small and may not be full grown.

Types.—Holotype, U.S.N.M. no. 77105; 1 unfigured paratype, U.S.N.M. no. 77106.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); 3/5 to 4/5 mile northeast of Chatfield (14117).

#### DRILLUTA BREVISPIRA Stephenson, n.sp.

## Pl. 67, fig. 7

Shell of medium size, thick. Spire relatively short: spiral angle measured on the larger whorls, about 35 degrees, increasing to 45 degrees or more nearer the apex. Protoconch unknown. Whorls 5 or 6. closely appressed; suture not deeply impressed; body whorl large, with broadly rounded periphery, and broadly excavated at the base. Twelve thick, moderately prominent, round-crested axial costae ornament the body whorl; these are subnodose at the top, gently sinuous in trend below, and fade out toward the base; the costae end above against a well defined, tumid, finely wrinkled collar which has a maximum width of about 3 mm.; this collar becomes narrower and less distinctly differentiated toward the apex, and is practically wanting on the earlier whorls. The base of the body whorl bears 5 or 6 low, squarish-topped spiral ribs separated by shallow interspaces about equal in width to the ribs. Spirals are wanting over the remainder of the body whorl and spire. The front part of the body whorl is broken away, but the aperture is lenticular, terminating posteriorly in a subacute sinus and anteriorly in a narrow siphonal canal of undetermined length. The inner lip forms a thin callus over the parietal wall. The columella bears one low. rather broad, roundcrested fold which is bordered above by a broad, shallow sulcus; minor folds may be present farther back on the unexposed part of the columella.

Dimensions of the incomplete holotype, the only available specimen: Height 33 +mm., diameter 18 + mm.

This species differs from *D. crassicostata* mainly in its shorter spire, coarser axial sculpture, and more finely wrinkled collar.

Holotype.--U.S.N.M. no. 77107.

Distribution in Texas.---Navarro group, Neylandville marl: 3½ miles west-northwest of Corsicana (16166).

#### Unidentified specimens of DRILLUTA

One incomplete shell from the Nacatoch sand near Kaufman, Kaufman County (761), probably belongs to *Drilluta*, but is too imperfect to serve as a type. The specimen includes part of the body whorl and two of the larger whorls of the spire. Most of the surface is covered with a thin coating of secondary crystalline calcite, but the main features of the sculpture are fairly well exhibited. The shell has a shorter spire and is plumper than that of D. crassicostata. The axials are low, thick, round-crested and closely spaced, there probably being not less than 19 on the body whorl and 16 on the penultimate whorl; the upper ends of the axials below the collar are obscurely noded. There is a tumid moderately wide collar, which is distinctly, though not sharply, differentiated from the main surface below and is broken into a series of coarse. low, round-topped nodes which do not seem to reflect strictly either the ribs below the collar, or those above the suture. Moderately distinct spirals appear on the base of the body whorl, but whatever obscure spirals may be present on the rest of the surface are concealed by the calcite coating. Dimensions of the incomplete shell: Height 33 + mm., diameter 21 + mm. U.S.N.M. no. 77108.

A rather large specimen, including incomplete portions of the interior and exterior molds, in a sandstone matrix, found in the Nacatoch sand on "Hurricane Ridge," on an east-west road on Will Martins farm, George Wetmore Survey, 6 miles south of Cooper in Hopkins County (12929), is questionably referred to Drilluta. Widely spaced, obscure axials appear on the body whorl and more distinct widely spaced axials on the penultimate whorl; the base is covered with fine, closely spaced spirals. U.S.N.M. no. 77109.

Internal molds, questionably referred to *Drilluta*, have been collected from the Corsicana marl at the following three localities: Public road, 14/2 miles N. 20<sup>5</sup> W. of Tona siding, in Hunt County (15545, U.S.N.M. no. 77110); Dallas road at the west edge of Kaufman, Kaufman County (7518, U.S.N.M. no. 77111); westward-facing bluff on Guadalupe River, 1 3/10 miles north of McQueeney, Guadalupe County (7637, U.S.N.M. no. 77112).

A poorly preserved internal mold, which may be a *Drilluta*, was found in the Kemp clay in a gully west of a public road, 2 miles north-northwest of Deatsville, Travis County (14128). U.S.N.M. no. 77113.

The Kemp clay has also yielded a fragment of a gastropod which appears to be a Drilluta. from Cibolo Creek, 11/2 miles west of Zuehl, in Bexar County (7721). This shell (pl. 67, fig. 8) includes part of the body whorl and the penultimate and antepenultimate whorls. The spire is more slender than that of the D. crassicostata, having a spiral angle of about 25 degrees, and the base of the body whorl slopes more steeply to the anterior canal. The costae are thick, widely spaced, round crested, and number 9 on the body whorl. The collar is narrow, tumid and distinctly differentiated. The base bears 7 or 8 sharply raised spirals, but spirals are very obscure on the remainder of the shell. No folds can be seen on the exposed part of the columella. Dimensions of the incomplete shell: Height 23+ mm., diameter 12 + mm. This is probably a distinct species, but is hardly complete enough to serve as a type. U.S.N.M. no. 77114.

## Genus PALEOSEPHAEA Wade PALEOSEPHAEA? sp.

A small incomplete internal mold with the sculpture imperfectly impressed upon it, possibly a *Paleosephaea*, was obtained from the Kemp clay at Black Bluff on Brazos River, 2 miles above the Milam County line in Falls County (13776). Narrow, widely spaced axial ribs are distinctly shown, but the fine spiral sculpture can barely be made out on the inflated part of the body whorl. Dimensions: Height 19 + mm., diameter 9 mm. U.S.N.M. no. 77115.

# Genus VOLUTOMORPHA Gabb VOLUTOMORPHA RETIFERA Dall

## Pl. 68, figs. 1-4

1907. Volutomorpha retifera Dall. Smithsonian Misc. Coll., vol. 50, pt. 1, p. 15, text figures 2 (p. 14) and 3 (p. 16).

Shell large and of medium thickness. Height of spire about one-third the length of the aperture; spiral angle 70 degrees

near the apex, decreasing to 50 degrees lower down on the larger whorls. Protoconch unknown. Whorls about 5, closely appressed; suture moderately impressed, but obscured by a thin layer of callus; body whorl greatly elongated, moderately inflated, very broadly rounded on the periphery, gently sloping below, separated from the anterior canal by a very broad, shallow excavation: the body whorl is bordered at its upper margin by a tumid collar of medium width, which is in turn bordered below by a much wider, steeply sloping, shallow shoulder excavation; shoulder angle subobtuse; traced back toward the apex the shoulder becomes narrower, less steeply inclined and more deeply excavated. The axial sculpture consists of narrow, nearly direct, moderately prominent, numerous ribs which die out abruptly on the shoulder above, and grow gradually weaker and fade out about halfway down the base of the body whorl below; on the body whorl of adults the surface also smooths out toward the aperture, the axials becoming replaced by coarse growth lines and irregular undulations; the axials number about 22 on the penultimate whorl of the largest of the two specimens figured by Dall. The spiral sculpture consists of numerous low, squarish-topped ribs, narrower than the interspaces, which override the axials and produce low nodes at the intersections; on the collar the spirals number 2 or 3, the upper one being weakest; the shoulder bears 2 or 3 very obscure spirals; from the shoulder angle downward the spirals number 20 or more on the body whorl, those toward the base becoming progressively smaller and weaker. The whole surface of the shell appears to be glazed over with a thin coating of enamel which dulls, but does not obscure, the sculpture. The aperture is elongate-lenticular, with an acute posterior sinus and a straight, wide-open, moderately deep siphonal canal at the front. Outer lip broadly arched, thin, notched at the suture; inner lip very broadly excavated centrally and forming a thin callus over the parietal wall. Columella nearly straight and bearing in the earlier stages two round-crested folds of medium strength, separated by a

broad, shallow sulcus; in the adult only one fold can be seen near the aperture; one young individual, not a cotype, bears two strong oblique folds (pl. 68, fig. 4).

Dimensions of the largest cotype (Dall's fig. 2) which is incomplete at the tip: Height 135 + mm., diameter about 45 mm.

This species is comparable in size to Volutomorpha eufaulensis Gabb, but has a lower spire, a more inflated body, stronger sculpture both axial and spiral, and a thinner surface coating of enamel; the Texas shells lack the striking polish of the Eufaula species, but this may be due to a difference in the condition of fossilization. V. mutabilis Wade, from Coon Creek, Tennessee, is a very closely related species, but it has a shorter spire.

Types.—Seven cotypes, U.S.N.M. no. 20996; the largest specimen, here selected as lectotype (U.S.N.M. no. 20996a), and part of the spire of another, (U.S.N.M. no. 20996b), bear green diamond markers, and served as the basis for Doctor Dall's figures 2 and 3, the originals of which were pen drawings. The lectotype and one of the cotypes (U.S.N.M. no. 20996c), are figured in this paper. One figured topotype, U.S.N.M. no. 77116.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); road 3 5 mile west of Kaufman (7545); field 3/5 mile west of Kaufman (14103).

### VOLUTOMORPHA? sp.

An incomplete, elongated body whorl of a shell questionably referred to Volutomorpha, found in the Neylandville marl on the Corbet road 21/2 miles north of Corbet (Tex. Bu. 17300) is of medium size and exhibits several axials which are strong on the upper part, but die out high on the base; where the axials are strong spirals are small and very obscure; the base is ornamented with 9 or 10 moderately strong spirals which are as wide or narrower than the interspaces; spirals are small and obscure on the siphonal canal. The suture appears to be sharply impressed, and is bordered below by a wide, well developed collar. The growth lines are broadly sinuous, and bend

strongly forward on the collar. Height of body whorl 31.5 mm., diameter 21 + mm. U.S.N.M. no. 77117.

#### VOLUTOMORPHA? sp.

Two imperfect internal molds, with the sculpture impressed upon them, found in the basal sandy bed of the Corsicana marl on the old Frieze place, 2 3/5 miles north by east of Malta, Bowie County (5310, U.S.N.M. no. 77118, pl. 68, fig. 7; 16159, U.S.N.M. no. 77119, pl. 68, figs. 5, 6), have the general form of Volutomorpha and are questionably referred to that genus. The spire is about one-third the total height of the shell and there is a moderately well defined, sloping shoulder. The axials are narrow, numerous, irregular, and on the body whorl tend to evanesce both toward the aperture and down over the base; they are more regular and more strongly developed and number about 17 on the penultimate whorl. The whole surface is ornamented with spiral ribs; on the shoulder are 3 small, narrow spirals: between the shoulder angle and the base of the body whorl are about a dozen low, flattish primary spiral ribs overriding the axials; on the basal slope the primaries are more widely separated than elsewhere and small, narrow secondaries appear in the interspaces producing an alternation of larger and smaller The periphery is very broadly ribs. rounded, and the base broadly excavated. The aperture is lenticular with an acute posterior sinus and an anterior siphonal canal of only medium length. The columella is not exposed. Dimensions of the larger specimen: Height 53 + mm., estimated diameter 22 mm.

### VOLUTOMORPHA? sp.

### Pl. 69, fig. 16

One large internal mold, including most of the body whorl and part of the penultimate whorl, with the sculpture imperfectly impressed upon it, was found in the Kemp clay in a ditch on north side of the Houston & Texas Central Railroad 3½ miles east of Manor, Travis County (15534, U.S.N.M. no. 77120). The columella is badly crushed and no folds

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can be seen upon it. The axials are relatively narrow, irregularly developed, and widely separated; they are overridden by moderately prominent spirals which are separated by interspaces of equal or greater width; the spirals number about 24 on the body whorl. A constriction in front of the suture forms a steeply sloping, ill-defined shoulder. The specimen bears some resemblance to *V. aspera* Dall,<sup>411</sup> from the Ripley formation at Ripley, Mississippi. Dimensions of the incomplete mold: Height 87 + mm., diameter about 40 mm.

#### Genus VOLUTODERMA Gabb

Type species.—Volutilithes navarroensis Gabb (not Shumard) (=Volutoderma averillii (Gabb).<sup>412</sup>

It is to be noted that Gabb<sup>413</sup> based his new genus, *Volutoderma*, on a California species which he incorrectly identified as *Volutilithes navarroensis* Shumard; he did not base it on Shumard's Texas species. He cited Paleontology of California, plate 19, figure 56; the specimen illustrated by this figure was later named *Volutoderma californica* by Dall,<sup>414</sup> but Stewart regards this name as a synonym of *Volutoderma averillii* (Gabb).

The name Rostellites Conrad (1855),<sup>415</sup> is preoccupied by Fischer (1806).<sup>416</sup> Although the Rostellites of Conrad has generally been regarded as congeneric with Volutoderma Gabb, and the two are undoubtedly closely related, nevertheless there are differences that fully justify the recognition of the eastern form as of subgeneric, if not of full generic rank. The new subgeneric name Longoconcha is therefore proposed for it.

#### Subgenus LONGOCONCHA Stephenson, n. subgen.

Type species.—Volutoderma tennesseensis Wade.<sup>417</sup>

Compared with Volutoderma averillii (Gabb), the genotype of Volutoderma Gabb, this subgenus is markedly more slender both in body and spire, the body whorl is conspicuously flattened on the side, is much less strongly constricted anteriorly, and the outer lip flares more widely toward the front. The subgenus is represented in the Atlantic and Gulf Coastal Plain by 8 or more named species, but some of these names may be synonyms.

The subgenus is represented in the Cretaccous of the Aachen district, Germany, by *Volutoderma fenestrata* (Römer).<sup>418</sup>

#### VOLUTODERMA (LONGOCONCHA) NAVARROENSIS (Shumard)

#### Pl. 69, figs. 10, 11

1861. Volutilithes navartoensis Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 192.

1907. Volutoderma texana (Conrad). Dall, Smithsonian Misc. Coll., vol. 50, pt. 1, no. 1704, p. 20, text fig. 9. (In part.) (Not Rostellites texana Conrad.)

Shell large, thick, elongate. Spire slightly more than one-fourth the total height of the shell. Spiral angle about Protoconch not preserved. 30 degrees. Whorls 5 or 6, closely appressed; suture not impressed but easily traceable. Body whorl greatly elongated; shoulder faintly differentiated, wide, very steeply sloping, separated from the main surface below by a very wide, obtuse angle; side of body whorl below the shoulder angle flattened in a spiral area having a maximum width of 40 mm. near the outer lip; below this area the base slopes off very gently to the anterior canal; sides of whorls of spire flattened. Axials are represented on the body whorl by a few obscure, broad, low undulations of unequal strength; axials become somewhat more strongly developed on the whorls of the spire,

<sup>&</sup>lt;sup>411</sup>Dull, W. H., Smithsonian Misc, Coll., vol. 50, pt. 1, p. 17, text fig. 5, 1907.

<sup>&</sup>lt;sup>412</sup>Stewart, Ralph, Acad. Nat. Sci. Philadelphia Special Pub. No. 1, p. 409, 1926. (Gives the synonymy of the species.)

<sup>&</sup>lt;sup>413</sup>Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 28, p. 289, 1876.

<sup>&</sup>lt;sup>414</sup>Dall, W. H., Smithsonian Misc. Coll., vol. 50, p. 10, 1907.

<sup>&</sup>lt;sup>415</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 268, 1855.

<sup>&</sup>lt;sup>416</sup>Fischer, Gotthelf, Museum Demidoff, vol. 2, p. 269, 1806.

<sup>417</sup>Wade, Bruce, U. S. Coel, Survey Prof. Paper 137, p. 115, pl. 41, figs. 1, 5, 1926.

<sup>&</sup>lt;sup>418</sup>Holzapfel, E., Die Mollusken der Aachener Kreide: Palaeontographica, Band 34, pp. 89, 90, 1888.

and number 8 or 9 on the penultimate whorl. The shoulder of the body whorl bears 4 narrow spirals, the second and fourth of which, numbered from above downward, are of medium prominence and the other two obscure: the rest of the body whorl below the shoulder bears 14 or 15 very narrow primaries, the upper 8 or 9 of which are of moderate strength and the others below weaker and more closely spaced; in each of the flat, broad interspaces between the larger primaries above are 1 to 4 more or less obscure thread-like secondaries. The surface is covered with fine, imbricating striae of growth, which become markedly coarser toward the aperture of adults, and are also coarse at their upper ends near the suture; the striae bend sharply forward as they approach the suture.

Aperture greatly elongate-lenticular, narrow above, widening out below; posterior sinus acute, bending sharply upward and forming a small notch at the upper end of the outer lip; anterior canal long and widely gaping. Outer lip very broadly arcuate, slightly notched at the ends of the spiral ribs; inner lip very broadly excavated and forming a thin polished wash of callus which spreads forward from the aperture in a broadly curved front for fully a quarter of a volution; the callus thickens somewhat in the vicinity of the posterior sinus. Columella long, very gently sinuous, and modified by a shallow, longitudinal channel on about the anterior one-fourth of its length between the narrow anterior fasciole and the inner margin of the aperture; the columella bears at least three folds above its midlength, only the ends of which are visible.

Dimensions of the incomplete neotype: Height 111 + mm., diameter 32.5 mm. The original height of this specimen is estimated to have been about 140 mm.

The specimen here selected as neotype of this species was identified by Dall as belonging to Conrad's *Rostellites texana*,<sup>419</sup> from near Eagle Pass, Texas; this specimen served as the basis for his drawing of that species (Dall's text fig. 9). Conrad's species is based on an internal mold which is inadequate for specific identification and the name proposed by him should not be applied to the Kaufman material.

A large incomplete specimen and another imperfect young shell from Kaufman (U.S.N.M. no. 30853) were referred by Doctor Dall<sup>420</sup> to his V. protracta, but they probably are only individual variants of V. navarroensis.

Volutoderma navarroensis belongs to a group of closely related species in the Navarro and equivalent formations in the Gulff region and, as the shells of this group show considerable individual variation in the prominence and spacing of the primary spiral ribs and in the presence or absence, and strength of development, of secondary spirals, the separation of the several recognized species can be made only with difficulty.

Volutoderma tennesseensis Wade,<sup>121</sup> though very similar to V. navarroensis, exhibits a more vigorous development of the sculpture; it is quite variable in the spacing of the spirals, and, though variable in the strength of development of the secondary spirals, these are as a rule much weaker or wanting.

Volutoderma protracta Dall<sup>422</sup> from near Eufaula, Alabama, as represented in the original drawing, which is a restoration from several fragments, is more slender than V. navarroensis. In addition this form has more spiral ribs both on the shoulder and on the main body, and the sculpture is more strongly developed on the spire.

The holotype of *Volutoderma dalli* Stephenson, described in this monograph, is less slender than *V. navarroensis* and differs in having a more constricted shoulder, more numerous spiral ribs on the shoulder, and more vigorous sculpture on the spire.

*Type.*—Neotype, U.S.N.M. no. 20992*a*.

<sup>&</sup>lt;sup>419</sup>Conrad, T. A., U.S. and Mexican Boundary Survey Rept., vol. 1, pt. 2, p. 158, pl. 14, fig. 2, 1857.

<sup>&</sup>lt;sup>420</sup>Dall, Wm. H., see reference in the synonymy, p. 21.

<sup>&</sup>lt;sup>421</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 115, pl. 41, figs. 1, 5, 1926.

<sup>&</sup>lt;sup>422</sup>Dall, Wm. H., Smithsonian Mise, Coll., vol. 50, pt. 1, no. 1704, p. 21, text fig. 10, 1907.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### VOLUTODERMA (LONGOCONCHA) DALLI Stephenson, n.sp.

### Pl. 70, figs. 13, 14

1907. Volutoderma texana (Conrad). Dall, Smithsonian Misc. Coll., vol. 50, pt. 1, No. 1704, p. 20, text fig. 9. (In part.) (Not Rostellites texana Conrad.)

In general form and in the character of its sculpture this species is similar to V. navarroensis (Shumard). It differs, however, in that it is less slender, has a broadly excavated, or constricted shoulder, is more profusely ornamented with spiral striae on the shoulder, lacks secondary spirals, has stronger axial undulations, and is more deeply notched at the suture. The shoulder bears 4 weak spirals, and the body below about 15 spirals, the upper 9 of which are strong.

Dimensions of the incomplete holotype: Height 104 + mm., diameter 43 mm.

Holotype.—U.S.N.M. no. 21183. Named in honor of Dr. William H. Dall.

Distribution in Texas.—Navarro group, Kemp clay: Near Deatsville (764).

# Genus PARAFUSUS Wade

PARAFUSUS? sp.

## Pl. 69, figs. 12, 13

In one of the collections from the Nacatoch sand from near Kaufman, Kaufman County (761), is one small, smooth shell which appears to fall within the limits of the genus Parafusus as described by Wade.<sup>423</sup> The shell has a spire of medium height, much shorter than the length of the aperture. The protoconch is not perfectly preserved, but appears to be small and flattish, and is coiled about two times. The shoulder is steeply sloping, of medium width, and is separated from the broadly rounded, gently descending surface of the body whorl by an ill-defined shoulder angle. On the whorls of the spire this angle appears as a broadly rounded spiral swell about midway between the sutures. The columella and anterior part of the shell

are partly broken away, but the columella bears two sharply defined folds, the anterior one of which is the more prominent. Wade stated that the columella of *Parafusus* may bear either one or two folds. The type species, *P. callilateris* Wade, has one prominent fold, whereas the other species described by him, *P. coloratus* Wade, has two pronounced folds, the anterior one the stronger. A question may be raised as to whether a shell with two strong folds should be included in the same genus with one having only one such fold; the difference would seem to justify at least a subgeneric separation.

The Texas shell here under consideration is too immature to serve as the type of either a species or a subgenus. U.S.N.M. no. 77122.

#### Genus PARVIVOLUTA Wade

## PARVIVOLUTA? spp.

The genus Parvivoluta Wade is questionably represented in the Nacatoch sand by two small incomplete shells representing two species. One was found on U.S. Highway 75, 4 miles north of the courtat Corsicana, Navarro County house (17366). The anterior canal is broken away, the outer lip is partly broken away, and the surface is corroded. The protoconch is gone. As preserved the shell exhibits 4 closely appressed whorls and the suture is deeply impressed (pl. 69, figs. 14, 15). Spiral angle 40 degrees. Sides of whorls moderately convex. Axials strong, thick, round-crested, numbering 11 on the largest whorl and 10 and 9 respectively on the next successively smaller whorls. There is no anal fasciole and the axials extend to the suture. The spiral sculpture consists of numerous low, weak ribs which are markedly coarser on the middle and lower slopes of the body whorl. The aperture is lanceolate with a broadly arched outer lip and a thinly callused inner lip which is broadly excavated above the midheight. The columella bears one narrow, distinct, but not very strong fold; below this fold is one very weak fold, and above it three very weak ones. Dimensions: Height 9.5 + mm., diameter 5 + mm. Compared with Parvivoluta concinna Wade, the

<sup>&</sup>lt;sup>423</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 120, 1926,

genotype, this shell has a more slender spire and a coarser and stronger axial sculpture. U.S.N.M. no. 77123.

The other shell is from near Chatfield (762). Although fairly well preserved it is not made the type of a new species because of its apparent youthful stage (pl. 70, figs. 15, 16). It measures: Height 6.9 mm. diameter 2.7 + mm. The spire is a little shorter than the aperture is long. The species is distinguished from the preceding one by its much finer and more subdued axial sculpture, having 20 axial ribs on the body whorl. The shoulder bears 3 small spiral ribs, below which on the body are three proportionately broad, low, slightly bifid ribs, followed below on the basal slope by two single ribs of medium strength, and still lower by smaller ribs that cover the rest of the shell to the end of the anterior canal. The anterior canal is of medium length, narrow, and twisted. The twisted columella bears at least three folds, the lowest one the strongest. U.S.N.M. no. 77124.

### Family VASIDAE

#### Genus LUPIRA Stephenson, n.gen.

Type species. -Xancus variabilis Wade.<sup>424</sup> Etymology.—By anagram from Pirula; gender, feminine.

The following description is based on the holotype of the type species, and on topotypes, from Coon Creek, Tennessee: Shell of medium size, pyriform. Spire low, less than one-fifth the total height of the shell; spiral angle 85 degrees or less at the apex, expanding to 95 degrees or more on the larger whorls below. Whorls of spire about 5, increasing rapidly in size; body whorl greatly expanded, strongly inflated in upper half, becoming constricted to a narrow canal in front. Suture slightly and narrowly incised. Protoconch not preserved in available material, but the scar is very small in contrast to the large, tall, towerlike protoconch of the Recent Xancus. Shoulder pronounced, deeply excavated;

anal notch small, hugging the suture, reflected slightly or not at all in the growth lines. Anterior canal long, narrow, twisted. Inner lip thickly callused in adults, deeply and broadly excavated above the middle. Columella twisted, bearing 5 or 6 narrow, rather crowded, moderately oblique folds, separated by shallow to moderately deep channels, the anterior channel broadest and deepest, and the anterior folds strongest. The genus differs from Xancus in its very small protoconch, its less oblique columellar folds, which on Xancus are nearly horizontal, and its lower spire.

#### LUPIRA PYRIFORMIS Stephenson, n.sp.

## Pl. 69, figs. 1, 2

The species is based on one shell, probably juvenile. Shell small, pyri-form. with 4 or 5 volutions. Spire low; spiral angle about 98 degrees. Whorls increasing rapidly in size. Body whorl greatly inflated in the upper half, constricted to a narrow canal below. Protoconch broken away, but the scar is small. Suture narrowly but not deeply impressed. Shoulder of medium width and moderately excavated. Body whorl with 12 strong axials, narrower than the interspaces, extending well down the basal slope, represented across the shoulder by gentle swells, oblique forward. From the shoulder down the body whorl is ornamented with about 16 rather weak spiral ridges narrower than the interspaces, coarsest low on the base and most obscure on the steepest part of the slope; they override the axials. The shoulder is covered with small, closely crowded obscure spiral lirae. The upper ends of the axials are exposed on the penultimate and antepenultimate whorls. Aperture widest above, very narrow anteriorly where it forms an elongated, slightly twisted canal; anal canal very small, not well preserved. Outer lip broken away, but is strongly arched at the inflation. Inner lip broadly excavated above the middle, forming a thin callus on the parietal wall. Columella twisted, bearing a broad swell above the canal; the swell is paralleled by a broad depression above which the ends of two

<sup>&</sup>lt;sup>424</sup>Wade, Brace, U. S. Geol. Survey Prof. Paper 137, p. 124, pl. 44, figs. 3, 4, 1926.

moderately strong columellar folds are visible; additional small folds are surmised to be present farther back in the matrix-filled cavity, as on the topotype of *Lupira variabilis* (Wade) shown in plate 69, figure 3, U.S.N.M. no. 77125.

Dimensions of the holotype: Height 19 mm., diameter 11.5 mm.

Compared with Lupira variabilis (Wade) this species, as known from the holotype, is much smaller, has much weaker ornamentation, and has the axials more widely spaced; compared with L. major (Wade) (=Xancus major Wade), it is much smaller and differs markedly in ornamentation.

Holotype.-U.S.N.M. no. 20895.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763).

### Family OLIVIDAE

#### Genus EOANCILLA Stephenson, n.gen.

Type species.-Eoancilla acutula Stephenson. Etymology.--An early Ancilla.

The characters of this small shell are given in detail under the heading of the genotype, Eoancilla acutula, described below. The distinguishing generic characters include: The rather high, smooth, evenly tapering spire; the small smooth trochoid protoconch; the smooth flattish, closely appressed band of callus covering the lower seven-tenths of the surface of the penultimate and earlier whorls; the flat, oblique band forming the lower part of the columella, bearing 7 or 8 narrow, small, sharply developed plications; the wide, deep, spiral sulcus paralleling this plicated band above; and the absence of columellar plications above the plicated band.

Closely related genera are Ancilla Lamarck, based on the Recent species Voluta ampla Gmelin, Olivella Swainson, based on the Recent species Olivia purpurata Swainson (=O. dama Mawe), and Olivula Conrad, based on the Eocene (Claiborne) species, Olivula staminea Conrad.

Compared with examples of *Ancilla ampla* (Gmelin): *Eoancilla* has a higher spire; a much shorter body whorl; a flatter and more sharply restricted band of callus on the whorls of the spire; greater obliquity of the flattened band on the anterior part of the columella and more numerous plications on this band; a different distribution of the spiral grooves above the basal sulcus of the body whorl; and a deeper notch at the end of the anterior canal.

Compared with Olivella purpurata (Swainson): Eoancilla has a higher, more acute spire; lacks a canaliculate suture; the band of callus on the whorls of the spire is more sharply limited on its upper margin; and the columella has more numerous, finer, and more regular plications on its anterior end.

Compared with Olivula staminea Conrad: Eoancilla has a much higher spire; a much shorter body whorl; a much smoother surface, practically lacking the spiral ribbing, and having a much weaker development of the growth lirae; and lacks the deep spiral sulcus, and the V-shaped cross lirae which characterize the band of callus bordering the suture. O. staminea resembles Eoancilla in having a similarly plicated, flattened band on the anterior part of the columella, and a pronounced sulcus bordering this band on the outer side.

#### EOANCILLA ACUTULA Stephenson, n.sp.

### Pl. 69, figs. 8, 9

Shell small, polished, with maximum inflation at about the midheight, from which region the surface slopes gently toward each extremity. Protoconch small smooth, trochoid, coiled about twice. Whorls four. Spire acute and a little less than half the total height of the shell; spiral angle about 45 degrees at the tip decreasing to about 40 degrees on the whorls below. Sides of whorls of spire nearly flat; the lower 7/10 of the surface of the penultimate whorl is covered with a smooth, nontumid, closely appressed band of callus, which is separated from the upper edge of the body whorl by a fine, sharp, slightly incised, but not canaliculate, suture; the upper edge of the band is gently undulating, but the band extends with about the same proportional width

all the way back to the protoconch. The main surface of the shell is smooth, except for growth lines and an exceedingly faint indication of fine spiral lines, and one fine spiral groove at about the position of the periphery. The growth lines cross the body whorl in a gently sinuous trend, bending sharply backward before they join the suture above, and more gently backward near their junction with a sharply incised groove on the base below. The aperture is lenticular with a narrow, sharply upturned, posterior canal, and widens anteriorly to a short, wide, deeply notched, siphonal canal. Outer lip broadly arcuate and notched at the suture above: inner lip broadly excavated and forming on the parietal wall a band of callus which spreads forward a little and extends upward, becoming thicker in front of the posterior canal; this callus spreads upward across about 7 10 of the surface of the penultimate whorl and is continued backward forming the band of callus on already described. The that whorl columella is flattened anteriorly and is ornamented with a band of 7 or 8 closely spaced, small, narrow oblique ridges which continue forward on the sharply twisted anterior fasciole to the terminus The anterior fasciole is of the shell. bordered on the outer side by a deep, wide, round-bottomed spiral sulcus which is traceable backward until it is covered by the callus of the lip; the anterior edge of the callus of the inner lip follows down the bottom of the sulcus to the terminus of the shell; the sulcus is bordered in front on the base of the shell by a wide, smooth band which is limited both above and below by narrow sharply incised grooves.

Dimensions of the nearly complete holotype: Height 9.25 mm., diameter 4 mm.

This shell is unique in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain.

Types.- Holotype, U.S.N.M. no. 77126; unfigured paratype, U.S.N.M. no. 77127.

Distribution in Texas.---Navarro group, Kemp clay: Webberville (7601).

## Superfamily TOXOGLOSSA

## Family CANCELLARIDAE

### Genus CANCELLARIA Lamarck

### CANCELLARIA? MATSONI Stephenson, n.sp.

# Pl. 69, figs. 4, 5

Shell small, firm, ornate, possibly a Spire of medium young individual. height; spiral angle about 50 degrees. Protoconch partly corroded, coiled about twice, the initial coil apparently flattish. Whorls 3, rapidly expanding, strongly convex on the side, closely appressed. Suture deeply impressed. Body whorl with a moderately distinct, gently sloping shoulder, separated from the side below by a subobtuse shoulder angle. The body whorl bears 12 prominent narrow axial ribs, separated by wider interspaces; the ribs are most prominent at the shoulder angle, but are strongly developed both across the shoulder to the suture and down over the side, dying out well down on the strongly constricted base; from below upward the axials trend noticeably forward; the axials number 11 on the penultimate whorl, and continue strongly developed backward nearly to the protoconch. The body whorl bears about 15 narrow, sharply developed spiral ribs which override the axials, and which are in general narrower than the interspaces, but which become more crowded on the most inflated part of the shell and also just above the basal constriction; the 3 or 4 spirals on the shoulder are smaller than the others; about 7 spirals are exposed on the penultimate whorl between the sutures. The aperture is short lenticular, with an obtuse posterior canal, and with a wide, short siphonal canal in front. The outer lip is broken away, but appears to be of medium thickness, and is strongly arched. The inner lip is deeply excavated at the base of the parietal wall and forms a thin callus over this wall, through which several of the spiral ribs stand out prominently. The columella is short and bears 2 prominent, very oblique folds; an anterior fasciole is obscurely developed and is separated from the inner lip by a narrow umbilical fissure.

Dimensions of the holotype: Height 4.5 mm., diameter 3 mm.

No species closely similar to this one has been described from the American Cretaceous. Although it is closely allied to the Recent *Cancellaria* Lamarck it exhibits differences that may perhaps justify its generic separation; it possesses much stronger axial ribs, a more pronounced shoulder angle, fewer columellar folds, and is scarcely excavated between the anterior fasciole and the base of the parietal wall above. The one available specimen is, however, juvenile, and the outer lip is broken away, and it is scarcely adequate to serve as the type of a new genus.

Holotype.—U.S.N.M. no. 77128. Named in honor of the late Dr. George C. Matson, the collector.

Distribution in Texas.—Navarro group, Kemp clay: At a depth of 730 feet in a well 2 miles west of Groesbeck (13132, type loc.). The buried zone from which this species was collected is at the surface in the left bank of Colorado River at Webberville, Travis County (7601), where fragments questionably referred to this species have been found.

### CANCELLARIA? sp.

### Pl. 69, figs. 6, 7

One small shell from the Nevlandville marl in the Corsicana road, 215 miles north of Corbet, Navarro County (17365), is characterized by prominent axials narrower than the interspaces, and by numerous fine spirals which override the axials; the base is sharply constricted. Spiral angle about 60 degrees. Suture deeply impressed. The axials are sinuous in trend and bend forward where they cross the shoulder above; they fade out low down on the base of the body whorl. The spirals alternate in strength on the middle and lower parts of the body whorl; a closely spaced group of 4 or 5 very fine spirals approximately follows the shoulder angle; only a few obscure spirals are present on the shoulder itself. The aperture is broadly lanceolate, the outer lip being strongly arched, and the inner lip broadly excavated. The incomplete shell measures: Height 8.7 + mm., diameter 6.5 mm. U.S.N.M. no. 77129.

### Genus CAVEOLA Stephenson, n.gen.

Type species.--Cancellaria acuta Wade. Etymology.--Diminutive of carea, a cage.

The characters which serve to differentiate *Caveola* from *Cancellaria* are its exceptionally high spire, the presence of varices on the whorls, the absence of both an anterior fasciole and an umbilical fissure, and the absence of a spiral sulcus at the base of the body whorl. The protoconch of *Caveola* is similar to that of *Cancellaria*. The surface is finely cancellated by the crossing of axial and spiral ribs, and this feature, together with a similar protoconch and the folds on the columella, seem to ally this genus with the Cancellaridae.

The species described by Conrad<sup>425</sup> under the name *Cancellaria subalta* (type, Acad. Nat. Sci. Philadelphia), from Haddonfield, New Jersey, appears to be a member of the genus *Caveola*. The species *Tritonium (Colubraria) cedri* Gardner<sup>424</sup> from the Wills Point formation of the Midway group, Bastrop County, Texas, although somewhat similar to *Tritonium* in form, has several columellar plications, and appears to be generically related to *Caveola*. Both *Tritonium* and *Colubraria* are based on recent species from oriental waters.

#### CAVEOLA ACUTA (Wade)?

Pl. 70, figs. 8 10

1926. Cancellaria acuta Wade, U.S.Geol. Survey Prof. Paper 137, p. 108, pl. 35, figs. 4, 5.

The following description is based on two small shells from Texas which appear to be the young of *Caveola acuta* (Wade). Shell small, fusiform. Spire higher than length of aperture; spiral angle about 45 degrees. Protoconch broken away. Whorls 3 or 4, plumply rounded on the sides, closely appressed. Suture deeply impressed. The upper part of the body whorl is slightly constricted to form an obscure narrow shoulder; periphery very broadly rounded, the surface descending rather abruptly to a moderately constricted

<sup>&</sup>lt;sup>425</sup>Conrad, T. A., Am. Jour. Conch., vol. 5, p. 100, pl. 9, fig. 22, 1869.

<sup>&</sup>lt;sup>420</sup>Gardner, Julia, Univ. Texas Bull. 3301, p. 262, pl. 21, figs. 9, 10, 1935.

The body whorl is ornamented base. with about 20 fine. low axials which bend forward as they approach the suture above, and which die out on the basal slope below; the axials continue proportionately well developed backward on the earlier whorls nearly to the protoconch; several of the axials are enlarged to form varices. The spiral sculpture consists of low, narrow, sharply developed ribs which are narrower than the interspaces and which number 17 or 18 on the body whorl of the figured specimen; the spirals override the axials and tend to develop nodes at the crests; 6 or more of the spirals are exposed between the sutures, on the penultimate and earlier whorls. The aperture is rather broadly lenticular, with a subacute posterior canal, and a short, narrow, deep anterior canal. The outer lip is broken away, but the internal mold shows the lip to be asymmetrically arched, with the strongest part of the curve above, and the inner edge is crenulated. Inner lip deeply excavated above the midheight and forming a very thin callus over the parietal wall. Columella bearing two distinct, oblique folds, with an additional sharp carina at the edge of the anterior canal below.

Dimensions of the incomplete figured specimen: Height 7 + mm., diameter 3.75 mm. The holotype is much larger, having a height of 18.5 mm., and a diameter of 8 mm.

The holotype of the species from Coon Creek, McNairy County, Tennessee, is a nearly perfect shell which has been described in detail by Wade. The two Texas specimens can not be referred to the Tennessee species with confidence, because of their small size and imperfections.

*Types.*—Holotype, U.S.N.M. no. 32844; from Coon Creek, McNairy County, Tennessee. Plesiotype from Texas, U.S.N.M. no. 77130.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170).

Outside distribution.—Tennessee: Coon Creek tongue of Ripley formation.

Range.---Known only from the type locality at Coon Creck, Tennessee (upper part of *Exogyra cancellata* zone), and questionably identified from one locality in the Neylandville marl in Navarro County, Texas. -

## CAVEOLA PRODUCTA Stephenson, n.sp.

# Pl. 70, figs. 11, 12

Shell small, of medium thickness, proportionately more slender than the geno-Spire high, more than half the type. total height: spiral angle about 35 degrees. Protoconch only partly preserved but apparently smooth, rather high, and naticoid. Whorls 4, closely appressed, plumply rounded on the side. Suture deeply impressed. Shoulder scarcely differentiated. Body whorl broadly rounded in outline, ornamented with 15 or 16 narrow, gently sinuous axials, and 2, perhaps 3, moderately strong, thick varices, one of which borders the outer lip; the axials bend forward as they approach the suture above, and backward as they pass downward and die out on the base below: each of the whorls bears 2 or 3 The axials are overridden by varices. narrow spiral ribs which number 17 or 18 on the body whorl; the interspaces are wider than the ribs on the upper part of the whorl, gradually diminish in width downward, and on the base of the shell are narrower than the ribs: 5 or 6 of the spirals are exposed between the sutures on the whorls of the spire. Aperture lenticular with a widely acute posterior canal, and a very short, narrow, deep anterior canal. Outer lip thick, broadly and regularly arcuate, crenulated within. Inner lip rather deeply excavated a little above the midheight, and forming a moderately thick callus at its forward edge, but through which the spiral ribs are plainly shown. The columella bears 2 oblique folds, and in addition a sharp carina at the upper border of the anterior canal.

Dimensions of the holotype: Height 10 mm., diameter 5 mm.

This shell, though very similar in form and ornamentation to *C. acuta* (Wade), is markedly more slender.

Holotype.-U.S.N.M. no. 77131.

Distribution in Texas.---Navarro group. Nacatoch sand: Vicinity of Chatfield (762).

## Unidentified specimens of CAVEOLA

A badly crushed internal mold of the body and penultimate whorls of a small gastropod, with the sculpture impressed upon the mold, from the Corsicana marl near the fork of the Mexia road, 2<sup>3</sup>/<sub>4</sub> miles east of Cooledge, Limestone County (13832), probably belongs to *Caveola*. In form, and in its fine, sharply cancellated sculpture, the specimen is very similar to *C. producta*, but the axial ribs appear to be finer and more closely crowded. The specimen is too imperfect for satisfactory specific identification. U.S.N.M. no. 77132.

Better preserved internal and external molds of a gastropod from the Kemp clay, in a field near the old Wortham road  $4\frac{1}{2}$  miles east-northeast of Cooledge, Linestone County (17374), exhibits sculpture like that of *Caveola*, but is even more slender and has a longer siphonal canal than has *C. producta*. U.S.N.M. no. 77133.

#### Genus MATAXA Wade

#### MATAXA VALIDA Stephenson, n.sp.

#### Pl. 70, figs. 1-3

Shell small, ventricose, rather thick. Spire a little less than 3/10 the total height of the shell; spiral angle about 70 degrees. Protoconch of medium size, smooth, trochoid, slightly tilted, coiled  $2\frac{1}{3}$  or 3 times: earliest coil very small. the later coils increasing rapidly in size. Whorls 3, closely appressed, gently and regularly convex on the sides. Suture sharply but not deeply impressed. Body ventricose, regularly rounded, whorl slightly constricted and grooved a little below the suture, thus producing a narrow, tumid, obscurely developed collar; periphery broadly rounded, base strongly constricted. Except for obscure undulations axial sculpture is wanting; the growth lines are sharp, and are inclined a little forward as they pass upward toward the suture. On the body whorl the spiral sculpture consists of low, flattish ribs of irregular width, separated by verv narrow interspaces, which, however, become wider in the basal constriction below; the groove below the suture is wider and deeper than any of these interspaces, and on the holotype bears a fine thread in its bottom; the groove is traceable backward on the whorls of the spire to the protocouch: the tunid collar between the groove and the suture bears 3 fine, obscure, crowded ribs; on the holotype 4 spirals are exposed on the penultimate whorl between the collar groove and the suture below; the spirals are fine and crowded on the anterior canal: there is a tendency for some of the spirals to become bifid as they extend forward on the larger Aperture lenticular, with a whorls. sharply acute posterior canal, and a short, narrow, deep, twisted, anterior canal. Outer lip broadly and regularly arched: though concealed by matrix the inner margin of this lip is probably crenulated, as in other closely related species. Inner lip deeply and broadly excavated at the midheight and forming a very thin callus in the younger stages, thickening up somewhat in adults. Columella with 3 or 4 oblique folds of markedly irregular trend and prominence.

Dimensions of the holotype, which is broken at the anterior extremity, and is probably about half grown: Height 11 + mm., diameter 6.5 mm. One of the two paratypes is larger than the holotype and is somewhat questionably referred to this species; it is 17 mm. high and 9.5 mm. in diameter.

The larger specimen to which reference was just made exhibits a shallow constriction below the suture, thus producing an obscure collar, but this shell lacks the pronounced groove which is present on the holotype. Otherwise this paratype is like the holotype at corresponding stages of growth; on this larger shell the spiral ribs tend to evanesce toward the aperture of the body whorl, thus producing a smoother surface; the strength of development of the groove probably is a variable feature on different individuals.

Compared with *M. elegans* Wade this species is smaller, has a slightly coarser spiral sculpture, is not so plump just below the collar groove, has a straighter columella, and is not so deeply constricted at the base. The two species are, however, very closely related.

Types.—Holotype, U.S.N.M. no. 77134: 1 figured paratype, U.S.N.M. no. 77135; 1 unfigured paratype, U.S.N.M. no. 77136.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); 3 miles northeast of Corsicana (9545); vicinity of Kaufman (761).

## MATAXA VALIDA MULTILIRA Stephenson, n.var.

#### Pl. 70, figs. 6, 7

One specimen has the general form of Mataxa valida and a closely similar protoconch, but is ornamented with much finer and more numerous spiral ribs. There is a narrow moderately deep collar groove, with 2 fine ribs on the tumid collar between the groove and the suture. Seven or 8 fine low spirals cover the surface between the collar groove and the suture below. on both the penultimate and antepenultimate whorls. The whole surface of the body whorl is covered with low, closely crowded spiral ribs which, toward the lower part of the base, become somewhat coarser and tend to alternate in size. The folds on the columella are markedly irregular in trend.

Dimensions of the holotype: Height 14.5 mm., diameter 8.5 mm.

Holotype.---U.S.N.M. no. 77137.

Distribution in Texas.—Navarro group, Nacatoch sand: 3½ miles north of Corsicana (16168).

#### MATAXA SUBTERES Stephenson, n.sp.

## Pl. 70, figs. 4, 5

Shell small, of medium thickness, Spire a little more plumply rounded. than one-third the total height of the shell; spiral angle about 65 degrees. Protoconch small, smooth, high trochoid, coiled 2 or 21/2 times. Whorls 2 or 3, closely appressed, broadly and regularly rounded on the side, with collar and groove obscure or wanting. Suture sharply but not deeply impressed. Body whorl broadly and evenly rounded, becoming rather strongly constricted at base. Surface covered with fine, closely packed spiral lines suggestive of the fine striations produced on wood turned in a lathe. Aperture lenticular, with a sharply acute posterior canal and a short, narrow, deep, twisted anterior canal. Outer lip broadly arched, thin at the edge, bevelled within, with a row of crenulations at the inner edge of the bevelled strip. Inner lip broadly excavated and forming a thin wash of callus on the parietal wall. The uncovered part of the columella of the holotype shows the ends of 3 or 4 folds of irregular trend and strength.

Approximate dimensions of the slightly defective holotype: Height 11 mm., diameter 7 mm.

The practical absence of a collar groove and collar, the finer spiral sculpture, and the smaller and higher protoconch, serve to distinguish this species from the other representatives of the genus in the Gulf region.

*Types.*—Holotype, U.S.N.M. no. 77138; 2 unfigured paratypes, U.S.N.M. no. 21024.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### Family PALADMETIDAE

#### Genus PALADMETE Gardner

#### PALADMETE CORBULIFORMIS Stephenson, n.sp.

#### Pl. 71, figs. 9-11

Shell small, of medium thickness, ventricose. Spire about half the total height of the shell, with spiral angle of about 58 degrees. Protoconch coiled 21/2 or 3 times, smooth, high naticoid, the initial coil very small, increasing rapidly Whorls 21/2 or 3, closely apin size. pressed, plumply rounded, noticeably Suture deeply impressed. shouldered. Shoulder on body whorl narrow, sloping obtusely, subangulated at the outer edge; traced backward the shoulder remains proportionately well developed all the way to the protoconch. Body whorl broadly rounded, sharply constricted toward the columella. The body whorl of the holotype bears 19 moderately prominent axials of varying thickness, which are sinuous in trend, bending sharply forward and becoming weaker where they cross the shoulder above, and bending backward below as they approach the inner lip; on the penultimate whorl the

axials increase in number to 25 and are more closely spaced; an occasional axial is slightly enlarged, suggesting a weak arix. The body whorl bears about 9 primary spiral ribs, which are narrow, low. squarish on top, and override the axials; no spirals are present on the shoulder of the holotype, but 2 small, weak spirals make their appearance toward the aperture on the shoulder of the figured paratype; 3 of the spirals and the edge of a fourth are exposed on the penultimate whorl; numerous obscure spiral threads can be detected between the primary spirals, over most of the shell. Aperture very broadly lenticular, with a wide open, subobtuse posterior canal and a short, shallow, incipient, anterior canal which is little more than an obtuse notch. Outer lip arched, slightly angular and broadly notched at the intersection of the shoulder. Inner lip deeply and broadly excavated and forming a callus of medium thickness on the parietal wall. Umbilical fissure narrow and shallow. Columella slender, twisted, without folds.

Dimensions of the incomplete holotype: Height 14.5 mm., diameter 10 mm.

It has been customary to refer the Texas shells here included under *Paladmete* corbuliformis to *P. cancellaria* (Conrad). The type of Conrad's species was obtained from the Owl Creek formation at Owl Creek, Tippah County, Mississippi. His original figure<sup>127</sup> represents a shell with more widely spaced axial ribs than those on the Texas shells. His type is lost and there are no other shells from Owl Creek now available for comparison. A new name is therefore given to the Texas shells.

The shell referred to P. cancellaria (Conrad) by Wade<sup>428</sup> is very close to P. corbuliformis, but it has a much stronger development of the axials, especially on the shoulder, and it also exhibits several well developed varices.

A shell from the Ripley formation,  $2\frac{1}{2}$  miles south of Dumas, Tippah County,

Mississippi, figured by Gardner<sup>420</sup> as *P. cancellaria* (Conrad), is also closely related to *P. corbuliformis*, but it too is more strongly sculptured than the Texas species.

*Types.* Holotype, U.S.N.M. no. 77139; 1 figured paratype, U.S.N.M. no. 77140; 3 unfigured paratypes, U.S.N.M. no. 23343.

Distribution in Texas. Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); road 3 5 mile west of Kaufman (14098); field 2 miles southwest of Kaufman (7547); 14/5 miles northeast of Quinlan (16162, 16171).

### PALADMETE ALTA Stephenson, n.sp.

### Pl. 71, figs. 12, 13

With the exceptions indicated below this species is similar to *P. corbuliformis*. The spire is much higher, the spiral angle being about 58 degrees; the shoulder is more rounded; the axials are more prominent and more irregularly developed: there is more of a tendency for an axial here and there to develop into a prominent varix: the sutures are more deeply impressed. The spiral sculpture is obscured by a thin coating of earthy, calcareous matrix which cannot be readily removed, but there appear to be about 9 low, narrow, squarish, widely spaced ribs closely analogous to the spiral ribs on P. corbuliformis, and as in that species, 3 of the spirals and the edge of a fourth are exposed on the penultimate whorl. The aperture is subovate, the outer lip is broken away, and the inner lip forms a moderately thick callus on the parietal wall. The columella is slender and twisted, and is bordered in front by a short, narrow, shallow canal which forms only a slight notch in the margin.

Approximate dimensions of the slightly incomplete holotype: Height 17 mm., diameter 8.5 mm.

Holotype .--- U.S.N.M. no. 77141.

Distribution in Texas.—Navarro group, Kemp clay: 2 miles north-northwest of Deatsville (14128).

<sup>&</sup>lt;sup>437</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d scr., vol. 3. p. 333. pl. 35, fig. 8, 1858.

<sup>&</sup>lt;sup>42</sup> Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 107, pl. 35, figs. 1, 2, 1926.

<sup>&</sup>lt;sup>429</sup>Gardner, Julia, Maryland Geol, Survey, Upper Cretaceous (2 vols.), p. 413, pl. 18, figs. 14, 15, 1916.

### PALADMETE INAEQUALIS Stephenson, n.sp.

## Pl. 71, figs. 14, 15

Shell small, of medium thickness. Spire about half the total ventricose. height of the shell: spiral angle measured on the earlier whorls 68 or 70 degrees. decreasing to about 60 degrees on the later whorls of adults. Protoconch small, smooth, naticoid, coiled 2 or 21/2 times. Whorls 3 or 31/2, rather plumply rounded, but flattened a little on the side, with a steep inclination away from the suture, increasing rapidly in size, and showing a slight tendency to loose coiling in the later stages. Suture deep and sharply impressed at the bottom. Periphery of body whorl with a very obscure, obtuse subangulation: body sharply constricted toward the columella. The shells occur in great numbers locally and they exhibit a great individual variation in axial sculpture, and some variation in the height of the spire and in the profile of the sides of the spire. On the body whorl of the specimen selected as holotype the axial ribs are markedly variable in thickness, prominence, and spacing, so much so that it is impracticable to count them and they die out at about the peripheral angle; several of the axials are strong enough to be classed as varices: a similar variation is exhibited by the penultimate whorl, though the sculpture is more subdued: on the antepenultimate whorl the axials are finer and more regular; on some of the paratypes the axials are more regular than on the holotype; the penultimate whorl of one of the paratypes bears 29 fine. subregular axials. The axials curve markedly forward above, and on the body whorl below the periphery bend backward toward the inner lip; on many specimens scattered varices are strongly developed, numbering 2 to 4 on each of the later The spirals are low, narrow, whorls. variable in thickness, and crowded over the entire surface; they show a tendency to alternate in size; on some specimens the spirals on the body whorl can be divided into primaries, secondaries and tertiaries; generally the spirals on the periphery are a little coarser than the others. Aperture broadly subovate, with an obtuse posterior canal and a shallow anterior canal ending in a slight notch at the subrounded anterior margin. The outer lip is partly broken on the holotype, but is obviously thin and strongly arched, with generally a slight flattening on the highest part of the arch. Inner lip deeply and broadly excavated and forming a fairly thick callus on the parietal wall. Columella slender, flattened, twisted, without folds.

Dimensions of the holotype which is slightly broken at the anterior extremity: Height 13 mm., diameter 8.5 mm.

This species is characterized by the great number of individuals occurring at one place, and by its marked individual variation in sculpture. A collection from near Chatfield includes many individuals which are in general smaller, slightly more slender, and bear more numerous varices, than the specimens from the type locality near Corsicana; they have the appearance of a depauperate colony living in a comparatively less favorable environment.

Paladmete gardnerae Wade,<sup>430</sup> from Coon Creek, Tennessee, is similar in form to *P. inaequalis*, but is much more strongly and regularly sculptured.

*Types.*—Holotype, U.S.N.M. no. 77142; 12 selected unfigured paratypes, U.S.N.M. no. 77143.

Distribution in Texas. --Navarro group, Nacatoch sand: Vicinity of Corsicana (763, type loc.); 3 3/10 miles west-southwest of Corsicana (16163); road 5 miles south-southwest of Corsicana (7573); Watkins' place 4 miles north of Corsicana (9558); 3 miles northeast of Corsicana (9545); vicinity of Chatfield (762); loose pieces of rock in street at Chatfield (7568).

## PALADMETE ELEGANS Stephenson, n.sp.

### Pl. 71, figs. 16, 17

Shell small, plump, elegantly sculptured. Spire a little less than half the total height; spiral angle about 68 degrees. Protoconch small, smooth, coiled about twice. Whorls about 2½, plumply rounded on the side, increasing rapidly in size, closely appressed. Suture deeply

<sup>450</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 108, pl. 35, figs. 3, 6, 1926.

impressed. Body whorl inflated, narrowly shouldered, sharply rounded but not angulated at the outer edge of the shoulder; periphery broadly rounded, the surface passing downward to a sharply constricted base. Body whorl ornamented with 18 narrow irregular axial ribs which bend forward on the shoulder above and die out irregularly on the base below, and by 3 distant prominent, thick, roundtopped varices which extend farther down the base than the axials; on the penultimate whorl are about 23 narrow axials and 3 varices. The spiral ribs are numerous, of irregular size and spacing, and override the axials; about 9 may be classed as primaries with widest spacing above: 4 secondaries occur on the shoulder and 3 between each of the two uppermost primaries just below the shoulder; the primaries and secondaries become subequal and more closely spaced in the basal constriction; very small, obscure tertiaries and fine threads may be detected between the larger ribs over most The aperture is broadly of the shell. subovate, with an obtuse posterior canal, and a very short, shallow anterior canal making a shallow notch at the margin. Outer lip thin, and strongly and regularly arched. Inner lip deeply excavated and forming a thin callus over the parietal Columella slender, smooth, and wall. twisted.

Dimensions of the holotype, which is slightly broken at the anterior extremity: Height 6 mm., diameter 4 mm.

With the exception of the broken outer lip the holotype is a nearly perfect shell, but it is probably juvenile, as are also the paratypes which are less complete than the holotype. Two large shells from Cibolo Creck, Bexar County, whose surfaces are poorly preserved, are questionably referred to this species; allowing for variability in the development of varices these specimens appear to be similarly ornamented, and have about the same form at corresponding stages of growth; the larger of the two is 16 mm. high and 9 mm. in diameter.

On Paladmete corbuliformis the primary spirals are more regularly spaced and

secondaries are practically wanting. Compared with *P. alta* the spire of *P. elegans* is much lower and the spiral sculpture is less regular. The shells from Mississippi and Tennessee usually referred to *P. cancellaria* are more strongly and more regularly sculptured.

Holotype.-U.S.N.M. no. 77144.

Distribution in Texas.--Navarro group, Kemp clay: Webberville (7601; 13910, type lot); at depth of 730 feet in a well 2 miles west of Groesbeck (13132); ?west of Zuehl (7720).

#### Family TURRITIDAE

## Genus AMULETUM Stephenson, n.gen.

Type species.—*Turricula menairyensis* Wade. Etymology.—Latin *amuletum*, an ornament.

The genus Amuletum is slender, exhibits fine, sharp, axial and spiral ornamentation, has a small, smooth trochoid protoconch coiled 3 times, and the spire is a little less than half the total height of the shell; the spiral angle is approximately 25 degrees. A constriction below the suture produces a sloping collar and a narrow, ill-defined shoulder. The outer lip is interrupted at the intersection of the shoulder by a moderately deep, broadly curved notch. The anterior canal is long, narrow, deep and twisted, and the columella appears to be smooth.

The genotype of Amuletum, Turricula menairyensis Wade,431 is a small shell with the sculpture perfectly preserved; the only imperfection is a slight break along the The genus Turricula, to outer lip. which Wade referred his species, is founded on the Recent Turricula flamea Schumacher<sup>432</sup> (= Murex javanus Chemnitz,433 not Linné = Murex tornatus Dillwyn, not Turris tornatum Bolten), from the oriental seas. This species is a large, nearly smooth form having a spiral angle of about 35 degrees; it has a proportionately larger body whorl, a conspicuous constriction below the suture, and a pronounced shoulder; these characters seem

<sup>&</sup>lt;sup>431</sup>Wade, Bruce, U. S. Geol, Survey Prof, Paper 137, p. 113, pl. 36, figs. 8, 9, 1926.

<sup>&</sup>lt;sup>432</sup>Schumacher, Chrétien Fréderic, Essai, nouv. syst., p. 217, 1817.

<sup>433</sup>Chemnitz, Johann H., Neues system. Conchylien-Cabinet, p. 172, pl. 143, figs. 1336-1338, 1789,

to amply justify erecting a new genus for the Cretaceous shell. None of the species referred by Wade to *Turricula* belongs to that genus. His *Exilia ripleyana*<sup>131</sup> appears to be an *Amuletum*.

### AMULETUM BOYLEI Stephenson, n.sp.

# Pl. 71, figs. 3, 4

Shell small, slender, of medium thickness. Spire broken, but is high, probably about half the total height of the shell; spiral angle about 25 degrees. Protoconch and early whorls broken away. Whorls 4 or 5, gently convex on the side, closely Suture sharply appressed. but not deeply impressed. Body whorl elongated, constricted above to form a somewhat tumid, but not sharply defined collar, the surface sloping steeply away from the constriction below; periphery very broadly rounded, the surface passing down to a very broad basal excavation. The body whorl is ornamented with numerous narrow, closely crowded, nonprominent, more or less irregular axial ribs which curve broadly backward to the collar constriction, thence turning sharply forward across the collar to the suture; the axials fade out as they pass down over the base; on the body whorl the axials are too irregular to be easily counted, but on the penultimate they are more regular and number about 30. The surface is completely covered with small, narrow, low, closely crowded spiral ribs which number about 30 on the body whorl and anterior canal; these override the axials, and are coarsest on the periphery and basal slope of the shell; 2 or 3 small spirals on the collar are very obscure; irregularities in the trend of the spirals about 2 mm. back of the outer lip indicate an injury to the shell, which was healed as growth proceeded. Aperture long, lanceolate, with a very acute posterior canal and a long, narrow, deep, slightly sinuous anterior canal. Outer lip not well preserved, but apparently thin, broadly arched in the upper half of its length and rather deeply notched at the collar constriction. The inner lip is

poorly preserved, but is broadly excavated above, and apparently forms a rather thick callus which is badly corroded. A narrow, slightly raised, closely striated anterior fasciole borders the canal in front.

Dimensions of the incomplete holotype: Height 9 + mm., diameter 3 mm.

This species differs from the genotype, *Amuletum menairyensis* (Wade), in having a more subdued sculpture, and a proportionately less strongly inflated body whorl; the two species are, however, very closely allied.

Pleurotoma minor Evans and Shumard ( $=Turris\ minor\ Meck^{435}$ ) is a related form, but its more strongly inflated body and its broad, steeply sloping shoulder throw doubt on its generic identity with Amuletum.

Holotype.-U.S.N.M. no. 77145. Named in honor of Mr. C. B. Boyle who, with Dr. C. A. White, collected Navarro fossils near Corsicana in 1887.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); 4 miles north of Corsicana (17366).

#### AMULETUM CURVOCOSTATUM Stephenson, n.sp.

#### Pl. 71, figs. 1, 2

Shell small, of medium thickness, turreted. Spire probably a little higher than the length of the aperture; spiral angle about 25 degrees. Protoconch imperfectly preserved, but apparently small and smooth. Whorls 5. moderately convex on the side, closely appressed. Suture deeply impressed. Body whorl elongated with steep shoulder of medium width, limited below by an obtuse shoulder angle. Periphery broadly rounded, base broadly excavated. Axial sculpture dominant; axials strong, sharply rounded on the crest, a little narrower than the interspaces, continuing well developed on the earlier whorls. On the body whorl the axials number about 19, and die out about

<sup>434</sup>Op. cit., p. 128, pl. 45, figs. 13, 14.

<sup>&</sup>lt;sup>435</sup>Evans, John, and Shumard, B. F., St. Louis Acad. Sci. Trans., vol. 1, p. 41, 1857. Meek, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 381, pl. 31, figs. 9a, b, c, 1876.

midway of the basal slope; on the upper part of this slope they trend upward and obliquely backward to the shoulder angle where they curve sharply forward and cross the shoulder to the suture. The spirals are narrow, numerous and sharply developed all over the shell; in general they are a little wider than the interspaces and are coarsest and flat-topped on the basal slope. Aperture elongate, angular at the rear, produced anteriorly into a somewhat twisted canal of medium length. Outer lip broadly arched, with a broad anal notch of medium depth, the deepest part of which lies just above the shoulder angle. Inner lip broadly excavated, and forming a callus of medium thickness on the parietal wall. Columella apparently smooth and slightly twisted.

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Dimensions of the holotype, the anterior canal of which is partly broken away: Height 10.5 + mm., diameter 3.5 mm.

Types.--Holotype, U.S.N.M. no. 77146; 1 unfigured paratype, U.S.N.M. no. 77147; 1 unfigured paratype, U.S.N.M. no. 77148.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, holotype and 1 unfigured paratype).

Navarro group, Nacatoch sand  $2\frac{1}{2}$  miles west by south of Corsicana (17368, 1 unfigured paratype).

#### AMULETUM VENUSTUM Stephenson, n.sp.

#### Pl. 71, figs. 5, 6

Shell small, spire high, spiral angle about 35 degrees. Protoconch small, smooth, trochoid coiled about 21/2 times, with angle much wider than the spiral angle. Whorls 4 or 5, moderately convex on the side. Sutures rather deeply impressed. Body whorl elongated, rather strongly and broadly constricted at base, slightly constricted above to form a weak collar below the suture; this collar becomes weaker toward the apex and practically fades out on the earlier whorls. Periphery broadly rounded. Axial and spiral ribs present and numerous, the axials dominant. The axials number about 28 on the body whorl and 21 or 22 on the penultimate whorl; they are broadly convex toward the aperture on

the inflated part of the shell, are strongly flexed forward on the collar just below the suture, and die out rather high on the basal slope. The fine, closely crowded spirals cover the whole shell below the protoconch and are coarsest on the basal slope; they override the axials. Aperture long lanceolate with a rather wide acute angle at the rear, passing into a narrow slightly sinuous canal of moderate length in front; the canal is incomplete at the terminus. Outer lip badly broken, but broadly arched above, becoming broadly excavated below. The inner lip is broadly excavated at the base of the parietal wall, and appears to form only a very thin wash of callus. The columella appears to be smooth.

Dimensions of the holotype, the only available specimen: Height 6.8 + mm., diameter 2.7 mm.

The shell is more coarsely sculptured, and has a shorter spire, than either *Amuletum menairyensis* (Wade) or A. *boylei*, but is closely related to both of them.

Holotype.--U.S.N.M. no. 77149.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

#### Unidentified specimens of AMULETUM

A small, incomplete specimen from the Nacatoch sand near Corsicana (763), is similar in form and sculpture to *Amuletum boylei* but the axial sculpture is a little coarser and more prominent; it is probably a young individual. The dimensions are: Height 5 mm., diameter 2 mm. U.S.N.M. no. 77150.

A fragment of a young shell questionably referred to *Amuletum* was found in the Kemp clay at a depth of 800 feet in Cargile No. 1 well of the Robinson Oil and Gas Company, 2 miles west of Groesbeck, Limestone County (13124). This fragment consists of a nearly perfect protoconch, all of the first whorl, and part of the second whorl in advance of the protoconch. The protoconch includes 2½ plump, smooth coils, the whole being plumper and larger than the protoconch of *Amuletum menairyensis* (Wade), the type species of the genus. The sculpture on the early whorls consists of a grid of numerous fine, sharp, closely spaced axials, crossed by nearly equally fine spirals. Complete adult shells, when found, may show this fragment to be generically distinct from *Amuletum*. U.S.N.M. no. 77151.

### Genus FULGERCA Stephenson, n.gen.

Type species.—Fulgerca renusta Stephenson. Etymology.—By anagram from graceful. Gender, feminine.

Shell small, slender, spire elevated, spire and body whorl of about equal length. Shoulders of whorls narrow, sloping; sides of whorls below shoulder broadly rounded to nearly flat, and nearly parallel to the vertical axis. Peripherv very broadly rounded; a sharply incised sulcus is present well down on the base, and ends at the outer lip a little back of the anterior siphonal notch. Aperture elongate-ovate, sharply angular at the rear, passing into a short, slightly twisted canal in front. Outer lip thin with a broad notch at the shoulder angle; inner lip broadly excavated and forming a thin callus on the parietal wall and columella. Surface very finely cancellated with numerous spirals and axials, the latter of which are a little the more prominent. The protoconch is smooth, trochoid, with about 3 volutions.

Wade's *Pseudoliva? attenuata*,<sup>436</sup> from Coon Creek, Tennessec, founded on one small shell, is a member of this genus. Wade questioned the reference of his species to *Pseudoliva*, and expressed the opinion that with better material it would be found to belong to a new generic group. Aside from the spiral sulcus on its base, this shell possesses no characters which would seem to ally it with the Buccinidae; its slender spire and the broad notch in its outer lip below the suture suggest a closer relationship with the Turritidae.

# FULGERCA VENUSTA Stephenson, n.sp.

## Pl. 71, figs. 7, 8

The species is represented by one well preserved shell, with a small portion of the anterior canal broken away, and by another smaller and very incompletely Shell small, preserved individual. slender. Spire high, with spiral angle of about 32 degrees. Whorls about four, with broadly rounded to nearly straight sides, which are nearly parallel to the vertical axis; each whorl ends above in a narrow, sloping shoulder which makes a broad subobtuse angle with the side below: the shoulder slope becomes slightly excavated on the body whorl. Body whorl nearly as long as the spire, broadly rounded on the periphery, cut near the base by a distinctly impressed spiral sulcus. Suture deeply impressed. Protoconch trochoid, moderately large, smooth, making  $2\frac{1}{2}$  or 3 volutions. The surface is very finely and elegantly cancellated with spiral and axial ribs, of which the latter are a little the coarser and more prominent; the axials and growth lines have a nearly vertical trend on the sides of the whorls, but bend sharply forward where they cross the shoulder to the suture; the axials are very irregular in thickness and spacing, being in certain bands little more than closely crowded growth lamellae, these bands apparently recording resting stages; counting the smaller ones there are more than 75 axials on the body whorl; the axial sculpture becomes coarser toward the apex as far as the antepenultimate whorl which has less than half as many ribs as the body whorl; back of the antepenultimate the ribbing becomes finer again. The spiral ribbing is somewhat irregular and is still finer than the axial. and covers practically the whole shell excluding the protoconch; about 45 spirals were counted on the body whorl between the suture and the sinus near the base of the shell, and there are 7 or 8 somewhat coarser spirals below this sinus; about 24 spirals are exposed on the penultimate whorl between the sutures. Aperture clongate-subovate with a narrow deep anal canal at the rear, and a narrow, short, broadly recurved siphonal canal in front. Outer lip thin with a broad notch at the shoulder angle. Inner lip broadly excavated, forming a thin callus over the parietal wall and columella. Columella

<sup>430</sup> Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 146, pl. 51, figs. 4, 5, 1926.

broadly twisted and bearing a narrow, nonprominent fold at the border of the anterior canal.

Dimensions of the holotype: Height about 13 mm., diameter 4.5 mm.

Compared with Wade's species, *Pseudoliva? attenuata*, this one is larger, is not quite so slender, and is more coarsely sculptured at the same stage of growth. The two unquestionably belong in the same genus.

*Types.*—Holotype, U.S.N.M. no. 77152; 1 unfigured paratype, U.S.N.M. no. 77153.

Distribution in Texas.---Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, type lot; 17365).

#### Genus LUTEMA Stephenson, n.gen.

Type species.-Lutema simpsonensis Stephenson. Etymology.-By anagram from amulet. Gender, feminine.

Shell small, turreted. Spire about equal in height to the length of the aperture. Spiral angle 32 to 42 degrees. Protoconch of medium size, smooth, naticoid, coiled 2 or 3 times. Shoulder rather broad, broadly excavated, moderately steep, limited below by an obtuse shoulder angle. Body whorl broadly rounded on the periphery, broadly excavated on the base. Axials short, oblique, numbering 13 to 20, and may or may not be noded on the shoulder angle. Spirals numerous, narrow, weak, and may be practically wanting on the inflated part of the whorls. Aperture long; outer lip broadly arched and thin; inner lip forming a thin callus on the parietal wall; anal notch of moderate depth, sharply rounded at inner end; canal narrow, deep, and straight or only slightly twisted.

Compared with the type species of Surcula H. and A. Adams<sup>437</sup> (genotype, the Recent Pleurotoma nodifera Lamarck== Murex javana Linné, not Chemnitz), this new genus is much smaller, is ornamented with short axials, has the anal notch lower on the shoulder, and has a straight, or nearly straight siphonal canal.

## LUTEMA SIMPSONENSIS Stephenson, n.sp.

#### Pl. 71, figs. 22, 23

Shell small, moderately thick, turreted. Spire about as high as length of aperture; spiral angle 35 degrees above, widening to about 40 degrees below. Whorls 5, increasing regularly in size, closely appressed. Protoconch naticoid, smooth, and coiled about 3 times. Suture sharply Body whorl moderately inimpressed. flated, broadly rounded; shoulder broad, steeply inclined, very broadly excavated; shoulder angle broadly obtuse, and forming the most inflated part of the whorls; periphery broadly rounded, sloping gently to a broadly rounded basal excavation; canal straight. The axials are numerous, there being about 20 on the penultimate whorl; they are oblique, short, moderately strong, but not noded. The shoulder just below the suture on the body whorl is roughened by a series of rather coarse growth rugosities which fade out as they reach the penultimate whorl. The shoulder is covered with fine, rather weak spiral threads; spirals are obscure or wanting on the inflated part of the body whorl, but fine spiral threads are present on the base and on the outer surface of the canal. The anal notch is moderately pronounced and is deepest a little above the shoulder angle.

Dimensions of the holotype, which is slightly broken at the tip of the anterior canal: Height 13.5 + mm., diameter 5.5 mm.

Types.—Holotype, U.S.N.M. no. 77154; 1 unfigured paratype, U.S.N.M. no. 77155.

Distribution in Texas.—Navarro group, Nacatoch sand: Road at Simpson's Hill 2 miles southwest of Kaufman (7546, type loc.); vicinity of Kaufman (761).

### LUTEMA HUBBARDI Stephenson, n.sp.

## Pl. 71, figs. 24, 25

In form this species is much like Lutema simpsonensis, but has a less deeply excavated shoulder and duller and more obscure sculpture, especially on the larger whorls. Spiral angle 35 degrees. Whorls 5 or 6, closely appressed. Suture sharply impressed. Body whorl moderately inflated, broadly rounded; shoulder broad,

<sup>&</sup>lt;sup>437</sup>Adams, II. and A., General Record of Mollusca, vol. 1, p. 88, 1853.

very broadly excavated, steeply inclined; shoulder angle broadly obtuse and forming the inflated part of the whorls of the spire; periphery broadly rounded, sloping gently to a broadly rounded basal excavation; canal straight. Each of the carlier whorls bears from 16 to 20 axials of moderate strength, rounded on the crest: they trend upward and backward, bending forward again on the shoulder; on the larger whorls the axials become strongly oblique, more widely and irregularly spaced, and tend to become obscure: on the body whorl the axials are present only on the shoulder and are irregular in strength of development. The growth lines on the body whorl curve strongly backward from below upward to and a little beyond the shoulder angle where they curve sharply forward, thus marking the successive growth stages of the anal notch. Very fine obscure spiral threads are present, strongest on the base of the body whorl and on the shoulder, absent or dimly discernible on the inflated part of the whorls. The individuals referred to this species show considerable range in the strength of development of the sculpture. Aperture elongated, sharply angular at the rear, narrowly channelled in front. Outer lip broadly arched, strongly notched just above the shoulder angle. Inner lip broadly excavated and forming a thin callus on the parietal wall. Columella straight, smooth.

Dimensions of the holotype, which is slightly broken away at both extremities: Height 19.5 + mm., diameter 8.5 mm.

Types.—Holotype, U.S.N.M. no. 77156; 1 unfigured paratype, U.S.N.M. no. 77157. Named in honor of the Hon. Richard B. Hubbard, Governor of Texas, 1877-1879.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); vicinity of Corsicana (763); vicinity of Kaufman (761); ?field 2 miles southwest of Kaufman (7547).

## LUTEMA MUNDA Stephenson, n.sp.

## Pl. 71, figs 18, 19

This species is smilar in form to *Lutema* simponsensis but is more slender and has coarser axial ornamentation. Spiral angle about 32 degrees. The axials are oblique and strongly developed on the shoulder angle of the body whorl, but die out rather quickly both on the shoulder above and on the body below; they number 13 on the body whorl, 14 on the penultimate whorl, and 16 on each of the next two smaller whorls. Spiral ornamentation is very faint on the inflated part of the whorls, but becomes distinct on the shoulder, on the base of the body whorl, and on the canal; the spirals consist of low, flat, narrow ribs, separated by very narrow incised lines. The anal notch is sharply developed.

Dimensions of the holotype, which is slightly broken on each extremity: Height 13 + mm., diameter 5 mm.

Holotype.-- U.S.N.M. no. 77158.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

#### LUTEMA GENICULATA Stephenson, n.sp.

## Pl. 71, figs. 20, 21

This species has the general form of the three preceding species except that it is less slender and more inflated in the body whorl than any of them. The spiral angle is 42 degrees. The axials are oblique, short and stout, and on the shoulder angle of the larger whorls are developed into rather conspicuous, dull nodes; the axials number about 13 on each whorl. The shoulder is covered with fine, fairly distinct spirals, and the third interspace below the suture forms a wider and deeper furrow than the others; spirals are present though barely discernible on the inflated part of the body whorl; the basal slope and anterior canal are covered with low, relatively broad, flat-topped spirals separated by very narrow, shallow interspaces. The anal notch is moderately deep, its deepest part lying slightly above the shoulder angle. The shell exhibits faint, irregular spots, or mottling, suggestive of color markings; individually some of the better preserved of these marks consist of a center of dark gray, surrounded by a band of light gray, cream, or brown, outlined without by a narrow band of dark gray.

Dimensions of the incomplete holotype: Height 11+ mm., diameter 6 mm.

Holotype.-- U.S.N.M. no. 77159.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761).

### LUTEMA sp.

#### Pl. 71, fig. 26

Incomplete internal and external molds of one specimen of Lutema found in the Kemp clay of the Navarro group at the north corner of the John A. Thompson estate, 1500 feet east of the west line of the Wm. Fisher Survey, about 3.5 miles northwest of Bazette, Navarro County (12922), exhibit numerous sharply developed axial ribs which tend to fade out on the body whorl, and a moderately deep anal sinus, the inner end of which is sharply rounded and lies just above the shoulder angle. The shoulder is broadly concave: on the earlier whorls it is crossed by the recurved axials, but on the body whorl it becomes smooth with the exception of the growth lines. U.S.N.M. no. 77160.

#### Genus BERETRA Stephenson, n.gen.

Type species.—Beretra firma Stephenson, n.sp. Etymology.—By anagram from terebra (Latin), a gimlet. Gender, feminine.

Shell of medium size, thick, turreted. Spire about as high as length of aperture; spiral angle 25 to 30 degrees. Whorls 7 or 8. Protoconch apparently small, smooth, rather high naticoid. Axial sculpture strong; spiral sculpture fine and weak. Anal sinus rather narrow and of medium depth. A tumid collar above the sinus is coarsely noded. Body whorl only moderately inflated, periphery broadly rounded, base broadly excavated. elongate-lanceolate; anterior Aperture canal long, narrow, nearly straight; anal notch of medium depth, rather sharply rounded at inner end. Columella smooth, straight.

Species which should be referred to this genus include: *Turris ripleyana* Conrad from the upper part of the Ripley formation of Mississippi; *Surcula amica* Gardner from the Monmouth formation of Maryland; and Turricula ripleyana (Conrad), Turricula gracilis Wade, and Turricula amica (Gardner) of Wade, from the Coon Creek tongue of the Ripley formation, in Tennessee. (See references on p. 376.)

## BERETRA FIRMA Stephenson, n.sp.

## Pl. 72, figs. 13, 14

Shell of medium size, thick, turreted. Spire about as high as length of aperture; spiral angle about 25 degrees. Protoconch as seen incompletely preserved in one of the paratypes, apparently small, smooth, rather high naticoid. Whorls 7 or 8, closely appressed. Suture not deeply impressed, undulating over the axials. Body whorl moderately inflated; anal sinus of medium width and depth, bordered above by a tumid, coarsely noded collar, the nodes corresponding to the axials below; shoulder angle scarcely defined; periphery broadly rounded; base broadly excavated. Axials on body whorl strong, sharply rounded on the crests, obscurely noded on upper ends, fading out low down on base; axial sculpture extending with only slightly diminishing strength to the apex; the axials number 16 on the body whorl, 15 on the penultimate whorl, and 13 on both the antepenultimate and the next earlier whorl. The spiral sculpture consists of numerous, rather weak ribs, strongest and coarsest on the base of the body whorl, finest on the anterior canal, and weakest on the most inflated part of the body whorl; the spirals increase somewhat in strength and sharpness toward the apex. Aperture greatly clongated, angular at the rear, produced anteriorly into a long narrow straight canal. Outer lip broken, but obviously very broadly arched; anal notch narrow, of moderate depth, and broadly rounded at the inner end. Inner lip broadly excavated and forming a thick callus which completely covers the sculpture on the parietal wall.

Dimensions of the incomplete holotype: Height 50+ mm., diameter 15 mm.

Compared with this species, Beretra ripleyana (Conrad)<sup>438</sup> from the Owl Creek

<sup>&</sup>lt;sup>435</sup>Conrad. T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 332, pl. 35, figs. 21 and 29(?), 1858.

formation on Owl Creek, Tippah County, Mississippi, has more numerous axial ribs, and less sharply developed spiral ribs. Beretra amica (Gardner),439 from the Monmouth formation at Friendly, Maryland, has fewer ribs, and fewer and more strongly developed spirals. Turricula amica (Gardner) of Wade,440 although having an equal number of axial ribs, has fewer spirals, a narrower collar band, and a more sharply constricted base. Turricula ripleyana (Conrad) of Wade<sup>441</sup> has fewer ribs, and much more strongly developed spiral sculpture. Both of Wade's species belong to Beretra.

Types.—Holotype, U.S.N.M. no. 77161; 4 unfigured paratypes, U.S.N.M. no. 20941; 1 unfigured paratype, U.S.N.M. no. 77162; 1 unfigured paratype, U.S.N.M. no. 77163.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Corsicana (763, loc. of 2 paratypes); north edge of Corsicana (518, loc. of holotype and 4 paratypes); 2½ miles north of Corsicana (14114); vicinity of Chatfield (762); vicinity of Terrell (U.S.N.M. no. 77164, replacing old no. 12246).

# BERETRA CONTRACTA Stephenson, n.sp.

Pl. 72, figs. 17, 18

This species is similar in general form to Beretra firma, but has a shorter body whorl, which is more sharply contracted at the base. Shell of medium size, thick. Spiral angle about 30 degrees. Protoconch not preserved. Whorls 6 or 7. Body whorl short, moderately inflated; anal sinus narrow, of medium depth, rounded on bottom; the collar above is wider than the sinus and is coarsely noded, the nodes corresponding to the axials; periphery broadly rounded; base strongly contracted. Axials ribs coarse, rounded on the crests, faintly noded at upper ends, extending well down into the basal constriction; on the holotype the ribs number 12 on the body whorl, 11 on the penultimate whorl, and 10 on the antepenultimate

whorl; the axials continue strong to the apex. The spirals are narrow, weak to moderately strong, and are square-topped; they vary in width, ranging from narrower to wider than the interspaces, being narrowest and closest in the anal sinus; they are coarsest and most widely spaced on the base of the body whorl, and are weakest on the inflated part of the body whorl.

The aperture is elongate-lanceolate, sharply acute at the rear and produced anteriorly in a long, narrow, straight, siphonal canal. Outer lip broadly arched, anal notch of medium depth and broadly rounded at inner end. Inner lip forming a thin callus over the parietal wall. Columella smooth, straight.

Dimensions of the holotype, which is broken at the apex and slightly broken at the anterior end: Height 34+ mm., diameter 13 mm.

The species bears a superficial resemblance to *Beretra firma*, but has a more sharply contracted base, and coarser and more strongly developed spiral sculpture.

*Types.*—Holotype, U.S.N.M. no. 77165; 2 unfigured paratypes, U.S.N.M. no. 77166.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

### BERETRA STRIATA Stephenson, n.sp.

#### Pl. 72, figs. 15, 16

This incomplete shell is practically identical in size and form with Beretra contracta, but differs in ornamentation. The axial ribs, though of about the same number and thickness are less prominent; they are weakly noded at their upper ends, and are represented on the collar above the anal sinus by moderately prominent, broadly round-topped nodes. An important difference between the two species is in the spiral ribbing. In striata these ribs, though not prominent, nevertheless are distinctly developed over all the surface except the collar. The body whorl between the fasciole and the periphery is covered with 10 or 12 low ribs that alternate in breadth, the wider ones being slightly the more prominent; the separating interspaces are narrower than the ribs, and on

<sup>&</sup>lt;sup>439</sup>Gardner, Julia A., Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 420, pl. 14, figs. 8, 9, 1916.

<sup>440</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 112, pl. 36, figs. 1, 2, 1926.

<sup>411</sup> Wade, Bruce, op. cit., p. 111, pl. 36, figs. 6, 7.

the whorls of the spire are little more than sharply incised striae. Eight or 9 ribs on the basal slope are wider, more prominent, and more widely spaced than the ones above. The anal sinus bears 5 small, narrow, closely spaced spirals. The growth lines indicate a narrow anal notch of moderate depth.

The incomplete holotype measures: Height 26+ mm., diameter 13.5 mm.

Holotype.-U.S.N.M. no. 77167.

Distribution in Texas.—Navarro group, Kemp clay: 3½ miles north-northwest of Bazette (17375).

#### BERETRA ORNATULA Stephenson, n.sp.

## Pl. 72, figs. 9, 10

The incomplete holotype is the only available specimen. Shell proportionately small, turreted, with strong spiral and axial sculpture, the latter dominant. Spiral angle 30 degrees. Protoconch broken away. Whorls 7, strongly appressed. Suture moderately impressed, wavy. Body whorl moderately inflated, broadly rounded on the periphery, sharply contracted at base. Axials thick, prominent, round-crested, numbering 12 on the body whorl, decreasing to 7 on the smallest whorl. On the body whorl the axials are obscurely noded on their upper ends just below a deep moderately wide anal sinus; the latter is bordered above by a prominent, strongly noded collar that is narrower than the sinus; the axials die out well down on the base; they continue prominent on the smaller whorls to the tip of the spire. Spirals of moderate strength, squarish-topped, averaging about as wide as the interspaces; they override the axials on whose crests they may be weak or partly worn away. On the body whorl the spirals number about 12 between the lower edge of the anal sinus and the base, and are strongest on the basal slope; several weak, closely spaced spirals are present still lower on the shell; 4 or 5 of the upper spirals are exposed on the smaller whorls. The anal sinus bears 4 small, closely spaced spirals; the collar is without spirals except in places on its lower slope where one or two small weak ones appear. The growth lines indicate an anal notch of only moderate depth. The outer lip is badly broken, and most of the siphonal canal is gone. The inner lip forms a thin callus and is broadly excavated above. The exposed portion of the columella is smooth.

Dimensions of the incomplete holotype: Height 19+ mm., diameter 8 mm.

The sharply developed spirals give to this shell a more strongly ornate appearance than that of the other recorded species.

Holotype.--U.S.N.M. no. 77168.

Distribution in Texas.--Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

### BERETRA? ELONGATA Stephenson, n.sp.

#### Pl. 72, figs. 11, 12

One specimen from the Corsicana marl has the general form of Beretra firma, except that the spire is higher, the anterior canal is longer, and the base is more sharply constricted. Although the specimen is not well preserved, it exhibits the specific characters clearly enough for description. Shell elongated, turreted. Spire shorter than length of aperture; spiral angle approximately 23 degrees. Protoconch not preserved. Whorls 6 or 7. Body whorl moderately inflated, the maximum inflation being about at the periphery; anal fasciole of medium depth and a little wider than the collar above it; collar with dull nodes corresponding to the axials; periphery broadly rounded, base sharply constricted. Axials of somewhat unequal development, ranging from narrow and sharply rounded to moderately wide and broadly rounded; they die out about midway of the base; axials 15 on body whorl, and 12 each on the penultimate and antepenultimate whorls; the axials continue well developed, though poorly preserved, on the earlier whorls. Spirals numerous, narrow and of unequal development; they are coarsest and most widely spaced on the base, very weak on the upper part of the body whorl, a little stronger on the penultimate whorl, and rather sharply developed and closely crowded on the antepenultimate whorl.

The aperture is about 33 mm. long in the holotype, the upper 16 mm. being broadly and moderately arched, and the anterior part forming a long, narrow, straight siphonal canal. The anal notch as shown by the growth lines is of medium depth and rounded at the inner end. The inner fip is broadly excavated above; the callus is incompletely preserved but remnants on the upper half of the canal indicate a rather thick layer.

Dimensions of the holotype: Height 55 + mm., diameter about 13 mm.

This species is much more elongated than any of the other species referred to the genus *Beretra*.

Holotype.-U.S.N.M. no. 77169.

Distribution in Texas.—Navarro group, Corsicana marl: 1 3/10 miles north of McQueeney (7637).

### Genus FUSIMILIS Stephenson, n.gen.

Type species .-- Fusimilis robustus Stephenson. Etymology. Combination of Fusus and similis.

Shell of medium size, thick, robust. Spire a little shorter than length of aperture; spiral angle about 47 degrees at the tip, decreasing to about 35 degrees on the larger whorls. Whorls 7 or 8. Body whorl short, inflated, strongly constricted at base; anterior canal long, narrow, slightly sinuous. Axial sculpture strong, with numerous ribs. Spiral sculpture comparatively weak or absent on the spire and upper part of the body whorl, but coarse on the base. Collar band strongly sculptured with nodes or coarse growth lamellae. Notch of outer lip broad, shallow, and situated a little below a narrow sinus bordering the collar on its lower side. Columella smooth with the exception of a low, narrow ridge bordering the upper edge of the siphonal canal.

This genus is only provisionally referred to the family Turritidae; the broad shallow notch which lies below the usual position of the anal notch on the representatives of this family may not be a true anal notch.

The shells which  $Wade^{442}$  called *Turris* proxima and *T. constricta* belong to this

new genus; these two species may in reality represent two stages of growth of one species only. *Drillia novemcostata* Conrad<sup>413</sup> from the Owl Creek formation at Owl Creek, Tippah County, Mississippi, is a member of this genus, and *Drillia? tippana* Conrad may belong to it.

## FUSIMILIS ROBUSTUS Stephenson, n.sp.

## Pl. 72, figs. 21-23

Shell of medium size, thick, robust. Spire a little shorter than length of aperture: spiral angle about 47 degrees at the apex, decreasing to about 35 degrees on the larger whorls. Protoconch not preserved. Whorls 7 or 8, closely appressed. Suture moderately impressed, undulating over the axials. Body whorl most inflated a little above the periphery: collar rather wide and closely set with rounded nodes which correspond to the axials below: collar bordered below by a narrow sinus of medium depth; periphery broadly rounded; base deeply excavated. Axials numerous, thick, closely set, rounded on the crests; on the body whorl the axials end abruptly below at the periphery and tend to evanesce toward the aperture on adults; the axials number 20 or 21 on the body whorl, 18 on the penultimate whorl, and 15 on the antepenultimate whorl: from below the axials first sweep upward and backward in a broad curve, then bend sharply forward above, ending abruptly at the sinus below the collar: the upper end of each axial is obscurely noded; due to the sharp forward curve of the growth lines the collar node corresponding to a given axial is set forward to a position directly above the interspace in front of the axial; the axial sculpture continues strong on the whorls of the spire to the apex. Spiral sculpture is wanting on all the surface of the shell above the periphcry of the body whorl; on the base of the body whorl are 5 or 6 rather coarse, rugged lirae, narrower than the interspaces; on the upper part of the canal are 5 or 6 much finer and more closely spaced lirae which on the holotype become zigzag in trend as they approach the aperture.

<sup>&</sup>lt;sup>412</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 110, pl. 35, figs. 11, 12; pl. 36, figs. 5, 10, 1926,

<sup>443</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 331, pl. 35, fig. 13, 1858.

Aperture acutely angular at the rear, extended anteriorly into a long, narrow, slightly sinuous canal. Outer lip broken away, but strongly arched at the main opening of the aperture, with, as shown by the growth lines, a very broad, shallow notch below the intersection of the collar sinus. Inner lip rather deeply excavated, forming a callus on the parietal wall, which is thin above and thicker below. The columella is smooth with the exception of a narrow, nonprominent ridge bordering the upper edge of the siphonal canal.

Dimensions of the incomplete holotype: Height 50 + mm., diameter 21 mm.; one of the paratypes is 60 + mm. high.

Closely related species occur in the Owl Creek formation of Mississippi.

*Types.*—Holotype, U.S.N.M. no. 77170; 1 figured paratype, U.S.N.M. no. 77171; 1 unfigured paratype, U.S.N.M. no. 77172.

Distribution in Texas.---Navarro group, Nacatoch sand: Vicinity of Kaufman (761, loc. of holotype and 1 paratype); road 2 miles southwest of Kaufman (7546, loc. of 1 paratype).

## Genus REMNITA Stephenson, n.gen.

Type species.—*Turricula biacuminata* Wade. Etymology.—By anagram from *minaret*. Gender, feminine.

The following description is based on the holotype of Turricula biacuminata Wade. Shell of medium size, fusiform, Spire turreted, with 9 or 10 slender. whorls. Apical angle 25 degrees; this angle is variable on different species. Suture moderately impressed, Whorls broadly convex on the side, the larger ones having a flattened band above bordering the suture; this band develops into an increasingly excavated shoulder on the three largest Body whorl greatly elongated, whorls. constricted at the base. Shell covered with numerous, squarish spiral ribs which are irregularly undulating in trend. Axial sculpture feebly developed or wanting; on the larger whorls a few broad, obscure axial undulations may be present but these die out posteriorly before reaching the antepenultimate whorl. Aperture greatly elongated with a narrow, acute anal canal at the rear, widest above the middle,

gradually narrowing below and passing into a long, narrow anterior canal which becomes slightly bent near the tip; the aperture is approximately equal in length to the height of the spire, but varies a little one way or the other on different species. Columella smooth. Outer lip not preserved but a decided notch above the shoulder angle is indicated by the sharply deflected growth lines on the shoulder.

Turricula faccolata Wade and T. anomalocostata Wade are members of this genus. Amuletum Stephenson is a closely related genus.

## REMNITA BIACUMINATA (Wade)

Pl. 72, figs. 19, 20

1926. Turricula biacuminata Wade, U.S. Geol. Survey Prof. Paper 137, p. 112, pl. 36, figs. 13, 14.

For a detailed description of this species, see Wade's paper cited above. The following description is based on the one available incomplete specimen from Texas. Shell as preserved small, turreted, with a spiral angle of 28 degrees, incomplete at both ends, with 31/2 whorls remaining. Whorls broadly rounded on the sides. modified by a flattened band just below the suture. Suture moderately but sharply impressed. Body whorl broadly rounded on the side and base, becoming constricted below, and exhibiting a faint suggestion of coarse axial undulations on the most inflated part. The body whorl is ornamented with about 17 spirals of unequal strength and spacing as follows: 4 spirals on the inflated portion are moderately coarse and are separated by slightly wider interspaces; the 4 uppermost spirals are smaller and more closely crowded; 4 or 5 spirals on the base are of about equal size and are separated by interspaces of corresponding width; the remaining spirals in the basal constriction are small and obscure; 7 or 8 spirals are exposed on the penultimate and antepenultimate whorls. The growth lines on the body whorl trend upward and backward in a broad curve to about the center of the flattened shoulder band, thence bend sharply forward to the suture; this sharp

bend indicates the presence of a pronounced notch on the upper part of the outer lip. The aperture is not preserved but is obviously elongate-lanceolate with an acute posterior angle.

Dimensions of the incomplete figured specimen: Height 10.7 + mm., diameter 5 + mm.

The identification with the Coon Creek species is made with a fair degree of confidence, though perfect material might show differences.

*Types.* Holotype and paratype, U.S.N.M. no. 32857; from Coon Creek, McNairy County, Tennessee. One plesiotype from Texas, U.S.N.M. no. 77173.

Distribution in Texas. --Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366).

Outside distribution.- Tennessee: Coon Creek tongue of Ripley formation.

Range. The type material came from the upper part of the *Exogyra cancellata* zone: the Texas specimen came from a slightly higher position.

### Order OPISTHOBRANCHIA

## Suborder TECTIBRANCHIATA

### Family ACTEONIDAE

### Genus ACTEON Montfort

Type species. -Voluta tornatilis Gmelin. (:= Voluta tornatilis Linné.)

## ACTEON? THROCKMORTONI Stophenson, n.sp.

### Pl. 72, figs. 5, 6

Shell small and of medium thickness. Spire low: spiral angle about 80 degrees. Protoconch broken away, but obviously very small. Whorls about 3, closely ap-Suture shallow. Body whorl pressed. proportionately very large, elongate, with a narrow shoulder of medium steepness, and an ill-defined, obtuse shoulder angle; body whorl very broadly rounded from shoulder angle to anterior terminus. Axial sculpture wanting. Spiral sculpture consisting of numerous, rather sharply incised, punctate lines of nearly uniform strength, separating flattish ribs of differing widths; on the body whorl the ribs are narrower on the basal slope than they are midway of the height, but several of the ribs one-third the length of the body

whorl below the suture are narrow and closely crowded; 4 or 5 of the ribs are exposed on the penultimate whorl. Aperture elongate, very narrow above, acutely angular at the rear, widening below, but sharply rounded at the anterior terminus. The anterior part of the body whorl is broken away, but the outer lip is obviously broadly arched. Inner lip deeply excavated about midway of the height; the parietal wall is covered nearly to the suture above with a thin wash of subtransparent callus through which the underlying sculpture may be seen. The columella is short and twisted and bears a strong oblique fold.

Dimensions of the incomplete holotype: Height 8 + mm, diameter 4 + mm.

Compared with the genotype, Acteon tornatilis (Linné), of the Recent seas of Europe, this species has a closely similar, strong columellar fold, but is smaller, has a more pronounced shoulder angle, and the whorls are more closely appressed.

Holotype.- U.S.N.M. no. 77174. Named for the Hon. James W. Throckmorton, Governor of Texas, 1866-1867.

Distribution in Texas.-Navarro group, Neylandville marl: 2½ miles north of Corbet (16170).

### ACTEON? NITIDUS Stephenson, n.sp.

## Pl. 72, figs. 7, 8

Shell small, thick, plump. Spire short; spiral angle approximately 90 degrees at the apex, decreasing below. Protoconch not preserved. Whorls 4, closely appressed, broadly rounded on the sides. Suture moderately impressed. Body whorl plump, regularly rounded from the suture above to the anterior terminus below. Axial sculpture wanting. The spiral sculpture consists of numerous sharply developed, narrow, squarish-topped ribs, separated by interspaces of equal or narrower width; the spirals number about 30 on the body whorl where they are coarsest on the basal slope and on the upper part, and are finest on the most inflated part; 5 or 6 of the spirals are exposed on the penultimate whorl. The interspaces are partitioned off into small rectangular spaces by thin sharp growth lamellae which appear to slightly override the spirals. Aperture elongate, narrow above and sharply acute at the posterior extremity, wider below and sharply rounded at the anterior extremity. The outer lip is broken, but is broadly arched and is probably finely crenulated within. Inner lip deeply excavated below the midheight and, though poorly preserved, it probably forms a thin callus on the lower part of the parietal wall. Columella short. slightly twisted, and set with a rather thick. rounded. oblique fold of moderate strength.

Dimensions of the holotype: Height 12 mm., diameter 7.25 mm.

The columellar fold on this species appears to be more like that on *Acteon* than it is like that on *Troostella*.

Types.—Holotype, U.S.N.M. no. 77175; 1 unfigured paratype, U.S.N.M. no. 77176.

Distribution in Texas.—Navarro group, Kemp clay: Near Deatsville (764, paratype; 14125, holotype).

## Genus TROOSTELLA Wade

1926. Troostella Wade, U.S. Geol. Survey Prof. Paper 137, p. 103.

Type species .- Troostella perimpressa Wade.

The Cretaceous species here referred to the genus *Troostella* are usually assigned to *Acteon*, which is based on *Acteon tornatilis* (Linné). a Recent species of European seas. Although the Recent and Cretaceous forms are closely allied, the latter possesses a longer columella, a much less prominent and less oblique columellar fold, and a deeper and more open suture. These differences, though not great, probably justify the recognition of a separate genus to hold the Cretaceous species.

Species referred to *Troostella*, in addition to the type species, are: *Acteon substriatus* Wade,<sup>444</sup> from Coon Creek, Tennessee; *Troostella sublinearis* Stephenson from the Nacatoch sand, Navarro County, Texas; and *T.? brevispira* Stephenson, also from the Nacatoch sand.

## TROOSTELLA SUBLINEARIS Stephenson, n.sp.

### Pl. 72, figs. 1, 2

Shell of medium size and thickness. glazed: height about twice the diameter. Spire rather low, less than half as high as the length of the aperture; spiral angle about 70 degrees at the apex, decreasing to 65 degrees on the larger whorls of adults. Protoconch not preserved. Suture at the bottom of a narrow V-shaped channel. Whorls 5, broadly rounded on the side. Body whorl moderately plump. broadly and regularly rounded from suture to anterior terminus, with neither shoulder nor peripheral angle. Axial sculpture wanting. Growth lines fine and broadly convex in trend toward the aperture. Spiral sculpture consisting of numerous fine, slightly impressed, punctate lines of irregular strength and spacing: the lines are coarsest on the base below and just below the suture above: there is a tendency toward alternation of larger and smaller lines. Aperture clongate. narrow and acutely angular posteriorly, broader below but sharply rounded at the anterior extremity. Outer lip thin, broadly arched, faintly crenulated within. Inner lip rather deeply excavated a little below the middle: parietal wall bare above. rather thickly callused over below. Columella slightly twisted with one broad, low, rounded fold well above the extremity.

Dimensions of the incomplete holotype: Height 13 + mm., diameter 10.5 mm.

The type specimens of this species bear the label Solidula riddelli Shumard. The original description of Shumard's445 species fits this lot of shells in most respects, but the spiral striae are said to number only 9 or 10, whereas on Troostella sublinearis they are fully twice as numerous, if only the more sharply impressed striae are counted. As Shumard's types are lost and can not be compared with the specimens now under consideration, it seems best to treat the latter as a distinct species.

<sup>444</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 102, pl. 33, figs. 10, 11, 1926.

<sup>445</sup>Shumard, B. F., Boston Soc. Nat. Hist. Proc., vol. 8, p. 194, 1862.

The genotype of *Troostella*, *T. perimpressa* Wade,<sup>446</sup> is larger and plumper than the Texas species, and its spiral lines are more deeply impressed, though they are fewer in number and more irregularly spaced.

*Types.* -Holotype, U.S.N.M. no. 77177; 6 unfigured paratypes, U.S.N.M. no. 77178.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518, type loc.); vicinity of Chatfield (762).

Range. —Known only from the Nacatoch sand in Navarro County. A closely related, if not identical, species occurs in the Nacatoch sand of Arkansas.

## TROOSTELLA? BREVISPIRA Stephenson, n.sp.

#### Pl. 72, figs. 3, 4

Shell small, of medium thickness. Spire low; spiral angle about 95 degrees. Protoconch not preserved. Suture channelled, V-shaped in cross section. Whorls 3 or 4, broadly rounded on the side; body whorl moderately inflated, broadly and regularly rounded. Spiral sculpture consisting of numerous slightly impressed punctate lines of unequal strength and spacing, but showing a tendency to alternate in size. Aperture elongate, narrow above and sharply angular at the posterior end, becoming wide open below; anterior end broken away. Outer lip thin, broadly arched. Inner lip moderately excavated below the midheight; parietal wall bare above, callused over below. No columellar fold can be seen from the aperture.

Dimensions of the incomplete holotype: Height 8 + mm., diameter 5 mm.

This species is smaller, shorter, and has a wider aperture than *Troostella sublinearis:* the spiral sculpture is also proportionately finer. The failure to see a columellar fold at the aperture leaves doubt as to the assignment of the shell to *Troostella*.

Holotype .---- U.S.N.M. no. 77179.

Distribution in Texas.—Navarro group, Nacatoch sand: North edge of Corsicana (518).

#### TROOSTELLA? sp.

One imperfect shell from the Kemp clay, in a gully 2 miles north-northwest of Deatsville. Travis County (14128), has the general form of Troostella sublinearis, but is more elongated and compressed on the side, perhaps mechanically so. There is a slight suggestion, though no certain indication, of the beginning of a columnar fold at the aperture. The sculpture consists of numerous, sharply impressed, punctate, spiral lines. The suture is channelled as in T. sublinearis. This is probably a distinct species but is not well enough preserved to serve as a Dimensions: Height 21 + mm., type. diameter 10 + mm. U.S.N.M. no. 77180.

#### Genus NONACTEONINA Stephenson, n.gen.

#### Type species.--Nonacteonina graphoides Stephenson

Etymology .-- Non, not; Acteonina.

Shell of medium size and thickness, elongated. Spire high, but in the genotype is less than two-fifths the total height of the shell, and has an apical angle of about 42 degrees. Protoconch small, smooth, coiled  $2\frac{1}{2}$  or 3 times. Whorls broadly and evenly convex on the side, Suture sharply but closely appressed. not deeply impressed. Body whorl elongated, broadly rounded, but slightly compressed on the side. Shoulder and peripheral angles wanting. Axial sculpture wanting. Spiral lines numerous, punctate. Aperture clongated, narrow above, acutely angular at the rear, wide below, but sharply rounded at the anterior end. Outer lip thin, broadly arched, faintly crenulated within. Inner lip with a deep excavation well below the middle, and forming a callus only on the lower part of the parietal wall. Columella thin and twisted, with no evidence of a fold on the available specimens.

An imperfect shell from Coon Creek, Tennessee, which Wade<sup>447</sup> called *Acteonina orientalis*, appears to be a member of this new genus. *Acteonina* d'Orbigny is based on a Carboniferous species, *Chemnitzia* 

<sup>&</sup>lt;sup>46</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 103, 1926.

<sup>&</sup>lt;sup>415</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 104, pl. 33, figs. 8, 9, 1926.

carbonaria de Konick,<sup>448</sup> which, judging from the original figure, is entirely different in form, has a much lower spire, and cannot reasonably be regarded as congeneric with this Cretaceous species.<sup>449</sup> An inner portion of the columella of the specimen described by Wade is exposed, and it bears no fold.

The internal mold figured by Weller<sup>450</sup> under the name *Actaeon gabbana* Whitfield, which is not the species described and figured by Whitfield, probably is a species of *Nonacteonina*.

## NONACTEONINA GRAPHOIDES Stephenson, n.sp.

# Pl. 73, figs. 24, 25

Shell of medium size and thickness, elongated. The spire is high, but is less than two-fifths the total height of the shell; spiral angle about 42 degrees at apex, decreasing somewhat below on the spire. Protoconch small, smooth, coiled 21/2 or 3 times. Whorls 5, broadly and evenly convex on the side, closely appressed. Suture sharply but not deeply impressed. Body whorl clongated, broadly rounded above and below, slightly compressed centrally; shoulder and peripheral angles wanting. Axial sculpture wanting. Trend of growth lines broadly convex toward the aperture. Spiral lines fine and numerous, punctate, coarsest on the basal slope and just below the suture; spiral lines somewhat irregular with respect to strength and spacing, but showing a tendency to alternate between narrow, sharply incised channels and very fine grooves; about a dozen of the stronger spiral grooves are exposed on the penultimate whorl and 8 or 9 on the antepenultimate whorl. One incomplete specimen from near Chatfield, Navarro County (14117), exhibits much more sharply incised, and more closely spaced spiral lines, than other specimens studied, and is questionably referred to this species. Aperture elongate, very narrow above, acutely angular at the rear, widening out below, but sharply rounded at the anterior extremity. Outer

lip rather thin, faintly crenulated within, broadly arched, but slightly subtruncated above the midheight. Inner lip strongly excavated well below the midheight; parietal wall bare above, callused over low down on the base. Columella thin and twisted with no evidence of a fold on any of the available specimens.

Dimensions of the nearly complete holotype: Height 23.5 + mm., diameter 9 mm.

The holotype and 3 of the paratypes bear an original identification label, "Acteon linteus (Conrad)," but comparison with topotypes of Conrad's species shows that the Texas shells have a much higher spire, and apparently lack a columellar fold, and cannot be that species.

*Types.*—Holotype, U.S.N.M. no. 77181; 3 unfigured paratypes, U.S.N.M. no. 20893; 1 unfigured paratype, U.S.N.M. no. 77182.

Distribution in Texas. Navarro group, Neylandville marl: 2½ miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, loc. of holotype); 23/5 to 4/5 mile northeast of Chatfield (14117); north edge of Corsicana (518, loc. of paratypes).

# NONACTEONINA DEFLEXA Stephenson, n.sp.

## Pl. 73, figs. 26, 27

Shell small, elongate, fullest below the midheight. Spire a little more than onethird the total height of the shell; spiral angle about 54 degrees near the apex, decreasing markedly below. Protoconch broken away. Whorls 1 or 5, closely appressed. Suture shallow but sharply impressed, curving obliquely downward as it approaches the aperture. Body whorl elongated, slightly flattened on the side, drooping noticeably toward the aperture. Axial sculpture wanting. Trend of growth lines very broadly convex toward the aperture, fullest below the midheight of the body whorl. Spiral grooves numerous, sharply impressed, punctate, somewhat irregularly spaced, with a decided tendency to alternation in strength on the lower twothirds of the body whorl. Five or 6 grooves are exposed on the antepenultimate whorl, but owing to the downward

 <sup>&</sup>lt;sup>438</sup>d'Orbigny, Alcide, Prod. Pal., vol. 1, p. 118, 1850.
<sup>449</sup>See also Stewart, Ralph B., Acad. Nat. Sci. Phil-

adelphia Proc., vol. 78, p. 433, 1926. <sup>450</sup>Weller, Stuart, Geol. Survey New Jersey, Palcontology,

<sup>\*\*\*</sup>Weller, Stuart, Geol. Survey New Jersey, Paleoatology, vol. 4, p. 807, pl. 99, figs. 78, 1907.

trend of the suture the number of exposed grooves increases successively to a maximum of 10 on the larger part of the penultimate whorl. Aperture greatly elongated, sharply acute above, widening out below, but sharply rounded at the anterior extremity. Outer lip thin, forming a very broad, slightly truncated curve. Inner lip forming a thin callus on the parietal wall, deeply and broadly excavated on the lower part of the base. Columella thin and twisted.

Dimensions of the slightly incomplete holotype: Height 8.7 + mm., diameter 3.2 mm.

The three incomplete, questionably identified specimens from near Chatfield (U.S.N.M. no. 21073) resemble this species, but they appear to be a little more slender, more flattened on the side, and have slightly finer spiral sculpture; they have the same drooping suture at the upper side of the body whorl. This species is much smaller than N. graphoides and is more slender and more flattened on the side of the body whorl.

*Types.*- Holotype, U.S.N.M. no. 77183; one young incomplete paratype, U.S.N.M. no. 77184.

Distribution in Texas.—Navarro group, Nacatoch sand: 4 miles north of Corsicana (17366, type loc.); ?vicinity of Chatfield (762).

### NONACTEONINA TENSA Stephenson, n.sp.

## Pl. 73, figs. 22, 23

Shell small, slender, of medium thick-Spire high, slightly exceeding the ness. length of the aperture; spiral angle about 35 degrees at the apex, decreasing to about 25 degrees below on the larger whorls. Protoconch broken away. Whorls 5 or 6, closely appressed, broadly rounded on the Suture shallow. Body whorl sides. elongated, broadly and regularly rounded on the side. Spiral grooves on the body whorl sharp, punctate, numbering about 4 to the millimeter: an occasional weak groove is intercalated between the others, becoming stronger toward the aperture; spacing of grooves somewhat irregular, being widest centrally and narrower above and below on the body whorl. Aperture long, sharply acute above, widening out below, and sharply rounded at the anterior

extremity. Outer lip thin; inner lip forming a thin callus.

Dimensions of holotype: Height 10 + mm., diameter 3.2 mm.

The species resembles *N*. *deflexa*, but has a longer and more slender spire, and lacks the pronounced lateral flattening of the body whorl.

Holotype.-U.S.N.M. no. 77185.

Distribution in Texas.--Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, type lot; 17365).

### NONACTEONINA? TRITICEA Stephenson, n.sp.

## Pl. 73, figs. 20, 21

Shell small and of medium plumpness. Spire short for the genus, equalling about 0.3 the total height of the shell; spiral angle 53 degrees on the holotype. Protoconch trochoid in form but corroded, poorly preserved and broken at the tip. Whorls 3 or 4, closely appressed. Body whorl elongated, broadly rounded from suture to anterior end. Shell covered with numerous, flattish spiral ribs of differing widths, separated by punctate striae which vary in depth and width; there is a noticeable crowding of several of the ribs in a narrow band just below the suture. Aperture elongated, very narrow and acute at the rear, widening considerably below the midheight, sharply rounded at the anterior end. Outer lip thin and partly broken away; it is broadly arched. Inner lip deeply excavated below the midheight, and forming a thin callus on the parietal wall. Columella smooth, long, and nearly straight.

Dimensions of the holotype: Height 8 mm., diameter 3 mm.

This species is much smaller, and has a proportionately shorter spire and longer columella, than *N. graphoides*. It has a shorter spire and is plumper than either *N. tensa* or *N. deflexa*.

Types.—Holotype, U.S.N.M. no. 77186; 1 unfigured paratype, U.S.N.M. no. 77187.

Distribution in Texas.- Navarro group. Nacatoch sand: 4 miles north of Corsicana (17366).

## NONACTEONINA sp.

One incomplete, small shell from the Neylandville marl, on the Corsicana road  $2\frac{1}{2}$  miles north of Corbet (Tex. Bu.

17300) has finer sculpture and a shorter spire than *Nonacteonina tensa*, the type of which came from the same locality.

One internal mold with the sculpture sharply impressed upon it, including the body whorl and part of the penultimate whorl (pl. 73, fig. 28), from the Corsicana marl in a westward-facing bluff on Guadalupe River. 1 3/10 miles north of Mc-Queeney, Guadalupe County (15524), is similar in form to *Nonacteonina graphoides*, but it exhibits more numerous, more sharply incised, and more sharply punctate, spiral grooves. Although doubtless a distinct species this specimen is scarcely well enough preserved to serve as a type. U.S.N.M. no. 77188.

#### Genus TORNATELLAEA Conrad

#### Type species .- Tornatellaea bella Conrad.451

The genotype, *Tornatellaea bella* Conrad, is from the Eocene at Claiborne, Alabama. It is larger than the Upper Cretaceous species found in the Neylandville marl and in the Nacatoch sand, but is comparable in size to *T. grandis* Stephenson from the Kemp clay.

The Cretaceous species present certain differences which render uncertain the correctness of their reference to Tornatellaca; they have a wider spiral angle at the apex, which decreases somewhat on the larger whorls below, whereas in T. bella Conrad the angle is acute at the apex and increases markedly below; the folds on the columella are less oblique and occupy a slightly lower position. On the other hand the shells of the two epochs have a general similarity in form, a similar kind of sculpture, are striated on the inner surface just back of the outer lip, and have 2 strong columellar folds; for the present it seems best to refer the Cretaceous shells to the Eocene genus.

#### TORNATELLAEA SCATESI Stephenson, n.sp.

### Pl. 73, figs. 16, 17

Shell small, thick, moderately plump. Spire shorter than length of aperture; spiral angle 75 or 80 degrees at apex, decreasing to about 50 degrees below on the larger whorls. Protoconch not well

preserved, but apparently small, smooth and not very high. Whorls 4, closely appressed. Suture not deeply impressed, but narrowly channelled. Body whorl large, broadly and evenly rounded near the outer lip from suture to anterior extremity, becoming steeply compressed on the parietal wall. Surface sharply lined with spiral, punctate furrows which are somewhat irregular in size and spacing on a given individual, and noticeably different on different individuals; on the body whorl just in advance of the aperture fine lines appear in the spaces between some of the furrows and these increase in strength in the direction of growth, splitting the basal slope into a series of narrow paired ribs and interspaces; 6 to 8 of the spiral lines are exposed on the penultimate whorl. Aperture elongate-ovate, acutely angular at the rear, widening out quickly below, ending in front in a pronounced siphonal notch of moderate width. Outer lip thin, broadly arched, lined on the interior with striations which reflect the ribs and furrows. Inner lip deeply excavated a little below the midheight; parietal wall apparently bare above, thinly callused over below. Columella short, twisted, and bearing two strong, narrow, oblique folds, the lower one of which lies just above the siphonal notch.

Dimensions of the nearly complete holotype: Height about 10 mm., diameter 5.5 mm.

In form and ornamentation this species is similar to *Tornatellaea cretacea* Wade, but it is plumper and the whorls are more closely appressed.

Types.—Holotype, U.S.N.M. no. 77189; 10 unfigured paratypes, U.S.N.M. no. 21019. Named in honor of William B. Scates, a signer of the Declaration of Independence of Texas.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761, type loc.); road 3/5 mile west of Kaufman (14098); vicinity of Chatfield (762); loose pieces of rock in street at Chatfield (7568); 3 miles northeast of Corsicana (9545); north edge of Corsicana (518); vicinity of Corsicana (763).

<sup>&</sup>lt;sup>451</sup>Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 294, pl. 47, fig. 23, 1860.

#### TORNATELLAEA CRETACEA HEBES Stephenson, n.var.

## Pl. 73, figs. 12, 13

This variety differs from Tornatellaca cretacea Wade,452 from Coon Creek, Tennessee, in its blunter apex and more closely appressed whorls. The available specimens are all smaller than Wade's holotype, and they appear to be a little more slender. The protoconch is not perfectly preserved on any of the specimens. but it appears to be small, trochoid and the succeeding whorl of the main shell expands rapidly away from it. The spiral grooves are deep, finely punctate, and vary considerably in number and spacing on different individuals; they are, however, more closely spaced on the base than on the main surface above. The two columellar folds are not perfectly preserved on the available material, but they are moderately oblique and rather prominent.

Dimensions of the incomplete holotype: Height 6 + mm., diameter about 4 mm.

Types.—Holotype, U.S.N.M. no. 77190; 6 unfigured paratypes, U.S.N.M. no. 77191.

Distribution in Texas.—Navarro group. Neylandville marl: 2½ miles north of Corbet (16170, type lot; Tex. Bu. 17300).

#### TORNATELLAEA CRETACEA APPRESSA Stephenson, n.var.

### Pl. 73, figs. 14, 15

This variety is similar in form and ornamentation, and is comparable in size, to *Tornatellaea cretacea* Wade, but its whorls are more closely compressed and its spire is a little more slender. As in other members of the genus the spiral grooves are somewhat irregular in strength and spacing. There is a slight flattening of the side of the body whorl.

Dimensions of the holotype: Height about 7.5 mm., diameter 4 mm.

Compared with the variety *hebes*, this variety is less blunt at the apex, and has a more slender profile; the ornamentation is similar in the two varieties. *Types.*—Holotype, U.S.N.M. no. 77192; 2 unfigured paratypes, U.S.N.M. no. 77193.

Distribution in Texas.—Navarro group, Nacatoch sand: Field west of Kaufman (14103); vicinity of Chatfield (762); <sup>3</sup>/<sub>4</sub> mile east of Chatfield (7571); 3 miles northeast of Corsicana (9545); 3<sup>1</sup>/<sub>5</sub> miles north of Corsicana (16168); road 5 miles south-southwest of Corsicana (7573, type loc.).

# TORNATELLAEA GRANDIS Stephenson, n.sp.

# Pl. 73, figs. 18, 19

Shell large as compared with other Cretaceous species. Height of spire a little less than length of the aperture; spiral angle about 70 degrees at the apex, decreasing to about 50 degrees on the larger whorls below. Protoconch small, but poorly preserved. Whorls 5, broadly rounded on the side, closely appressed. Suture moderately impressed. Body whorl broadly and evenly rounded near the aperture from the suture above to the anterior extremity. Surface ornamented moderately impressed all over with grooves, a little wider than the intervening squarish ribs; each groove is divided into many small, transverse rectangles by thin axial partitions which, on the smaller whorls, give to the grooves a punctate appearance; about 20 grooves appear on the body whorl, and 7 or 8 are exposed on the penultimate whorl: the grooves low on the base of the body whorl are narrower and more closely spaced. Aperture elongate-subovate, acutely angular at the rear, and sharply rounded, with a siphonal notch in front. Outer lip broken, but broadly arched. Inner lip deeply excavated a little below the midheight, apparently not forming a callus on the parietal wall. Columella bearing 2 large, strong, moderately oblique folds.

Dimensions of the slightly defective holotype: Height about 16 mm., diameter 8.5 mm.

This is the largest Cretaceous species known in the Coastal Plain, and is about equal in size to the genotype, *Tornatellaea bella* Conrad, from the Eocene of Alabama. The apex of grandis is much less

<sup>472</sup>Wade, Bruce, U. S. Geol. Survey Prof. Paper 137, p. 103. pl. 34, figs. 3, 4, 1926.
acute than that of *bella* which becomes increasingly more slender from the penultimate whorl backward, ending in a small, elevated protoconch: the spiral grooves of *bella* appear to be more deeply impressed.

*Types.*—Holotype, U.S.N.M. no. 77194; 2 unfigured paratypes, U.S.N.M. no. 77195.

Distribution in Texas.—Navarro group, Kemp clay: Near Deatsville (14125. type loc.); ?Webberville (7601).

#### Family RINGICULIDAE

## Genus RINGICULA Deshayes

## **RINGICULA PULCHELLA Shumard**

### Pl. 73, figs. 3-5

- 1861. Ringicula pulchella Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 192.
- 1926. Ringicula pulchella Shumard. Wade, U.S. Geol. Survey Prof. Paper 137, p. 105, pl. 34, figs. 10, 11.

Shumard described this species as follows:

Shell small, oblong oval; spire moderately elevated, conical, acute at tip, enlarging rather rapidly from apex, volutions five, rounded; last one large and ventricose; suture distinct, depressed; aperture narrow, curved, pointed above, gradually widening to the base; outer lip thickened, broad, acute above, prolonged upon the spire, inner edge strongly crenulated, outer surface [of lip] marked with distinct, longi-tudinal, and transverse lines, and presenting a finely cancellated appearance; columellar lip thickened and marked below with strong teeth. Surface with rather coarse, rounded revolving lines, of which there are about sixteen on the body volution; these are crossed by very fine, crowded striae of growth, which give to the intervals between the revolving lines a minute punctate appearance. Length, 0.26 inch; width, 0.2 inch; apical angle, 60°.

Shumard's types are probably lost, but among the collections at the National Museum are 7 specimens from near Chatfield, the type locality, which are believed to belong to the species, and about 125 specimens have been collected near Corsicana. These collections reveal considerable individual variation in specific characters, but some specimens conform closely the to original description. Shumard's delineation of the species may be supplemented by the following notes.

The angle of the spire near the apex varies on different shells from 60 to 73 degrees. The protoconch is small, smooth, conical, and coiled about 11/2 times. The number of whorls in addition to the coils of the protoconch is 4 instead of 5, on even the largest shells. The sutures are closely appressed. The surface may be described more accurately as ornamented with spiral, flat-topped ribs separated by narrow punctate grooves: these ribs vary in number on different individuals from 12 to 21, but on many the number is 16; the ribs on the basal slope are generally narrower than those higher on the body whorl. The cancellated outer surface of the thick outer lip of adults is a striking feature of the shell; this sculpture is produced by the spiral grooves overriding the thick callus, crossed by coarse growth ridges: the thickened outer lip is prolonged upward across the penultimate, and halfway across the antepenultimate whorl. The thick callus forming the inner lip of the aperture presents curious, irregular features which vary somewhat in detail on different individuals, but which include from below upward: A narrow, prominent, oblique ridge bordering the narrow twisted anterior canal; just above this ridge is a profound, very oblique channel; next above is a prominent. very oblique columellar fold which is bifid at its outer end, but quickly coalesces into a single fold as it passes inward; paralleling this fold above is a wider, less profound channel which is almost at right angles to the linear direction of the columella; bordering this channel above is a narrow, moderately prominent fold which at its outer end bends sharply upward and continues for 2 or 3 mm. as an irregular ridge of callus with a general vertical trend. The ridge just described forms the anterior side of the anal canal, the posterior side of which is formed by the upward prolongation of the thick outer lip. A very wide, curved, anterior fasciole, which forms the anterior end of the columella, is marked with 3 or 4 narrow, longitudinal ridges, and by numerous, more or less obscure, transverse striations.

Dimensions of the medium sized ncotype: Height 6.5 mm., diameter, including the thick outer lip, 5 mm. The largest specimens do not exceed 9 mm. in height.

The one beautifully preserved shell from Coon Creek, Tennessee, which Wade referred to this species, appears to be correctly identified.

Types.—The whereabouts of Shumard's type material is unknown; presumably it is lost. The neotype is selected from seven specimens from near Chatfield, Navarro County, the type locality: Neotype, U.S.N.M. no. 77196; 5 typical examples, unfigured, U.S.N.M. no. 77197; 1 figured example, U.S.N.M. no. 77219. One hundred and twenty-five specimens, many of them better preserved than those from Chatfield, have been collected from near Corsicana in the same county (U.S.N.M. no. 20944).

Distribution in Texas. -Navarro group, Nacatoch sand: Northeast of Quinlan (16162); vicinity of Chatfield (762,neotype and 5 typical examples); from loose pieces of rock in street at Chatfield (7568, 1 example figured); 3 miles northeast of Corsicana (9545); Watkins' place 3 miles north of Corsicana (9552); 2 miles north of Corsicana (9553, 9554);  $2\frac{1}{2}$  miles north of Corsicana (14114): north edge of Corsicana (518); vicinity of Corsicana (763); road 5 miles southsouthwest of Corsicana (7573); 4 miles north of Corsicana (17366); 5 miles northeast of McClanahan (17371).

Outside distribution. -Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: Ripley formation.

Chattahoochee region (Alabama): Upper part of Ripley formation.

Range.—In Texas the species has been recorded only from the Nacatoch sand. The occurrence of the species in the Coon Creek tongue in Tennessee indicates a slightly lower range there than the known range in Texas. There is no record of the species in the uppermost beds of the *Exogyra costata* zone.

# RINGICULA CULBERSONI Stephenson, n.sp.

## Pl. 73, figs. 1, 2

Shell large for the genus. Spire high, acute. Spiral angle about 55 degrees at

the apex, increasing to 60 degrees on the larger whorls below. Protoconch small, conical, coiled  $1\frac{1}{2}$  or 2 times. Whorls 5, closely appressed, broadly rounded on the side, expanding rapidly. Suture rather Body whorl large, deeply impressed. plump, evenly rounded in profile. The surface is ornamented all over with numerous flat-topped ribs of irregular width, separated by narrow, shallow, squarebottomed, finely punctate grooves; 27 ribs appear on the body whorl of the holotype, the widest, about midway of the height, being half a millimeter wide: 3 or 9 ribs are exposed on the penultimate whorl. Aperture rather widely open, elongate-subovate, increasing somewhat in width from above downward; the siphonal canal is short, twisted, and forms a narrow, deep notch on the front margin. The outer lip is broadly arched and thickened, and is prolonged about halfway across the penultimate whorl above, where it forms the inner side of the anal canal. The inner lip is rather thickly callused, is deeply excavated below, and bears 3 folds: the lower fold is narrow, prominent, moderately oblique and borders the anterior canal; the middle one is narrow, prominent and curved, becoming strongly oblique as it passes backward; the third one is narrow, weak, strongly oblique, and is high on the parietal wall; on well preserved shells a ridge of callus forms the outer edge of the inner lip, extending upward and slightly backward and becoming at its upper end the outer side of the anal canal. The callus of the inner lip differs considerably in strength of development on different individuals, and is not well preserved on some specimens.

Dimensions of the holotype: Height 13.9 mm. diameter 9.5 mm.

This species has no rival in size among our Upper Cretaceous Ringiculas from the Coastal Plain.

Types.—Holotype, U.S.N.M. no. 77198; 1 unfigured paratype, U.S.N.M. no. 21187; 3 unfigured paratypes, U.S.N.M. no. 77199. Named for the Hon. Charles A. Culberson, Governor of Texas, 1895-1899.

Distribution in Texas.--Navarro formation, Kemp clay: Near Deatsville (764, holotype and 1 paratype; 14125, 3 paratypes).

## RINGICULA ANFRACTOLINEATA Stephenson, n.sp.

## Pl. 73, figs. 6, 7

Shell small, thin. Spire elevated, acute; spiral angle 70 degrees at the apex, increasing somewhat below. Protoconch small, conical, coiled about twice. Suture sharply but not deeply impressed. Whorls three, closely appressed, broadly curved on Body whorl proportionately the sides. large, broadly and regularly curved in Surface of body whorl ornaprofile. mented with 15 closely spaced grooves, each of which is finely zigzag in trend, thus producing an elegantly patterned surface; 6 grooves are exposed on the penultimate whorl. Aperture elongate, rather narrow, acutely angular at the posterior end, widening somewhat anteriorly, ending in front in a relatively broad notch, overhanging a little on the outer Outer lip thick, longitudinally side. striated, produced above a little more than halfway across the penultimate whorl; inner surface of outer lip transversely striated. The inner lip is deeply excavated below, and forms a thick, irregular callus the upper part of which on the holotype has become peeled off and lost; the description of this lip is based in part on the holotype and in part on the paratypes; a narrow sharply upraised fold borders the short, twisted, siphonal canal below; above this fold is a broad, oblique channel which is bordered above by another narrow prominent oblique fold, sometimes bifid; the second fold is bordered above on the parietal wall by a broad, shallow, oblique channel; from the outer end of this channel there extends upward a bifid ridge of callus which borders the outer side of the well developed anal canal. The anterior fasciole, which in reality forms the anterior prolongation of the callus of the inner lip, is broad, strongly twisted and grooved near its outer border.

Dimensions of the holotype: Height about 4.75 mm., diameter 2.5 mm.

This elegant and remarkably well preserved species is much smaller than *Ringicula pulchella* Shumard, and is characterized by its exquisite surface pattern of zigzag lines. Types.—Holotype, U.S.N.M. no. 77200; 3 unfigured paratypes, U.S.N.M. no. 77201.

Distribution in Texas.—Navarro group, Kemp clay: Webberville (7601, 3 paratypes; 13910, holotype).

## RINGICULA SUFFLATA Stephenson, n.sp.

## Pl. 73, figs. 8, 9

Shell of medium size, plump. Spire low, conical; spiral angle about 85 degrees. Protoconch small, apparently coiled 11/2 times. Whorls 3, expanding rapidly, broadly curved on the sides. Suture moderately impressed, slightly channelled. Body whorl proportionately very large, plump, evenly rounded in profile. Surface of body whorl ornamented with 17 sharply incised grooves which are finely zigzag in trend, and show some unevenness in spacing; 7 grooves are exposed on the penultimate whorl. Aperture elongate, moderately wide open, acutely angular at the rear, widest centrally and narrowing slightly at the front; anal canal wide and strongly developed, siphonal canal narrow, twisted and rather Outer lip broadly arched, thick, deep. prolonged posteriorly across the penultimate and nearly across the antepenultimate whorl, there forming the inner wall of the anal canal. Inner lip strongly excavated below and forming a heavy, strongly differentiated callus; a narrow, sharply upraised oblique fold borders the anterior canal; on the lower part of the parietal wall is a still more prominent, more oblique fold separated from the lower fold by a profound, rather wide channel; beginning a little above the second fold is a prominent, vertical, bifid ridge of callus which extends upward high onto the spire, forming the anterior side of the anal canal; behind the vertical ridge near its lower end is a weak transverse fold; anterior fasciole narrow, strongly curved.

Dimensions of the holotype: Height 8 mm., diameter including the thickened lip 6.5 mm.

This species has a lower spire and is more globose than any previously described species in the Coastal Plain.

*Types.*—Holotype, U.S.N.M. no. 77202; 2 unfigured paratypes, U.S.N.M. no. 77203. Distribution in Texas.—Navarro group, Kemp clay: 3 miles S. 30° W. of Thrall (15537, holotype; 17370, 2 paratypes).

## Unidentified species of RINGICULA

Two small imperfectly preserved specimens of *Ringicula* from the Corsicana marl, in a bluff on Onion Creek, 2½ miles west of old Garfield, Travis County (15532), can not be assigned to any described species. U.S.N.M. no. 77204.

A badly crushed internal mold of a medium sized shell, with the spiral grooves impressed upon it, from the same formation in a branch below the public road,  $2\frac{1}{2}$  miles north of Tona siding, in Hunt County (15546), is questionably referred to *Ringicula*. U.S.N.M. no. 77205.

#### Genus OLIGOPTYCHA Meek

Type species. -Actaeon concinnus Hall and Meek (= Cinulia (Oligoptycha) concinna (Hall and Meek) Meek).

The name Oligoptycha was proposed by Meek453 as one of three subgenera of Cinulia, of which Cinulia s.s. and Avellana were the other two subgenera. Oligoptycha differs sufficiently from either Cinulia or Avellana to justify its recognition as a separate genus, and has already been so recognized by Stewart.<sup>454</sup> However, a careful comparison of the California shells in the National Museum, labelled Cinulia obliqua Gabb, with material in the Museum which was studied or figured by Meck, shows that in the former the siphonal canal lies higher above the anterior terminus of the aperture, and in addition to the strong fold above the canal it has a weaker fold on the lower side of the canal; in the typical Oligoptycha the margin of the shell itself forms the lower margin of the canal. The California shell is doubtfully an Oligoptycha, as Stewart considered it to be.

Oligoptycha is particularly characterized by one prominent fold at the base of the columella. This fold is so strongly oblique that its outer end ascends instead of descends as is usual with such folds; the fold borders the upper side of a narrow, deep siphonal canal, which also rises at its outer end. Although Mcek mentions only one columellar fold, the removal of matrix from within one of the specimens handled by him reveals swellings on the parietal wall well back in the shell that may be the beginnings of two weak folds.

The shells from Texas and Tennessee, described on following pages as Oligoptycha americana (Wade), exhibit such a close similarity to Oligoptycha concinna (Hall and Meek) in form and sculpture, and in the character and trend of the basal columellar fold and the siphonal canal, that it seems reasonable to treat them as generically identical. Possible objections to this classification are 2 to 4 small folds on the parietal wall, and crenulations on the inner margin of the outer lip, of the Texas and Tennessee specimens, but in view of the other similar features, the differences mentioned should perhaps be regarded as specific, or perhaps sectional, rather than generic.

The genus *Eriptycha*, to which Wade questionably referred his species *americana*, though similar in form, is quite different from *Oligoptycha* in the character of its columellar folds and its siphonal canal.

### OLIGOPTYCHA AMERICANA (Wade)?

## Pl. 73, figs. 10, 11

#### 1926. Eriptycha? americana Wade, U.S. Geol. Survey Prof. Paper 137, p. 105, pl. 34, figs. 13, 14.

Shell very small, subglobose. Spire low, almost dome-shaped. Protoconch small and apparently coiled less than twice, with axis slightly tilted. Suture slightly but sharply impressed. Whorls 2 or 3, closely appressed, rapidly expanding. Body whorl proportionately large, plump, almost semicircular in profile. Body whorl ornamented with about 17 closely spaced, finely punctate spiral grooves which are subequally spaced. Aperture crescentic, sharply acute posteriorly, less so anteriorly; anal canal prolonged upward on the penultimate whorl; siphonal canal narrow, inclined upward toward its outer terminus. Outer lip

<sup>&</sup>lt;sup>453</sup>Meek, F. B., Rept, U. S. Geol, Survey Terr., vol. 9, pp. 283-284, pl. 31, figs. 6 bis, a b c, 1876.

See also: Hall and Meek, Am. Acad. Arts and Sci. Mem., Boston. vol. 5 (n. ser.), p. 390, pl. 3, fig. 4, 1851; Cossmann, M., Essais Paleoe. Comp., vol. 54, no. 1, p. 121, 1895.

<sup>&</sup>lt;sup>454</sup>Stewart, Ralph, Acad, Nat, Sci. Philadelphia Proc., vol. 78, p. 436, 1926.

thickened, with coarse longitudinal striations, its upper end prolonged upward onto the penultimate whorl; inner margin of outer lip finely crenulated, except at the lower broadly curved margin which is smooth. Inner lip strongly callused at the outer margin, broadly excavated below. Bordering the upper side of the ascending anterior canal is a narrow, prominent fold which is so oblique as to incline downward as it passes into the shell; on the parietal wall somewhat back from the outer margin of the inner lip are at least 4 short very oblique fold-like processes which are distinct from each other and are irregularly distributed.

Dimensions of the figured specimen: Height 2 mm., diameter, including the outer lip, 2 mm.

The description given is based on one small specimen which seems essentially like Wade's species *americana*, except that it is only about half as large. Should a large suite of specimens show this difference in size to be constant, the Texas shell should perhaps be classed as a separate species, since it occurs in a higher stratigraphic position. This shell was accidentally broken beyond repair after it was photographed.

Types.—Holotype, U.S.N.M. no. 32836; from Coon Creek, McNairy County, Tennessee; 1 plesiotype? from Texas, U.S.N.M. no. 77206.

Distribution in Texas.--Navarro group, Kemp clay: At a depth of 800 fect in a well 2 miles west of Groesbeck (13124). Outside distribution.--Tennessee: Coon

Creek tongue of Ripley formation.

#### Family SCAPHANDRIDAE

## Genus ELLIPSOSCAPHA Stephenson, n.gen.

Type species.—Cylichna striatella Shumard. Etymology.—Combination of ellipsis (an ellipse) and scapha (a boat).

Should a question be raised in the future as to the correctness of the identification of the shells here under consideration with Shumard's species, the present author expressly specifies that the generic name *Ellipsoscapha* is based upon the species represented by the specimens here referred to Shumard's species, and described and illustrated in this work.

The genotype of *Scaphander* Montfort is *S. lignarius* (Linné), from the Recent seas of Europe; it is a large, convolute, umbilicate shell so openly coiled that one can see practically all of the interior to the apex which, however, is imperforate. The California Eocene shell, *Scaphander* (*Mirascapha*) costatus (Gabb) Stewart, which Stewart<sup>455</sup> made the type species of the subgenus *Mirascapha*, is more slender and more closely coiled than the typical *Scaphander*.

The Cretaceous shells to which the name *Ellipsoscapha* is here given, are similar to *Mirascapha*, but they approach more nearly an ellipse in vertical profile, are more tightly coiled, producing a nearly straight columella bearing a broad gentle fold, and have a much smaller, apical depression.

Stewart assigned Scaphander ligniticus Aldrich, from the Eocene of Alabama, to Mirascapha. This shell is sufficiently coiled to form a sinuous columella; it is rather slender in its upper portion, widening to its maximum diameter a little below the midheight; it has a proportionately large open apical depression, with a wash of callus covering the bottom and extending part way up the sides. If this shell is correctly referred to Mirascapha, its characters would seem to justify raising Mirascapha to the rank of genus.

Another related shell is *Abderospira* from the Chipola Miocene of Florida, which Dall<sup>456</sup> described as a subgenus of *Bullina*, but which Stewart<sup>457</sup> raised to the rank of genus. The type species, *Bullina (Abderospira) chipolana* Dall, is a small shell having a profile similar to that of *Ellipsoscapha*, but more broadly ovate, a proportionately larger apical depression which appears to be perforate, a fairly open umbilical fissure and similar spiral sculpture.

The species Haminea cylindrica Gardner,<sup>453</sup> Bulla mortoni Forbes,<sup>459</sup> Bulla

<sup>455</sup>Stewart, Ralph B., Acad. Nat. Sci. Philadelphia Proc., vol. 78, p. 437, pl. 27, fig. 5, 1926.

<sup>453</sup>Dall, Wm. H., U. S. Nat. Mus. Proc., vol. 18, p. 32, 1895. See also Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, pl. 59, fig. 23, 1903.

<sup>457</sup>Stewart, Ralph B., Acad. Nat. Sci. Philadelphia Proc., vol. 78, p. 439, 1926,

<sup>475</sup>Gardner, Julia, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 409, pl. 18, figs, 8, 9, 1916.

<sup>459</sup>Forhes, Edward, Quart, Jour, Geol, Soc. London, vol. 1, p. 63, text fig. a, 1845. concinna Whitfield,<sup>460</sup> Haminea occidentalis Meek and Hayden, H. subcylindrica Meek and Hayden, and H. minor Meek and Hayden,<sup>461</sup> belong in the new genus Ellipsoscapha.

Haminea Gray is based on the Recent species, II. hydatis (Linné), which is a broadly subovate, rather openly coiled shell, almost smooth to the naked eye, but covered with closely spaced, finely wavy, submicroscopic spiral lines; it appears to belong to a decidedly different group than that to which Ellipsoscapha belongs.

## ELLIPSOSCAPHA STRIATELLA (Shumard)

#### Pl. 73, figs. 29, 30

1861. Cylichna striatella Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 194.

Shumard described this species as follows:

Shell elongate-ovate, rounded at apex, nearly elliptical, length almost double the width; spire umbilicate; aperture narrow, arched, with subparallel sides above the middle and gradually enlarging below to near the base, where it is again slightly narrowed; umbilicus closed by the callus of the columella; surface marked with fine lines of growth, and from fifty-six to sixty distinct, revolving striae much narrower than the raised intervening spaces. Length 0.90 inch; width 0.48 inch.

Shumard's description may be supplemented by the following notes: The shell is convolute, the apex being submerged in a moderately deep depression about 1 mm. in diameter. In vertical profile the shell is subelliptical, the sides being very broadly convex with a very slight flattening centrally. The sculpture consists of numerous sharply incised, obscurely punctate grooves, which are in general much narrower than the intervening flat surfaces, but which show marked unevenness in spacing; the spacing is much closer near the apex and on the lower part of the The shell is so base than elsewhere. closely coiled that the columella is nearly straight; and there is a broad, but very weak fold on the columella.

Dimensions of the figured neotype: Height 25 mm., diameter 12 mm.; the largest specimen in the collection is 28 mm, high.

Haminea cylindrica Gardner<sup>462</sup> is a closely related species of *Ellipsoscapha*, but the holotype is a crushed, imperfectly preserved shell that cannot be satisfactorily compared with *E. striatella*.

Bulla mortoni Forbes<sup>463</sup> and B. concinna Whitfield,<sup>464</sup> from the Upper Cretaceous of New Jersey, probably belong to Ellipsoscapha; the former has a more inflated body than E. striatella, and the latter has its greatest inflation too low for that species.

Haminea subcylindrica Meek and Hayden<sup>465</sup> is closely analogous to the Texas species, but is proportionately less slender.

A closely related unstudied species similar to *Ellipsoscapha striatella*, but less slender, occurs in the Owl Creek formation in Mississippi (U.S.N.M. no. 20453).

Types.—Neotype, U.S.N.M. no. 77207; 2 unfigured examples. U.S.N.M. no. 21040.

Shumard's type material is believed to be lost. It is recorded as having been found in the so-called Ripley group of Navarro County, Texas. The original description is fairly complete and agrees well with the specimens from Chatfield here referred to Shumard's species.

Distribution in Texas.--Navarro group, Nacatoch sand: Road 3/5 mile east of Kaufman (14098); road 2 miles southwest of Kaufman (7546); vicinity of Chatfield (762, neotype, and 2 examples); field south of Chatfield (7569); 3/4 mile east of Chatfield (7571); 3/5 to 4/5 mile northeast of Chatfield (14117); vicinity of Corsicana (763); 4 miles north of Corsicana (17366).

## Unidentified specimens of ELLIPSOSCAPHA

Two imperfect specimens found in the Corsicana marl, on the old Frieze place, 2 3/5 miles north by east of Malta, Bowie County (16159), are similar to *Ellipsoscapha striatella* (Shumard), but

<sup>403</sup>Whitfield, R. P., U. S. Geol. Survey Mon., vol. 18, p. 189, pl. 23, figs. 12, 13, 1892.

<sup>&</sup>lt;sup>461</sup>Meek, F. B., Rept. U. S. Geol, Survey Terr., vol. 9, pp. 271-273, 1876.

<sup>&</sup>lt;sup>462</sup>Gardner, Julia, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 409, pl. 18, figs. 8, 9, 1916.

<sup>403</sup>Forbes, Edward, Quart. Jour. Geol. Soc. London, vol. 1, p. 63, text fig. a, 1845.

<sup>&</sup>lt;sup>404</sup>Whitfield, R. P., U. S. Geol. Survey Mon., vol. 18, p. 189, pl. 23, figs. 12, 13, 1892.

<sup>&</sup>lt;sup>405</sup>Meek, F. B., Rept. U. S. Gool. Survey Terr., vol. 9, p. 272, pl. 18, figs. 10 a, b, 1876.

appear to be proportionately more inflated. U.S.N.M. no. 77208.

A crushed specimen from the same formation on the San Antonio road, 6 miles east of Castroville, in Bexar County (15502), may be the same species as the preceding. U.S.N.M. no. 77209.

In the same formation in a westwardfacing bluff on Guadalupe River, 1 3/10 miles north of McQueeney, Guadalupe County (7637, U.S.N.M. no. 77210; and 15524, U.S.N.M. no. 77211), 3 imperfect internal molds of a large convolute gastropod, possibly an Ellipsoscapha, were found. The sculpture is weakly impressed on the molds and consists of numerous spiral grooves of somewhat uneven spacing. The apical depression is quite small, and similar to that of *Ellipsoscapha*. The most striking feature of the shell is its rotund form. The height of the largest specimen is 37 + mm., and the diameter is estimated to be about 24 mm.

Two poorly preserved specimens from the Kemp clay, from a branch  $\frac{1}{2}$  mile south of McLeod school,  $\frac{6}{2}$  miles southwest of Currie, Navarro County (14139), appear to differ from *Ellipsoscapha striatella* (Shumard) in having much more sharply punctate spiral grooves. U.S.N.M. no. 77212.

## Family AKERATIDAE

### Genus AKERA Müller

Type species.—*Akcra bullata* Müller,<sup>466</sup> from the Recent seas of Europe.

The one internal mold from Texas representing the genus *Akera* is remarkably similar to *A. bullata* Müller, but it differs in that the upper part of the shell is noticeably more constricted, the apex is somewhat more sunken, and the shell is proportionately a little less slender. A striking similarity exists in the size and position of the protoconchs of the two species. In the Recent species there is no columella other than the sinuous inner edge of the conch, and the Cretaceous shell appears to correspond to the Recent one in this feature. There can be scarcely any doubt of the generic identity of the Cretaceous and Recent species.

Although the Texas specimen has been referred to *Bullopsis cretacea* Conrad, as indicated by the accompanying label, Conrad's species belongs to an entirely different group having a columella with 2 strong folds, and differing markedly in other features.

## AKERA CONSTRICTA Stephenson, n.sp.

## Pl. 74, figs. 1-3

Shell small, thin. Spire exposed, but depressed, the rim of each successively smaller whorl being slightly lower than the preceding. Protoconch visible as a small, smooth bulb nestled in the center of the spiral depression. Whorls separated from each other in the spiral depression by a deep V-shaped groove, the inner wall of which is broadly convex, and the outer wall broadly excavated; this groove is bounded on its outer side by a subacute, subangulated ridge which becomes more round crested toward the aperture. The profile of the body whorl from the crest of the ridge above to the anterior extremity is broadly convex. The surface of the shell is nearly smooth, but it exhibits very small, narrow, very obscure, widely spaced spiral threads; under the most favorable light exceedingly fine, closely spaced, very obscure spiral lines can barely be detected under the microscope at several places on the surface. The fine growth lines bend strongly backward as they approach the crest of the sutural ridge above. The aperture is almost as long as the height of the shell; it is narrowly acute at the posterior end, but widens out strongly below, and ends in a rather narrowly rounded anterior extremity. Outer lip thin and broadly arched; inner lip broadly excavated and forming a thin wash of callus on the parietal wall. There is no columella other than the sinuous inner edge of the loosely coiled shell.

Dimensions of the holotype: Height 9 mm., diameter 6.5 mm.

The one specimen here described is the only known representative of this genus in the Cretaceous of the Atlantic and Gulf Coastal Plain.

<sup>&</sup>lt;sup>460</sup>Müller, O. F., Prodromus Zoologiae Danicae, p. 242, 1776.

Holotype.-U.S.N.M. no. 21080.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

### Genus HAMINEA Gray

### HAMINEA? SIMPSONENSIS Stephenson, n.sp.

## Pl. 74, figs. 9, 10

Shell of medium size, convolute, loosely coiled, broadly subovate in vertical profile. Spire sunken and concealed; apical depression small, probably imperforate. The shell material is nearly all gone from the polished internal mold, but the mold lears the impressions of numerous external, fine spiral grooves which are minutely zigzag in trend; the grooves on the lower half of the shell are finer and appear to be more obscure than those on the upper half. The aperture is as long as the total height, is moderately wide open above, widens out strongly below, but becomes rather sharply rounded at the anterior extremity. The outer lip is broadly convex above, becoming sharply curved toward the anterior extremity. Inner lip deeply excavated below the midheight; parietal wall thinly washed with callus.

Dimensions of the holotype: Height 11 mm., diameter 8.5 mm.

This shell is similar in form to the Recent Haminea hydatis (Linné), the genotype of Haminea Gray, but the spiral grooves are noticeably coarser than the exceedingly delicate, finely wavy, submicroscopic spiral lines of Linné's species.

Holotype. U.S.N.M. no. 77213.

Distribution in Texas.—Navarro group, Nacatoch sand: Field 2 miles southwest of Kaufman (7547, holotype); ?4 miles north of Corsicana (17366).

#### Genus CYLICHNA Lovén<sup>407</sup>

Type species, as subsequently designated by Herrmannsen.<sup>465</sup>—Bulla cylindracea Pennant.

The genus Cylichna differs from Ellipsoscapha in its much smaller size, its more slender and more nearly cylindrical form, its proportionately larger and more open spiral depression, its narrower aperture, and its weaker and finer spiral sculpture. Each of these genera has a broad, weak fold on the columella, and they seem to be closely related.

### CYLICHNA SECALINA Shumard

## Pl. 74, figs. 4 6

1861. Cylichna secalina Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 195.

The following is Shumard's description:

Shell small, subcylindrical, rounded at inferior extremity, subtruncate above, length more than double the width; spire umbilicate, aperture narrow, widest below, slightly expanded above, and prolonged a little above the summit of the body of the shell; umbilicus closed; surface with very fine striae of growth, and fine revolving striae, which are more distinct near the extremities than the middle of the shell, spaces between irregular, but broader than the striae.

This shell may be readily distinguished from the preceding [*Cylichna striatella* Shumard] by its narrow subcylindrical form, finer striae and small size.

On account of the presence of hard matrix it is difficult to determine whether the spiral depression is perforated at its bottom, or is sealed over; if present the opening must be very small. The spiral striae are decidedly coarser on about the posterior one-eighth of the shell, just below the rim of the spiral depression, and on about the anterior one-third of the shell, including the basal slope, than they are over the remaining intermediate surface; the intermediate grooves vary somewhat in strength on different individuals, and are very obscure on some of them. A thin wash of callus is present on the parietal wall at and just within the aperture, on well preserved specimens. The columella is twisted and bears a rather broad, moderately oblique, but very weak fold.

Dimensions of the neotype: Height 9 mm., diameter 4 mm. Dimensions of one of the larger examples: Height 10 mm., diameter 4.5 mm.

A nearly related but undescribed species from the upper part of the Ripley

<sup>&</sup>lt;sup>467</sup>Lovén, S., Index molluscorum lite-a Scandinavaiae occidentalia habitantium, p. 10, 1846. (Ofvers. K. Vetens Acad. Förh. Stockholm, vol. 3 (5), p. 142. Moll.)

<sup>&</sup>lt;sup>468</sup>Herrmannsen, A. N., Index Generum Malacozoorum, Supplement and Corrigenda, p. 42, 1852.

formation of Mississippi is covered with more sharply and more uniformly incised spiral grooves.

Cylichna recta (Gabb) from the Upper Cretaceous of New Jersey is based on an internal mold which does not show the specific characters.

The small shell from Coon Creek, Tennessee, which Wade<sup>469</sup> referred to *Cylichna recta* (Gabb), is not a *Cylichna*.

Types.—Shumard's type material, which came from near Corsicana, Navarro County, is believed to be lost. His description appears to be sufficiently accurate to enable a satisfactory identification of the Texas shells. Ncotype, U.S.N.M. no. 77214; 1 figured example, U.S.N.M. no. 77215; 16 unfigured examples, U.S.N.M. no. 77216; 23 unfigured examples, U.S.N.M. no. 20898.

Distribution in Texas.---Navarro group, Nacatoch sand: Vicinity of Kaufman (761): road 3/5 mile west of Kaufman (14098); field 3/5 mile west of Kaufman (14103); ?field 2 miles southwest of Kaufman (7547); vicinity of Chatfield (762); loose pieces of rock in street at Chatfield (7568); field south of Chatfield (7569); 3 miles northeast of Corsicana (9545); 2 miles north of Corsicana (9554); 2½ miles north of Corsicana (14114); north edge of Corsicana (518); vicinity of Corsicana (763, neotype); road about 5 miles south-southwest of Corsicana (7573).

## CYLICHNA INCISA Stephenson, n.sp.

## Pl. 74, figs. 7, 8

The six available specimens of this shell are all smaller than the larger specimens of *Cylichna secalina*, but they are very similar in form. The main differences exhibited by *C. incisa* are: The spiral grooves are more sharply and more uniformly incised, and are more distinctly punctate, making the sculpture relatively more pronounced, the grooves near the posterior extremity are just a little coarser as are also the grooves on the basal slope; in vertical profile the shells appear to be a little less slender. Dimensions of the holotype: Height 7 mm., diameter 3.25 mm.

*Types.*—Holotype, U.S.N.M. no. 77217; 5 unfigured paratypes, U.S.N.M. no. 77218.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170).

## Unidentified specimens of CYLICHNA

A mechanically flattened internal mold of *Cylichna* was obtained from the Corsicana marl, on the Mexia highway at the forks of the Wortham road, 2<sup>4</sup>/<sub>5</sub> miles east-southeast of Cooledge, Limestone County (14137); the mold indicates a shell about 8 mm. high; obscure spiral striae are impressed on the mold. U.S.N.M. no. 77234.

Two crushed, broken shells of *Cylichna*, found in the Kemp clay, in the left bank of Colorado River at Webberville, Travis County (7601, U.S.N.M. no. 77235; 13910, U.S.N.M. no. 77236), exhibit very fine, punctate, spiral striae; one is 5 mm. high and the other less than 3 mm. high; these may be young stages of a larger shell.

#### Order PULMONATA

#### Suborder THALASSOPHILA

#### Family SIPHONARIIDAE?

## Genus ANISOMYON Meek and Hayden

Type species, by subsequent designation.--Helcion patelliformis Meek and Hayden<sup>470</sup> (= Anisomyon patelliformis Meek and Hayden).

This genus is represented by one undescribed species from the Snow Hill member of the Black Creek formation in North Carolina,<sup>471</sup> by one undescribed species from the Owl Creek formation of Mississippi, by at least 6 species in the Upper Cretaceous (Montana group) of the Western Interior, and by 1 species from the Cretaceous of California.

<sup>&</sup>lt;sup>460</sup>Wade, Bruce, U. S. Geol, Survey Prof. Paper 137, p. 106, pl. 34, figs. 18-20, 1926.

<sup>&</sup>lt;sup>470</sup>Meck, F. B., and Hayden, F. V., Am. Jour. Sci., 2d ser., vol. 29, pp. 23-35, 1860. See also Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, pp. 285-288, 293, 1876.

<sup>&</sup>lt;sup>471</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, p. 389, pl. 96, figs. 1, 2, 1923.

The specimen described by Wade<sup>472</sup> under the name Anisomyon wieseri [cmcnd wieserae] is doubtfully a member of this genus.

The taxonomic position of this genus in the Siphonariidae has not been definitely established.

## ANISOMYON HAYDENI Shumard

## Pl. 74, figs. 11–15

1861. Anisomyon haydeni Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 198.

Shumard described this species as follows:

Shell patelliform, very thin; length greater than the width; apex situated nearer the posterior margin, curved slightly forward; base oval; anterior side forming a gently convex curve from the apex to front margin; posterior side nearly straight, forming, with the anterior side, an angle of about  $115^{\circ}$ ; sides nearly flat, sloping at an angle of 91°. Surface marked with fine, concentric lines of growth, and some indications of obscure concentric folds.

Length 13 lines [1 1/12 inches]; width 11 lines [= 11/12 inch]; height 6 lines [ $= \frac{1}{2}$  inch]. Nearly related to *A. patelliformis* Meek and Hayden but is not so elevated and the apex is nearer the center.

The description given by Shumard is sufficiently accurate to permit the identification of eleven specimens from near Chatfield. He, however, reversed the position of front and rear as determined by Meek,<sup>473</sup> who correctly states that the apex in this genus is situated between the middle and anterior end, or is sometimes nearly central.

The specimens from near Chatfield exhibit considerable individual variation in outline, form, height, and in the relative position of the apex. The one shown in plate 74, figures 11–13, is chosen as neotype. The profile of the slope in front of the apex is noticeably humped in some specimens, but is nearly straight in others; the profile of the longer slope back of the apex ranges from markedly humped to broadly and evenly convex, but in some specimens is undulating. The apex appears as a small tip which is directed

backward; this tip is broken away on most specimens. The muscular impression is rather obscurely preserved on several of the specimens, and agrees well with this generic feature as described by Meek. It is horseshoe-shaped, and is situated about midway of the inner slope; it is largest on the ends which lie slightly in advance of the apex; on the left side the impression is easily traceable as a narrow irregular band backward around and somewhat past the center of the rear curvature; from which point it is traceable as an irregular, obscure line, forward to the enlarged end of the impression on the right side. On most specimens the sides of the cone are noticeably constricted toward the front. The surface exhibits fine, but rather vigorous growth lines, and gentle growth undulations; very fine, obscure, radiating striae may or may not be present.

Dimensions of the neotype: Length 25.3 mm., width about 20 mm., height about 7 mm.

This species is scarcely distinguishable from Anisomyon patelliformis Meek and Hayden, the type species of the genus. Shumard's statement that the apex of the Texas species is not so elevated and is nearer the center does not seem to hold good in the light of the individual variations shown on the available material. On account of the wide geographic separation of the Texas and Montana localities, and the possibility that large sets of specimens might show consistent differences, it seems best for the present to retain Shumard's name for the specimens from the former locality.

Types.—Shumard's type material is believed to be lost; it was collected near Chatfield, Navarro County. Neotype, U.S. N.M. no. 77220; 3 figured examples, U.S. N.M. no. 77221; 7 unfigured examples, U.S.N.M. no. 21104.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, loc. of neotype and 3 figured examples); 3 miles northeast of Corsicana (9545); ?4<sup>1</sup>/<sub>2</sub> miles east by north of Rosali (14061).

Outside distribution.—Arkansas: Naeatoch sand.

<sup>&</sup>lt;sup>472W</sup>ade, Bruce, U. S. Geol, Survey Prof, Paper 137, p. 180, pl. 60, fig. 10, 1926.

<sup>&</sup>lt;sup>473</sup>Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 285, 1376.

#### ANISOMYON BOREALIS (Morton)?

## Pl. 74, figs. 16, 17

- 1842. Hipponyx borealis Morton, Acad. Nat. Sci. Philadelphia Jour., vol. 8, p. 210, pl. 11, fig. 6.
- 1856. Helcion carinatus Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 8, p. 68.
- 1860. Anisomyon borealis (Morton). Meek and Hayden, Am. Jour. Sci., 2d ser., vol. 29, p. 35.
- 1876. Anisomyon borealis (Morton). Meek, Rept. U.S. Geol. Survey Terr., vol. 9, p. 288, pl. 18, figs. 9a-e.
- 1877. Anisomyon borealis (Morton). White, Rept. U.S. Geol. Survey W. of 100th Meridian, vol. 4, pt. 1, p. 193, pl. 18, figs. 9a, b.
- 1880. Anisomyon borealis (Morton). Whitfield, Rept. Geol. Black Hills, Dakota, p. 436, pl. 12, figs. 21-23.
- 1888. Anisomyon borealis (Morton). Stanton, Colorado Sci. Soc. Proc., vol. 2, pt. 3, p. 185.

Morton's original brief description is "Apex marginal; follows: bodv as from apex to base: shell carinated smooth." His figure does not show the carina running from apex to base; the present whereabouts of the type is not The specimens described and known. figured by Meek are from the Great Bend of the Missouri below Fort Pierre, South Dakota, the type locality of the species, and presumably they may be accepted as topotypes. These specimens show the carina in variable strength.

The one poorly preserved internal mold from Texas here questionably referred to borealis is essentially like the material described by Meek except that the carina running from apex to base is thick and prominent; its strength may be exaggerated by mechanical squeezing. The apex is well toward the front, the front slope is nearly vertical below the apex, and the posterior part of the shell is broadly arched, rising well above the apex. Several widely but irregularly spaced obscure radiating lines and weak ridges are present on the mold, as are also fine concentric growth lines. The outline of the base is subovate with a maximum diameter of 39 mm. and a minimum diameter of 25 + mm. The height is 19 mm.

Types.—The holotype is believed to be lost; topotypes described by Meck, U.S.N.M. no. 248. Plesiotype from Texas, U.S.N.M. no. 77222.

Distribution in Texas.—Navarro group, Nacatoch sand: 5 miles northeast of McClanahan (17371).

Outside distribution.- Pierre shale of the Western Interior.

## Class CEPHALOPODA

#### Subclass TETRABRANCHIATA

#### Order NAUTILOIDEA

#### Family NAUTILIDAE

#### Genus EUTREPHOCERAS Hyatt

Type species. - Nautilus dekayi Morton<sup>474</sup> from the marls of Monmouth and Burlington Counties. New Jersey. According to Whitfield<sup>475</sup> the type material is from the Lower Green Marl (= Navesink marl).

In his original description of Eutrephoceras Hyatt<sup>476</sup> cites the locality "Dakotah, Cretaceous," from which it would appear that he had before him shells from the Pierre group of the Western Interior, which had been identified as belonging to Nautilus dekayi Morton. Nothing in the text indicates that he saw material of this species from the marls of New Jersey. There can be little doubt, however, that Morton's New Jersey species is congeneric with the western material.

### EUTREPHOCERAS PLANOVENTER Stephenson, n.sp.

### Pl. 75, figs. 1 6; pl. 76, figs. 9-11

Adult shell large, subglobose, broadly rounded on the sides, and noticeably flattened on the venter, closely coiled, umbilicus imperforate. Aperture much broader than high, reniform. Siphuncle a little dorsad of the center of the septum. Sutures rather widely spaced, very gently sinuous, with a gentle lateral lobe at the edge of the umbilicus, a broad lateral lobe, a broad ventrolateral saddle, and

<sup>474</sup>Nautilus dekayi Morton, Am. Jour. Sci., vol. 23, p. 291, pl. 8, fig. 4, 1833.

<sup>475</sup>Nautilus dekayi Morton. Whitfield (in part). U. S. Geol. Survey Mon., vol. 18, p. 213, pl. 37, figs. 1-6; pl. 38, figs. 1, 2 (not figs. 3, 4). (Geol. Survey New Jersey, Paleontology, vol. 2, p. 243, pl. 37, figs. 1-6; pl. 38, figs. 1, 2 (not figs. 3, 4)).

<sup>478</sup>Hyatt, Alpheus, Am. Philos. Soc. Proc., vol. 32, pp. 555-558, 639, 1894.

a broad ventral lobe. The surface is smooth with the exception of fine growth lines, and on young stages, fine, longitudinal striae, which generally die out before the shell reaches a diameter of 40 or 50 mm. The trend of the growth lines is broadly convex toward the aperture on the sides, and rather strongly concave toward the aperture on the venter, indicating a fairly pronounced hyponomic sinus on the margin of the aperture.

Dimensions of the incomplete holotype: Greatest diameter 84 mm., dorso-ventral diameter about 31 mm., greatest lateral diameter 71 + mm. The largest specimen in the collections attains a maximum diameter of about 140 mm.; this exceeds the greatest transverse diameter by 10 or 15 mm.

Well preserved shells from the Pierre group of the Western Interior, which generally have been referred to Morton's species *Eutrephoceras dekayi*, are comparable in size and general form to the Texas shells, but they have more closely spaced and markedly straighter sutures and should be treated as specifically distinct.

A comparison of the Texas shells from the Neylandville marl and the Nacatoch sand with the type of *Eutrephoceras dekayi* (Morton) shows a general agreement in size and form, but the New Jersey species appears to be less flattened on the venter. The same is true of the venter of *Eutrephoceras perlatus* (Morton).

Types.- Holotype, U.S.N.M. no. 77223; 1 figured paratype, U.S.N.M. no. 77224;

1 figured paratype, U.S.N.M. no. 77225.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, 17365);  $2\frac{1}{2}$  miles south of Ben Hur (15543).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761, 1 figured paratype); road 3/5 mile west of Kaufman (14098); vicinity of Chatfield (762, 1 figured paratype); 3/4 mile east of Chatfield (7571): 3/5 to 4/5 mile northeast of Chatfield (14117, loc. of holotype); 7 miles north of Chatfield (17236); 21/2 miles north of Corsicana (14114); north edge of Corsicana (518); vicinity of Corsicana (763).

Navarro group, Corsicana marl: ?4 miles southwest of Quinlan (17385).

Outside distribution.---Tennessee: Coon Creek tongue of Ripley formation.

Mississippi: ?Ripley formation.

# Unidentified specimens of EUTREPHOCERAS

Small, incomplete, or crushed specimens of *Eutrephoceras* from the Corsicana marl, too poorly preserved for specific identification, some of which may represent Morton's<sup>477</sup> p ro v i s i o n a l species, *Eutrephoceras perlatus* (Morton), from the Prairie Bluff chalk of Alabama, are recorded from the following localities:

Public road 11/1 miles south by east of Oak Grove, Bowie County (16160, U.S.N.M. no. 77226); from a small branch, W. H. Moore Survey, 100 yards south of Missouri, Kansas & Texas Railroad,  $\frac{1}{4}$  mile east of west line of Survey. 5 miles east by north of Greenville, Hunt County (12924, U.S.N.M. no. 77227); 3 7/10 miles southwest of Campbell (17384, U.S.N.M. no. 77228); road ditch 1 1/5 miles N. 20° W. of Tona siding, in Hunt County (15545, U.S.N.M. no. 77229); Dallas road on west edge of Kaufman (7548, U.S.N.M. no. 77230); dug well 7/20 mile south by west of St. Mary's University, Bexar County (16353, U.S.N.M. no. 77231); cut on San Antonio road, 6 miles east of Castroville, in Bexar County (15502, U.S.N.M. no. 77232).

## Order AMMONOIDEA

## Suborder EXTRASIPHONATA

## Family PTYCHOCERATIDAE

#### Genus SOLENOCERAS Conrad<sup>478</sup>

Type species.--Hamites annulifer Morton;<sup>479</sup> from the ferruginous sand [Crosswicks clay]<sup>180</sup> in the deep cut of the Chesapeake and Delaware Canal, Delaware.

<sup>477</sup>Morton, S. G., Synopsis of the organic remains of the Cretaceous group of the United States, Philadelphia, p. 33, el. 13, fig. 4, 1834.

478Conrad, T. A., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 4, p. 284, 1060.

<sup>479</sup>Morton, S. G., Acad. Nat. Sci. Philadelphia Jour., vol. 8, p. 213, 1842.

<sup>4-9</sup>Carter, C. W., Maryland Gool, Survey, vol. 13, pp. 251-256, 1937.

Ammonites like those here referred to Solenoceras Conrad have heretofore been generally assigned to Ptychoceras D'Orbigny.<sup>481</sup> The latter is, however, a Lower Cretaceous (Neocomian) genus whose size is greater than that of the Upper Cretaceous shells, reaching 200 mm. or more in length, and whose sutures are markedly different. The lobes and saddles of Ptychoceras are much more profound than those of Solenoceras: according to d'Orbigny's figure 4 of plate 137, the suture of *Ptychoceras* includes six subequal, bifid saddles, and six subequal lobes: in Solenoceras the antisiphonal lobe is very tiny and the zygous dorsal saddles are each only about half as large as the lateral saddles. These sutural differences. together with the presence of a double row of ventral nodes on the Upper Cretaceous forms, appear to confirm the validity of Conrad's genus.

Spath<sup>4×2</sup> evidently accepted the genus Solenoceras, but he did not explain on what differences of shell character his opinion was based. In the first paper cited, speaking of his new genus, Metaptychoceras, he says: "This is closer to the Albian Hemiptychoceras Spath than to the true Neocomian Ptychoceras; and probably stands in the same relationship to the last (Turonian) survivors of Hamitidae as the Campanian Solenoceras Conrad does to Diplomoceratidae." In the second paper he says: "The Upper Cretaceous forms of 'Ptychoceras' certainly have nothing to do with the Neocomian forms."

It would appear from the comparison made in the latter part of the first quotation that Spath regards *Solenoceras* as a member of the family Diplomoceratidae. Although the same elements may be recognized in the sutures of *Solenoceras* and *Diplomoceras*, the antisiphonal lobe of the latter is deeper and the lobes and saddles are more profound and more intricate than those of the former, and the habit of growth is markedly different. Except for the discrepancy in the proportional size of the lobes and saddles the sutures of *Solenoceras* appear to be more like those of *Ptychoceras* than those of *Diplomoceras*, and the similarity of form and habit of growth certainly suggest that the two former genera possess family affinities which justify placing them together in the Ptychoceratidae. This was obviously the conclusion of Meck.<sup>453</sup>

Oxybeloceras Hyatt (1900) (genotype, Ptychoceras crassum Whitfield) has the habit of growth of Solenoceras, but is much larger. It has the double row of ventral nodes and essentially the same type of suture pattern and may be a Solenoceras.

### SOLENOCERAS TEXANUM (Shumard)

#### Pl. 77, figs. 4, 5; pl. 79, figs. 1 4

1861. Ptychoceras texanus Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 190.

1891. Ptychoceras texanum Shumard. Hyatt, Am. Philos. Soc. Proc., vol. 32, p. 580.

Shumard described this species as follows:

Shell small and fragile, gently convex on the sides, and flattened on the dorsum [venter1; larger, or body portion, very slightly tapering to the curve behind, and marked with a moderately deep gutter on the ventral [dorsal] side. for the reception of the convex inner side of the slender portion, the transverse section of which is broad ovate; surface marked with strong, simple, annular costae, which are slightly oblique, wider than the spaces between, and on the dorsum [venter] each bearing two slightly elongated nodes.

This shell differs from *Ptychoceras (Hamites)* annulifer of Morton and *P. mortoni* Meek and Hayden, by its flattened form and larger size, also from the former by its nodose ribs, and from the latter by its simple instead of divided costae.

Formation and locality. Cretaceous septariae (Ripley group), near Chatfield Point and Corsicana, Navarro County.

Shumard's type material is lost, but a neotype is selected from a lot of three individuals (topotypes) from Chatfield (762), in the collection of the United States National Museum. These were collected and identified by Dr. T. W. Stanton in 1890, and were later (1894) studied by

<sup>&</sup>lt;sup>481</sup>D'Orbigny, Alcide, Paléontologie Française, Terrain Crétacé, vol. 1. p. 551, 1841.

<sup>&</sup>lt;sup>482</sup>Spath, L. F., Geological Magazine, vol. 63 (of whole series), p. 81, 1826.

<sup>-----, -----,</sup> Trans. Royal Soc. Edinburgh, vol. 53, series), p. 151, 1926.

<sup>&</sup>lt;sup>483</sup>Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, pp. 410-412, 1876.

Dr. Alpheus Hyatt. Shumard's description appears to be good, though it does not indicate the variation in strength, width, and spacing of the ribs, the variation in the size and spacing of the nodes, and the usual absence of both ribs and nodes on the earlier parts of the conch, which the species of this genus exhibit.

On the neotype (pl. 79, figs. 1, 2) the living chamber is compressed laterally and extends backward nearly around the main flexure which characterizes the shells of this genus. On the living chamber the ribs are strong and, on the sides, are markedly oblique backward from the dorsum. Back of the living chamber on the smaller limb of the shell the ribs are oblique forward from the dorsum instead of backward, and are of unequal development on different individuals; more commonly they are weak and irregular, but on an occasional individual they are strong and regular. The nodes on the venter are slightly elongated in the linear direction of the shell, and vary greatly in strength on the different ribs and on different parts of the shell; on the neotype they are strong on the most advanced part of the incompletely preserved living chamber, become weak backward, strengthen up again around the main hend, and become weak again back of the living chamber. On another specimen two marked annular constrictions appear about 8 mm. apart on the small, nearly smooth, early portion of the conch, and it appears that such constrictions may be present at almost any position on the shell, though always widely separated. The adult suture as shown on the neotype consists of 6 rather simple lobes and saddles of only moderate depth. The siphonal lobe is bifid and slightly acentric, and the two digitations are faintly bifid, rather widely separated, and directed obliquely toward the side. The first lateral saddle is bifid, rather broad, and the two subsaddles are each faintly bifid. The first lateral lobe is similar to the siphonal lobe, but is not quite so broad and the sublobes are less oblique. The second lateral saddle resembles the first but is noticeably broader. The second lateral lobe is much like the first in size and digitation. The dorsal saddles are proportionately very small and each is faintly bifid. The antisiphonal lobe is small, shallow and almost simple.

A fine specimen from the Nevlandville marl (pl. 77, figs. 4, 5), which is regarded as belonging to this species, is long and gently tapering, and has the costae strongly and nearly regularly developed on the body chamber, which also exhibits a prominent. regular development of the double row of nodes on the venter; the rest of the shell is nearly smooth with the exception of 4 or 5 well-marked, widely spaced constrictions; the living chamber is more strongly compressed posteriorly than it is toward the aperture, and the remaining slender portion of the shell is broadly subovate in cross section. One fragment in this lot exhibits sutures similar to that of the neotype except that the sutures are slightly more intricate in pattern.

The neotype has a maximum dorsoventral diameter of 4.8 mm., and a lateral diameter of 3.8 mm. In its doubled form the specimen from the Neylandville marl shown in plate 77, figures 4, 5, measures 36 mm. in length; if straightened out the conch would measure 71  $\pm$  mm.; neither the large nor the small end of the conch is quite complete; the maximum dorsoventral diameter is 5 mm., and the lateral diameter 5 mm.; farther back the sides become compressed, the corresponding dimensions being 4.5 and 4 mm.

The type of Solenoceras annuli/er (Morton), an internal mold of the body chamber only. is obviously specifically distinct from S. texanum. It is a plump species, lacking the characteristic lateral compression of the latter species, and, according to Whitfield,<sup>484</sup> has only a weak development of nodes on the venter.

Solenoceras mortoni (Meek and Hayden),<sup>485</sup> from the Pierre shale at the Great Bend of Missouri River, in the Western Interior, is a closely related species. Solenoceras crassum (Whitfield) and S. meekanum (Whitfield), also from the Pierre shale, are closely related species, but they are larger and more coarsely sculptured at all stages than the Texas species.

*Types.*—Shumard's type material, from near Chatfield, Navarro County, is lost.

<sup>&</sup>lt;sup>484</sup>Whitfield, R. P., U. S. Geol, Survey Mon., vol. 18, pp. 273-274, 1892.

<sup>455</sup> Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 412, pl. 20, figs. 4a-b. 1876.

The specimen shown in plate 79, figures 1, 2, from Chatfield (U.S.N.M. no. 21092a), is chosen as neotype; 1 other incomplete topotype from the same locality is figured, U.S.N.M. no. 21092b; several unfigured topotypes from the same locality. U.S.N.M. no. 21092; 1 typical specimen (pl. 77, figs. 4, 5) figured, U.S.N.M. no. 77237.

Distribution in Texas.—Navarro group, Neylandville marl: 2<sup>1</sup>/<sub>2</sub> miles north of Corbet (16170: 17365; Tex. Bu. 17300): 2<sup>1</sup>/<sub>2</sub> miles south of Ben Hur (15543, 1 specimen figured).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, loc. of neotype); 3 miles northeast of Corsicana (9545): 4 miles north of Corsicana (17366): 2 miles north of Corsicana (9555); 23 3/10 miles west-southwest of Corsicana (16163): 2½ miles west by south of Corsicana (17368).

Range.—Neylandville marl and Nacatoch sand of the Navarro group.

### SOLENOCERAS REESIDEI Stephenson, n.sp.

#### Pl. 77, figs. 1-3

Shell small, long and slender, and bent back upon itself in the manner characteristic of the genus. The two limbs of the shell are closely in contact, the smaller limb resting in a groove in the larger limb. The bend is sharp, leaving the umbilical perforation very small or wanting. Sides of living chamber broadly to plumply rounded: venter evenly rounded, or only slightly flattened. The cross section of the smaller limb is nearly circular at the small end, becoming broadly ovate in outline transverse to the plane of coiling, with no flattening on the venter. The venter becomes noticeably flattened around the bend connecting the two limbs. The living chamber is ornamented with strong rather sharp ribs, narrower than the interspaces which, on the holotype, number about 14 to the centimeter; on this limb the ribs slope a little backward from the dorsum. The two ribs nearest the aperture are much stronger than the others and are separated by a deep, relatively broad constriction; a similar feature is exhibited by at least 5 of the available shells and is obviously a mark of senility. The incomplete small limb of the holotype is covered with small, sharp ribs to within 5 mm. of the extremity, where the surface becomes nearly smooth; these ribs number 23 or more to the centimeter; they slope a little forward from the dorsum; the available material shows that the small limb may be smooth for differing distances from the apex on different individuals, up to 15 mm. or more. Widely spaced annular constrictions are present on the small limb of most individuals. A double row of small nodes is present on the venter around the bend connecting the two limbs and is traceable as far as the orifice on the living chamber of most specimens: on the small limb the nodes are traceable backward from the bend for differing distances on different shells, but they fade out before the apex is reached. The shell is thin at the aperture and there is no recognizable hyponomic sinus.

The sutures are not exposed on the type material, but on specimens from the Nacatoch sand near Corsicana (761) the sutures are very much like those of *S. texanum* (Shumard); they are shallow and rather simple, the lateral saddles being broader than the intervening lobes.

The length of the holotype, measured as accurately as possible around the bend, is 53 mm.; an undetermined apical portion of the shell is broken away. The length of the large limb is 22.5 mm. and of the small limb 30.5 mm., the latter projecting 7 or 8 mm. beyond the aperture of the former. The diameter of the smallest part of the shell preserved is 2 mm.; the dorsoventral diameter of the aperture is 4.7 mm., and the transverse diameter 4.2 mm.

The ribbing on the type of Solenoceras annulifer (Morton) is similar to that on S. reesidei, but the latter is more compressed and has a proportionately longer dorso-ventral diameter; Morton's species is from an older formation (Crosswicks clay, New Jersey; Exogyra ponderosa zone).

Compared with *S. texanum* this species has more numerous ribs, the small limb is typically more completely covered with ribs, the ventral nodes are smaller and less prominently developed, and the two limbs are more closely compressed together.

None of the described species from the Cretaceous of the Western Interior are apt to be confused with *S. reesidei*.

Types.—Holotype, U.S.N.M. no. 77238; 4 unfigured paratypes, U.S.N.M. no. 77239. Named in honor of Dr. John B. Reeside, Jr.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, type lot; 17365; Tex. Bu. 17300); 3½ miles west-northwest of Corsicana (16166).

Navarro group, Nacatoch sand: Road 3/5 mile west of Kaufman (11098); vicinity of Kaufman (761).

*Range.*—Neylandville marl and Nacatoch sand of the Navarro group.

### SOLENOCERAS MULTICOSTATUM Stephenson, n.sp.

#### Pl. 76, figs. 12-14

Shell much like that of Solenoceras reesidei except that the ribs are more numerous and the living chamber is more nearly circular back of the aperture, becoming broadly subovate transverse to the plane of coiling backward toward the main bend in the shell. On the living chamber the ribs number 20 to the centimeter, and on the smaller limb 26 or more to the centimeter: the small limb becomes smooth within 2 mm. of the small end as preserved, but an undetermined length of shell is missing at the apical end. The ribs are somewhat irregularly developed around the bend connecting the two limbs. The pair of strong ribs just back of the aperture is prominently developed. The double row of ventral nodes is moderately well developed around the bend, but the nodes are of irregular strength and are wanting on several of the costae. On the venter of the living chamber the nodes are weak and the two rows are rather wide apart; they are easily traceable, however, to the aperture. The nodes are weak and irregular on the small limb but the two rows are traceable for 10 mm. or more backward from the bend. The thin margin of the aperture is partly preserved.

The length of the incomplete holotype if straightened out would be 44 mm. The diameter of the small broken end is 2 mm. The dorso-ventral diameter of the aperture measures 4.2 mm. and the transverse diameter 4.5 mm. The greatest transverse diameter of the living chamber just in front of the bend is 5.5 mm.

One specimen from near Corsicana (518) resembles the holotype except that the ribs on the living chamber for about 7

mm. back from the aperture are a little coarser and more widely spaced than on other parts of the shell. Compared with the type of Solenoceras annulifer (Morton) (= Hamites annulifer Morton), S. multicostatum is closely related, but its ribs are finer and more closely crowded (19 versus 14 to 1 centimeter), it is more compressed in the lateral dimension, and is less compressed in the dorso-ventral dimension.

Holotype.-U.S.N.M. no. 21050.

Distribution in Texas.- Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); north edge of Corsicana (518); 2½ miles west by south of Corsicana (17368).

#### Family HAMITIDAE

### Genus HAMITES Parkinson

## HAMITES? sp.

Several fragments from the Corsicana marl in a westward-facing bluff on Guadalupe River, 1 3/10 miles north of Mc-Queeney, Guadalupe County (15521), are curved portions of living chambers ornamented with ribs like those of *Hamites*. Nodes are wanting. The specimens are too incomplete for satisfactory identification. U.S.N.M. no. 77240.

#### Family BACULITIDAE

## Genus BACULITES Lamarck

The shells of Baculites Lamarck are never found in a complete state of presservation, the reasons being their great length in proportion to their diameter, the fragile nature of the shell material, and the accidents to which they are subject during the processes of burial and fossilization. Because of the fragmentary condition of the material, the species of Baculites are difficult to determine. It is also generally difficult to determine whether or not detached fragments of small individuals are the young stages of the species represented by larger fragments in the same collection, or from elsewhere in the same formation. The difficulty of identification is increased by the variation in form and in suture pattern of the individuals within a given species. The remains of Baculites found in the Navarro group of Texas present the usual difficulties in identification. Some of the fragments are, however, well preserved both as to form and the pattern of the suture. As interpreted most of the material belongs to two species, *Baculites claviformis* and *B. undatus*. At least four other species are, however, represented by meager material.

## BACULITES CLAVIFORMIS Stephenson, n.sp.

## Pl. 1; pl. 77, figs. 6-8; pl. 78, figs. 1-6

Shell of adult large, attaining an estimated maximum length of over 170 centimeters (5.5 - feet). In general the shell tapers rapidly for the genus, but the individuals vary considerably in the degree of tapering. The ovate cross section is modified by a broad flattening of the dorsal surface, and noticeable flattening on the sides toward the venter, thus producing a more sharply rounded ventral edge; the dorsal flattening is scarcely noticeable in young stages, but becomes a marked feature as the shell approaches half an inch in diameter, and in the older stages is one of the principal characters separating this species from B. ovatus Say. The shell is smooth in the young stages but at differing distances from the apex on different individuals begins to develop broad, gentle undulations on the sides, and numerous more or less pronounced growth corrugations on the venter and on the adjacent slopes. The undulations are a little more than half as long as the dorso-ventral axis, are broadly curved concave toward the aperture, and lie nearest the dorsal side. On typical specimens the undulations do not become prominent until the shell has reached  $1\frac{1}{2}$  or 2 inches in its dorso-ventral diameter. The growth corruga-tions on the venter are closely spaced, extend obliquely backward on the sides parallel to the margin of the aperture, and each corrugation fades out near or a little before reaching the center line of the side; similar, though much fainter, growth corrugations ornament the flattened dorsal area of some shells. These corrugations are not equally developed on all individuals and may be practically wanting on some.

The sutures consist of six finely but not deeply digitate saddles and six similarly digitate lobes. The siphonal lobe is very broad and only moderately deep, and is

subdivided by a broad ventral saddle into two tripartite sublobes. The ventral saddle is about two-thirds as high as the ventral lobe is deep, is tripartite, finely digitate, and the two outer subsaddles are higher and much broader than the median subsaddle; the latter may be single, bipartite or irregularly digitate and in the young stages appears to be consistently very small and narrow. The lateral saddles are broad, subequal, bipartite, and finely digitate: the sublobe is narrow and about onethird as deep as the height of the saddle. The first lateral lobe is moderately digitate, is much narrower than the saddles and is bipartite; the subsaddle is small and narrow and is about three-tenths as high as the depth of the lobe. The second lateral lobe is broader than the first, is bipartite, and though nearly symmetrical is slightly oblique; the subsaddle is short, proportionately broad, nearly smooth in the young stages, becoming finely digitate in the later stages of large shells. The dorsal saddle is proportionately very broad, but is much shorter than the lateral saddles; it is bifid, the sublobe being small, narrow, and about one-fourth as deep as the saddle is high. The antisiphonal lobe is small, narrow, rather finely digitate, and more than half as deep as the adjoining dorsal saddles are high.

The incomplete holotype measures: Length 198 + mm.; maximum dorsoventral diameter 66 mm., maximum transverse diameter 47.5 mm.; at small end dorsal-ventral diameter 49 mm., transverse diameter 32 mm. The large exhibition specimen, described below, measures at large end: Dorso-ventral diameter 180 mm.; transverse diameter 115 mm. The next largest specimen, also from near Kaufman (14099), measures: Dorso-ventral diameter 87 mm.; transverse diameter 65 mm.

The largest specimens from the Neylandville marl, which are referred questionably to *B. claviformis*, are smaller than the largest specimens from the Nacatoch sand, but they do reach a maximum measured dorso-ventral diameter of 65 mm. These larger shells are more slender than those from the Nacatoch, but, as already stated, this feature is of doubtful importance as a specific character. Such minor differences as may be observed in shells from the two formations are probably within the range of individual variation.

The largest known shell of B. claviformis, and incidentally one of the largest shells of the genus ever collected anvwhere, is one from the Nacatoch sand, now on exhibition in the National Museum (no. 20953): it is labelled B. grandis Hall and Meek (see frontispiece). This specimen was collected by Dr. T. W. Stanton in 1890 from a large mass of calcareous, concretionary sandstone, in a road cut about 2 miles south-southwest of Kaufman. The specimen as found was not a complete individual, but was the large end of the shell, including an undetermined portion of the living chamber: sutures can be seen to within 45 or 50 centimeters of the large end; the specimen on exhibition is in part a restoration made by Dr. Charles Schuchert, at that time a member of the museum staff; parts of other individuals were introduced to complete the smaller end and some intervening spaces were filled in with plaster of paris. The authentic part of the specimen, measured along the dorsum, is about 88 centimeters long and the large end is incomplete; the dorsum is flattened as in the typical B. claviformis; the dorsoventral diameter at the large end is about 180 mm., and the transverse diameter 115 mm. (estimated); at the small end the dorso-ventral diameter is about 66 mm. The characteristic broad lateral undulations are present and continue with diminishing prominence to the large extremity; these do not show well in the illustration. The authentic part of this individual is followed apically by a section about 20 centimeters long, which bears the catalogue number 20965, and presumably belongs to another individual. although from its state of preservation it might well belong to the same individual. The small end of the restored shell has a dorsoventral diameter of 19 mm. The total length of the restored specimen, measured along the dorsum, is about 1.5 meters; if the restoration had been made complete to the protoconch 20 or more centimeters would have had to be added to the length as given. In its older stages the specimen departs from the usual straight trend of

the shell, and describes a broad curve concave on the dorsal side, as shown in plate 1 (frontispiece); the curved portion is about 80 centimeters long. The gentle curves in the reconstructed small end of the specimen, as shown in the illustration cited, give an incorrect impression of this part of the shell, which should be approximately straight. The three smallest pieces in the reconstructed end are incorrectly mounted, each of them having been turned 180 degrees in the longitudinal axis, so that the dorsum and venter occupy the reverse of their proper positions.

Specimens from the Neylandville marl at two localities (13835 and 16166), show a compression on the sides similar to that exhibited by *Baculites compressus* Say, but not as pronounced. On the larger specimens, however, the dorsum is flattened as in *B. claviformis*, and they may represent a varietal form of that species. For the present they are questionably referred to *B. claviformis*,

B. clavi/ormis differs from B. ovatus Say mainly in its great size and in the pronounced broad flattening of the dorsal area.

Baculites grandis Hall and Meek,<sup>486</sup> from "Mauvaises Terres, head of Bear Creck," South Dakota, from beds now known to belong to the uppermost part of the Pierre shale, is closely related to *B. claviformis*, but the types in the American Museum of Natural History (nos.  $\frac{9545}{1}$ and  $\frac{9516}{1}$ ) indicate a shell having a proportionately greater transverse diameter, more evenly and broadly rounded sides, and more broadly rounded venter.

*Types.*—Holotype, U.S.N.M. no. 77241; 2 figured paratypes (young individuals), U.S.N.M. no. 77242; 2 unfigured paratypes, U.S.N.M. no. 77243; 3 unfigured paratypes, U.S.N.M. no. 77244.

Distribution in Texas.—Navarro group, Neylandville marl: 2/5 mile north of Cooper (14063);  $2\frac{1}{2}$  mile north of

<sup>&</sup>lt;sup>183</sup>Hall, James, and Meck, F. B., Descriptions of new species of fossils from the Cretaceous formations of Nebraska, etc.: Ann. Acad. Arts and Sci., Boston, n. ser., vol. 5, p. 402, pl. 6, fig. 10; pl. 7, figs. 1, 2; pl. 8, figs. 1, 2, 1854.

Cooper (5318); 3/5 mile northeast of Royce City (13835);  $22\frac{4}{5}$  miles northeast of Royce City (13833);  $2\frac{1}{2}$  miles northeast of Royce City (13834); 1 mile east of Gastonia (7550); 23 7/10 miles west of Kaufman (14101);  $23\frac{1}{2}$  miles west-northwest of Corsicana (16166);  $21\frac{1}{2}$  to 2 miles northwest of Corbet (14119);  $2\frac{1}{2}$  miles north of Corbet (16170); 2 7/10 miles northwest of Cooledge (16169);  $22\frac{1}{2}$  miles south of Ben Hur (15543).

Navarro group, Nacatoch sand: 11/2 miles west of Campbell (12925); road 3.5 mile west of Kaufman (14098, loc. of 3 unfigured paratypes); field 3 5 mile west of Kaufman (14103); vicinity of Kaufman (761, holotype and 2 unfigured paratypes); road 2 miles southwest of Kaufman (14099); vicinity of Chatfield (762): 1 1/10 miles north-northeast of Chatfield (Tex. Bu. 17307); 3/5 to  $\frac{4}{5}$ mile northeast of Chatfield (7572); ?2 miles north of Corsicana (9553); ?31/5 miles north of Corsicana (16168): 4 miles north of Corsicana (17366); north edge of Corsicana (518); road ditch, 3 3/10 miles west-southwest of Corsicana (16163, 2 specimens figured); road 5 miles south-southwest of Corsicana (7573);  $2^{1}2$  miles west by south of Corsicana (17368); 5 miles northeast of Mc-Clanahan (17371).

Outside distribution .--- Arkansas: Nacatoch sand.

Tennessee: Coon Creek tongue of Ripley formation.

Western Interior: Upper part of the Pierre shale of South Dakota and other States.

*Range in Texas.*—Neylandville marl and Nacatoch sand of Navarro group.

## BACULITES UNDATUS Stephenson, n.sp.

#### Pl. 79, figs. 5-10

In form and in the pattern of the sutures this species is similar to *Baculites claviformis*, but broad nodes or ribs make their first appearance at a much earlier stage, and the shell appears to be plumper in cross section. The shell is smooth or only faintly undulating up to a dorsoventral diameter of about half an inch, beyond which the nodes appear and become more pronounced toward the aperture. The nodes are broad, rather long, and are strongly arched, with the concavity on the side toward the aperture; they produce a pronounced wavy contour on the sides; they are somewhat irregularly spaced, but in general increase in distance between crests from 8 or 10 mm. at the youngest stage to a maximum of 25 mm. on the largest stage measured, at which the dorso-ventral diameter is 38.5 mm.; in typical B. claviformis the shell is smooth or nearly so to and even beyond this stage. The relatively fine ventral corrugations are developed about as in B. *claviformis*, and the dorsum has the typical flattening of that species. On the holotype the conch increases in dorso-ventral diameter at the rate of 10 mm. in 10 centimeters and in other specimens the increase is 10 to 12 mm. in the same linear distance.

The dimensions of the large end of the holotype are: Dorso-ventral diameter 38.5 mm.; transverse diameter, measured on the crests of the nodes 32 mm., and between the nodes 27.5 mm.

Types.—Holotype, U.S.N.M. no. 77245; 1 figured paratype, U.S.N.M. no. 77246;

1 figured paratype, U.S.N.M. no. 77247.

Distribution in Texas.—Navarro group, Neylandville marl; ?2½ miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761); road 3/5 mile west of Kaufman (14098); road 2 miles southwest of Kaufman (14099); vicinity of Chatfield (762, loc. of holotype and 1 figured paratype); <sup>3</sup>/<sub>5</sub> to <sup>4</sup>/<sub>5</sub> mile northeast of Chatfield (14117); 1 1/10 miles north-northwest of Chatfield (Tex. Bu. 17307, 1 paratype figured); 3 miles northeast of Corsicana (9545); 3<sup>1</sup>/<sub>5</sub> miles north of Corsicana (16168); 2<sup>1</sup>/<sub>2</sub> miles north of Corsicana (14114); north edge of Corsicana (518).

### BACULITES COLUMNA Morton

#### Pl. 76, figs. 1-4

1834. Baculites columna Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 44, pl. 19, fig. 8.

### 1905. Baculites columna Morton. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 27.

Morton described the species as follows: "Transversely subovate, with numerous distant, arched ribs, which can be traced round the entire periphery, but are most distant at the sides. Diameter, half an inch. From Prairie Bluff, Alabama. Found by Mr. Conrad."

The holotype doubtless came from the Prairie Bluff chalk which is exposed in the upper part of Prairie Bluff, Alabama River, Wilcox County, Alabama. No topotypes are available, but one incomplete internal mold believed to represent this species has been found in the Prairie Bluff chalk at each of the following localities: Larry Dawson Bluff on Alabama River just above the mouth of Tearup Creek, Wilcox County, Alabama; Curls Station road three-quarters of a mile south of the courthouse at Livingston, Alabama; and a gully on the grounds of Mississippi State College. near Starkville, Mississippi. The specimen from Larry Dawson Bluff, the nearest of the three localities to the type locality, is shown in plate 76, figures 1-3. On this specimen the ribs are not all completely developed; in general they are strongest near the antisiphonal half of the flanks at which place they have a strong curvature convex toward the rear; from this curve the ribs run obliquely forward and cross the venter in a sharp forward curve and with undiminished strength; there is a much less pronounced forward curve of the ribs where they cross the dorsum, and here they become weak or This incomplete may even disappear. specimen measures: Length 40.4 mm., greatest dorso-ventral diameter 8.4 mm., greatest width 7 mm.

The small Texas specimen shown in plate 76, figure 4, is not well preserved but it agrees closely with the Alabama specimen at the same stage of growth, and is believed to be the same species. It measures as preserved: Length 16 mm., dorso-ventral diameter at the large end 7.1 mm., width 6.3 mm.

The sutures as seen incompletely exposed on the smaller of the two Texas specimens appear to be essentially like those of other species of *Baculites*. They are as nearly like the sutures on the Alabama specimen (pl. 76, figs. 1–3) as can be expected, in view of the known variability of ammonite sutures.

Type.—A specimen in the collection of the Academy of Natural Sciences of Philadelphia is labeled "type," but of this Johnson says: "The specimen, although marked type, does not agree with the figure. Morton's original label which accompanied all the others, was wanting in this case." The type locality is at Prairie Bluff, Alabama River, Wilcox County, Alabama. One plesiotype, Larry Dawson Bluff, Alabama River, Alabama, U.S.N.M. no. 77248; 1 plesiotype from Texas, U.S.N.M. no. 77249.

Distribution in Texas.—Corsicana marl: 2 miles east of Marion (Tex. Bu. 2395, figured).

Outside distribution.—Alabama: Prairie Bluff chalk.

Mississippi: Prairie Bluff chalk.

Range.--The species is known in the eastern Gulf region only in the Prairie Bluff chalk. In Texas it is known only in the one recorded locality in the Corsicana marl.

## Unidentified specimens of BACULITES

Two fragments of Baculites?, collected from the Nevlandville marl in a roadside ditch 21/2 miles south of Ben Hur, Limestone County (15543), differ from the more common species of Baculites in having a nearly circular cross section. The specimens are smooth and have a very gradual taper. The sutures are well preserved on one fragment, and are similar to those of Baculites, except that the siphonal saddle is quite low and small as compared with other associated species. One of the fragments is 6.5 mm. long and has a maximum diameter of 4.4 mm.; the other is 5 mm. long with a maximum diameter of 5.2 mm. U.S.N.M. no. 77250.

One internal mold of a portion of a living chamber (pl. 76, figs, 7, 8), found in the Neylandville marl in a cut of the Texas Midland Railroad, a mile north of Cooper, Delta County (7510), bears a row of well developed nodes on each side,

and is subtriangular in cross section with a subangular venter. The nodes are of moderate thickness, are curved concave toward the aperture, are about two-thirds as long as the dorso-ventral diameter, and lie nearest the dorsal side: they do not follow exactly the trend of the growth lines around the curve of the lateral sinus. but cut across it somewhat making a blunter curve. The specimen appears to be related to Baculites carinatus Morton, from the Prairie Bluff chalk. at Prairie Bluff, Alabama, but is not that species. The dorso-ventral diameter at the large end is 11 mm.; the lateral diameter measured on the nodes is 9.5 mm., and between the nodes 8.4 mm. U.S.N.M. no. 77251.

A smooth internal mold of a small shell with subtriangular cross section and narrow almost subangular venter was found in the Corsicana marl 1 1/5 miles N. 20° W. of Tona siding (15545, U.S.N.M. no. 77252). Similar molds were obtained from a public road 11/4 miles south by east of Oak Grove, Bowie County (13568, pl. 76, figs. 5. 6; U.S.N.M. no. 77254; 16160, U.S.N.M. no. 77253).

The genus *Baculites* is represented in our collections from the Kemp clay, the uppermost formation of the Navarro group, by a few poorly preserved, badly crushed fragments from one locality only, in Falls County at Black Bluff on Brazos River, about 2 miles above the Milam County line (13776). The containing bed lies only a few feet below the Cretaceous Paleocene contact. U.S.N.M. no. 77255.

#### Family TURRILITIDAE

### Genus NOSTOCERAS Hyatt

Type species. Nostoceras stantoni retrosum Hyatt (emend: Nostoceras stantoni Hyatt).

The genus Nostoceras was erected in 1894, by Hyatt,<sup>487</sup> who designated Nostoceras stantoni Hyatt as the genotype. Three varieties of N. stantoni, namely retrosum, prematurum, and aberrans, were described without illustrations, but oddly no description of a species, N. stantoni,

was given. It therefore becomes necessary to select one of the three varieties as genotype and to elevate it to the rank of species, discarding the varietal name. The variety *retrosum* is here chosen, and it becomes *N. stantoni* Hyatt.

The so-called ephebic stage of the shell includes a closely coiled spiral of 3 to 6 volutions, which may be either dextral or sinistral; typically this is followed by a free, down-drooping, U-shaped retroversal, old age volution, which brings the aperture back to a position just beneath the base of the last volution of the spire. The shell is ornamented with costae, most of which are single, but some of which may bifurcate. Two rows of ventral tubercles are more or less prominently developed. A contact furrow is present only where the whorls are in contact.

#### NOSTOCERAS STANTONI Hyatt (emend)

#### Pl. 80, figs. 1-5

1894. Nostoceras stantoni retrosus Hyatt, Am. Philos. Soc. Proc., vol. 32, p. 570.

Hyatt describes this form, now treated as a species, as follows:

This variety has from five to six complete turrilites-like whorls before the retroversal gerontic stage begins. The apex does not exhibit any indications that the species had an excentric young stage even at the small diameter of 5 mm. in one specimen. There appear to be no tubercles on the earliest whorls examined, probably the neanic stage. Two irregular rows of tubercles are introduced in the ephebic stage with alternating untuberculated costae. The tuberculated costae are sometimes bifurcated, and sometimes single. The costae are closely set, subacute ridges, with concave flutes between them both, arching apically, the flutings broader than the costal ridges, but the surface is otherwise smooth.

The height of the coil is over 40 mm. in the largest specimen, through the ephebic whorls, although the apex is imperfect. In two other specimens this length is much less, although the number of the whorls is about the same. The diameter of this specimen through the parcphebic whorl is 34 mm. The height (transverse diameter) of the parephebic substage is 19 mm. the ventro-dorsal diameter about 13 mm. The diameter of the umbilical opening must have been less than 12 mm.

The costae are wider apart in the last of the ephebic stage, or parephebic substage, and I expected to find that they died out altogether for a certain space, but there was no evidence of this. They, however, appear to be slightly

<sup>&</sup>lt;sup>487</sup>Hyatt, Alpheus, Am. Philos. Soc. Proc., vol 32, p. 569, 1894.

more prominent on the gerontic volution than on the parephebic substage.

The contact furrow begins early, being present on the smallest whorl examined. There is therefore no positive indication that this species had uncoiled or excentric young as in *Emperoceras*.

In the anagerontic substage the whorl bends downwards or orally in two dextral specimens, and in the metagerontic acquires larger tubercles and coarser costae, sometimes bifurcated, and bends upwards towards the base of ephebic volution, forming the retroversal living chamber. The last part of this, or the paragerontic substage, is nearly or quite straight, the bifurcations disappear, leaving the costae straight, and the tubercles also gradually disappear. The latest schile substage is also nearly if not quite bilaterally symmetrical and strongly contrasts in this respect with all the stages preceding the metagerontic substage. The return to the symmetrical form of whorl really begins in the metagerontic substage. The living chamber has an aperture in one specimen. This is straight across the venter, has slight crests on the sides, and is straight or with very slight crest on the dorsum.

The cotype shown in plate 80, figures 3-5, was regarded by Hyatt as two individuals, as shown by the following pencilled note in his handwriting in the tray with the other cotypes. "Variety retrosum has two specimens anchylosed or jammed together, and one large specimen without retroversal chamber." In other words the two cotypes were considered by him to three individuals. The so-called he anchylosed specimen instead of being two individuals is in reality one nearly perfect shell which was mechanically fissured after fossilization, and the fissure was subsequently filled with crystalline calcite, forming a vein 1 to 7 mm. thick. The trace of this vein, which runs vertically through the retroversal volution and upward through the spire, may be seen in plate 80, figures 3-5. In the retroversal volution, however, the fissure, although it split the shell approximately into halves, did not so divide the internal mold, but merely separated one of the halves of the shell from the mold, permitting the formation of the calcite vein in the space between the shell and the mold.

The height of the slightly incomplete cleft cotype just described is 71 mm. The measurements given by Hyatt pertain to the other cotype (pl. 80, fig. 2), which lacks the retroversal volution. The umbilical opening of this specimen, which was covered with matrix at the time Hyatt examined it, is now uncovered; this opening is ovate and measures 12.3 mm. in its long diameter and 8.7 in its short diameter.

Among the shells referred to this species are several which show the contact groove back to a stage where the diameter of the spire is only 3 or 4 mm. The smallest stage of the tube preserved is only 1.5 mm. in diameter and is practically smooth for the earliest 4 mm. of its length; on this specimen, whose earliest preserved volution is about 5 mm. in diameter, the contact groove can be traced almost to the end of the shell indicating that only a very small portion, if any, of the initial stage could have been uncoiled.

The tubercles are rather small and weak except around the main bend of the retroversal volution where they are coarse and prominent. In places on the shell the tubercles are present on each successive rib instead of on alternating ribs as stated by Hyatt. Bifurcation of ribs is a conspicuous feature of the gerontic volution except on the straight section approaching the aperture; bifurcation is much less common on the ribs of the spiral volution.

Many of the specimens here referred to this species lack the gerontic retroversal volution, and some of them, especially the smaller ones, may belong to one or the other of the varieties of the species.

The first three or four sutures back of the living chamber present the following features: There are six saddles and six lobes of very unequal size, all strongly digitate, with the exception of the antisiphonal lobe which is very small; the siphonal lobe is of medium depth and width and is rather strongly digitate; it is subdivided by a rather small ventral saddle which is a little higher than wide and is gently and about evenly tripartite at its upper end; the first lateral saddle to the left of the venter is broader than the siphonal lobe, and is deeply bipartite, the sublobe reaching about halfway to its base; the first lateral lobe is proportionately large and broad and is bipartite, the dividing subsaddle rising fully half the height of the lobe; the second lateral saddle is similar to the first, but is smaller: the dorsal saddle is proportionately very small and oblique; and the antisiphonal lobe is tiny; on account of the twist of the shell the lobes and saddles to the right of the venter are unsymmetrical with respect to the corresponding ones to the left.

Types.-Two figured cotypes, U.S.N.M. no. 23278a and b: 1 figured topotype, U.S.N.M. no. 21112a; 14 unfigured topotypes, U.S.N.M. no. 21112b; 1 specimen identified by Hyatt as questionably a varietal form, U.S.N.M. no. 23281.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); field south of Chatfield (7569); 3/4 mile cast of Chatfield (7571); 3/5 to 4/5 mile northeast of Chatfield (14117); 31/5 miles north of Corsicana (16168); vicinity of Corsicana (763).

## NOSTOCERAS STANTONI PREMATURUM Hyatt

#### Pl. 80, figs. 6-8

 Nostoceras stantoni prematurum Hyatt, Am. Philos. Soc. Proc., vol. 32, p. 572.
Nostoceras stantoni H ya t t. Cleland.

1916. Nostocerus stanton, ff y a t t. Clefand, Geology, physical and historical, p. 530, text fig. B.

The following is Hyatt's description of this variety:

This variety has more closely set costae and smaller tubercles and the gerontic stage begins earlier, there being, if my estimate is correct, only three or four closely coiled whorls. The last volution is well preserved in the only specimen of this variety that I have and this shows clearly an open aperture, almost straight across the venter, with slight crests on the sides and equally obscure crest on the dorsum. It is, in other words, precisely similar to the aperture of variety retrosum. The specimen here described is sinistral, and is the only one obviously belonging to this variety in the collection of the National Museum.

In the light of the material available for comparison this variety appears to be worthy of recognition. In addition to the holotype, our collections include two topotypes which Hyatt did not see, and some other material has subsequently been collected in the vicinity of the type locality. Some of the specimens here referred to the variety are dextral. In the general character of the ribbing and the tubereles the variety is like the typical form of the species. Should future more complete suites of specimens show a gradation from this variety into the typical species, the need for a varietal name would disappear.

The greatest dimension of the incomplete holotype is 54.6 + mm.; the dorsoventral diameter at the aperture is 13.5mm., and the transverse diameter 13.7mm.; the height of the spire is 27 + mm., and the greatest diameter of the spire about 24 mm.

*Type.*—Holotype, U.S.N.M. no. 23279; one topotype figured by Cleland as *N. stantoni*, U.S.N.M. no. 77256; 1 plesiotype, U.S.N.M. no. 77257.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield, (762, type loc.); <sup>3</sup>/<sub>4</sub> mile east of Chatfield (7571): 3/5 to <sup>4</sup>/<sub>5</sub> mile northeast of Chatfield (14117, 1 specimen figured); 2 1/10 miles northeast of Chatfield (Tex. Bu. 17302).

## NOSTOCERAS STANTONI ABERRANS Hyatt

#### Pl. 80, figs. 9, 10

1391. Nostoceras stantoni aberrans Hyatt, Am. Philos. Soc. Proc., vol. 32, p. 572.

The original description of this variety is as follows:

This variety may have three, four or five closely coiled whorls and considerable variation in the tuberculations, etc., but when the gerontic stage begins, the aspect is distinct. The anagerontic substage does not bend so abruptly as in *retrosum* or *prematurum*; it is more oblique to the axis of the spire and the retroversal metagerontic substage, if it be superadded in this variety, would be more oblique than in var. *prematurum*. One specimen is dextral and the other is sinistral.

The meager material available for comparison justifies the recognition of this as a separate variety. The two cotypes, though showing individual variation in sculpture, agree in the aberrant form of the gerontic shell. The spires agree rather closely with *Nostoceras stantoni prematarum*, and the possibility should be recognized that these may be pathologic shells of that variety.

Types.—1 figured cotype, U.S.N.M. no. 23280a; 1 unfigured cotype, U.S.N.M. no. 23280b.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); 3/5 to 4/5 mile northeast of Chatfield (14117); 2 1/10 miles northeast of Chatfield (Tex. Bu. 17302).

## NOSTOCERAS HYATTI Stephenson, n.sp.

## Pl. 81, figs. 9-12

The earliest stages of the shell in this The spire species have not been seen. consists of 4 or 5 volutions which rise and draw in rather rapidly toward the apex; the apical angle is about 60 degrees, but the slopes below diverge to an angle of about 80 degrees. On one of the cotypes the contact groove seems to disappear at a position such as to indicate a minimum spiral diameter of about 6 mm., and an uncoiled shell in the earliest stage. The final volution of the shell, which corresponds approximately to the living chamber, is retroversal and is essentially like that of typical Nostoceras stantoni. The shell is large and the ornamentation is coarser than that on stantoni and its varieties. On the spire the ribs are irregular in prominence and spacing and are in general rather sharp-crested though some of the larger ones are round-crested. The ribs may be simple or may bifurcate, in places very erratically, there being no recognizable system in this feature; generally a node is the point of bifurcation, but this is not always so. On the large retroversal volutions of several individuals the ribs are consistently strong and widely spaced. The two rows of nodes are prominently developed. The nodes vary in strength but in general increase in size in the forward direction until they become quite large around the main bend of the retroversal whorl, beyond which they become markedly weaker. In cross section the shell is subcircular in the spiral portion, becomes depressed to broadly ovate in the early and middle stages of the retroversal volution, and subcircular again in the straight portion approaching the aperture. In the holotype (pl. 81, fig. 9) the diameter of the umbilical opening is about 15 mm. The sutures are not fully uncovered on any of the available material, but on one medium sized shell the siphonal lobe, the first lateral saddle, and the first lateral lobe

appear to agree essentially with the corresponding features on *Nostoceras stantoni*.

The height of the holotype is 34 + mm., and the diameter of the spire through the largest volution is 42 mm. The dorso-ventral diameter in the largest part of this shell is 17 mm., and the transverse diameter 18.5 mm. The largest of the shells referred to this species has a dorso-ventral diameter near the aperture of 25 mm., and a transverse diameter of 31 mm.

This species differs from *Nostoceras* stantoni in its much greater size, in its coarser, sharper and more irregular ornamentation, and in the somewhat looser and more rapid incoiling of the spiral volutions. There is evidence in the contact groove of a short uncoiled initial stage.

*Types.*—Holotype, U.S.N.M. no. 77258; 2 figured paratypes, U.S.N.M. no. 77259; 2 unfigured paratypes, U.S.N.M. no. 77260.

Distribution in Texas.—Navarro group, Nacatoch sand: ?4½ miles east by north of Rosali (14061); vicinity of Chatfield (762); ¾ mile east of Chatfield (7571); 3/5 to ½ mile northeast of Chatfield (7572, 14117); north edge of Corsicana (518, type loc.); vicinity of Corsicana (763); 2½ miles west by south of Corsicana (17368).

### NOSTOCERAS HELICINUM (Shumard)

## Pl. 80, figs. 11, 12

1861. Turrilites helicinus Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 191.

1894. Nostoceras helicinum (Shumard). Hyatt, Am. Philos. Soc. Proc., vol. 32, p. 573. (In part.)

The original description by Shumard is as follows:

Shell sinistral, depressed conical, composed of about five rounded, contiguous volutions; spire very short; spiral angle about  $80^\circ$ ; suture very deeply impressed; aperture subcircular; umbilicus deep, exhibiting the inner volutions, not as wide as the last volution; surface ornamented with prominent, sharp, annular costae, which, on the last volution, pass obliquely backwards from the umbilicus to the suture. The costae are usually simple, but occasionally they bifurcate, and this generally occurs near the edge of the umbilicus; about forty ribs may be counted on the last volution. The ribs of the last volution, in some specimens, are garnished with a double series of small indistinct nodes, situated on the middle third of the volution. No traces of nodes have been observed on the turns of the spire.

This shell resembles in many respects Turrilites astierianus, D'Orbigny (Palacont. Franc. T. 1, p. 578, pl. 140, figs. 8–11), from which it may be at once distinguished by the nodes upon the last volution, when they are present. In specimens without nodes, there are no well marked characters to separate our shell from the foreign species. It cannot be confounded with any of the known Turrilites from American strata.

With the preceding species [*Turrilites splen-didus*] at Chatfield Point and Corsicana, Navarro County.

Two specimens, identified by Dr. T. W. Stanton, furnished the basis for the following description of the species by Hyatt:

At the diameter of 8 mm. in one of the two specimens before me, there are indications that the young was more loosely coiled, and perhaps more or less excentric in comparison with the later closer-coiled stages. The contact furrow was also obviously absent in these earlier substages. In the other specimen, at diameter of about 9 mm., there are similar indications. Nevertheless, I was by no means sure of what these changes indicated, whether a helicoceran, scaphetoid or hamites-like shell. All that can be said is that they show irregularities in the growth of the young not present in the turrillitean volutions of the ephebic stage.

The young, probably in the anephebic substage, has single costae, each tuberculated on either side of the venter. These become more or less irregularly bifurcated, and with intermediate entire costae without tubercles, usually one, sometimes two, in each interspace in the metephebic substage. The whole is a flat turbinated coil of not more than four or five whorls with prominent tubercles and costations.

In the anagerontic substage the volution abandons the spiral, the contact furrow disappearing immediately, and the shell grows downwards and outwards, as in the anagerontic substage of *Nostoceras Stantoni*, var. *aberrans*.

The single tuberculated costae of the young are similar to those of the later stages of *Ancyloceras Jennyi*, Whitf., *Pal. Black Hills*, and some of the helicoceran forms found elsewhere; but the young shells were obviously quite different, being more closely coiled and stouter shells. Specimen in Coll. U.S. Nat. Mus., No. 21103.

In the absence of Shumard's types, which are lost, it may never be positively known that the two shells selected by Doctor Stanton, and described by Hyatt, correctly represent the species. The specimen shown in plate 30, figures 11, 12, is selected as neotype. The other specimen is so markedly different in ornamentation that it is here classed as a varietal form. N. helicinum crassum. It was this varietal specimen that furnished the basis for Hyatt's description of the gerontic portion of the shell. None of the specimens here referred to the typical *helicinum* have more than the very beginning of this gerontic portion preserved. Shumard's statement that the bifurcations of the costae generally take place near the edge of the umbilicus needs modification, for on the neotype and other specimens some of the costae bifurcate at the nodes. None of the specimens in our present collections are entirely without nodes on the volutions of the spire. as stated by Shumard, but on some the nodes are very weak; evidently this is a variable feature, but the nodes on the spire are in general small and do not become prominent until the gerontic stage is approached. On the spire the lower row of nodes may be at the line of contact between the volution and the next one below, or it may be either a little above or a little below this contact. There is considerable difference in the prominence and spacing of the costae on different parts of a given individual, but in general the costae are numerous and closely spaced; the costae become markedly wider apart on the earliest portion of the gerontic stage. The costae bearing nodes may be separated by one, two, or three costae without nodes. The sutures are not well exposed on the specimen studied.

The height of the incomplete spire of the neotype is 31 + mm.; the dorso-ventral diameter at the beginning of the gerontic stage is about 15 mm., and the transverse diameter 16.5 mm.; the narrow, ovate umbilical opening is about 10 mm. long and 5 mm. wide.

*Types.*—Shumard's type material is lost; he records the species as from Chatfield and Corsicana, Navarro County, Texas. Neotype: U.S.N.M. no. 21103a.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Kaufman (761); vicinity of Chatfield (762, type loc.); 3/5 to 4/5 mile northeast of Chatfield (14117); 1/2 mile east of Chatfield (7570); 21/2 miles north of Corsicana (14114); north edge of Corsicana (518); vicinity of Corsicana (763). 412

## NOSTOCERAS HELICINUM CRASSUM Stephenson, n.var.

## Pl. 81, figs. 7, 8

One of the two shells identified by Dr. T. W. Stanton, as Shumard's Turrilites helicinus, and later described by Alpheus Hyatt as Nostoceras helicinum (Shumard), is much more coarsely ornamented than the other, and has a lower spire; it also has a more open spire at the apex, indicating a longer uncoiled initial stage. At the earliest coiled stage, the costae are equally as fine as on the typical helicinum but the intercostal spaces gradually widen out causing a much coarser ornamentation throughout the remainder of the length of the conch, the maximum separation of the costae in the gerontic stage being 5 mm. Except on the smallest volution of the spire the nodes are prominent and are about equally strong in each row; the costae bearing nodes are generally separated by either one or two costae which are either nodeless or bear only small, obscure nodal swellings: the nodes become markedly prominent and coarse in the gerontic stage. The shell in the gerontic stage becomes uncoiled, expands rapidly, and extends horizontally away with a slight twist and a very gentle curve downward. Nothing is definitely known of the length or form of the uncoiled initial stage of the shell, but the contact groove indicates that the diameter of the first volution is about 10 mm.

The holotype as a whole has a maximum length of 57 mm.; the maximum dorsoventral diameter of the gerontic part of the shell is 17.5 mm., and the maximum transverse diameter 20.7 mm.; the corresponding dimensions at the beginning of the gerontic stage are 13.5 and 16.8 mm.; the height of the incomplete spire is 23 +mm.; the ovate umbilical opening has a maximum diameter of about 11 mm., and a minimum diameter of 7 mm.

A poorly preserved, coarsely sculptured paratype which accompanies the holotype has the gerontic stage represented by a long, smooth, irregular internal mold which has the appearance of a pathologic condition; the shell becomes free from the spire at about the same size as in the holotype, but it expands and contracts irregularly and bends down strongly toward the aperture; it has a maximum diameter of fully 22 mm.

Types.—Holotype, U.S.N.M. no. 77261; 1 unfigured paratype, U.S.N.M. no. 77262.

Distribution in Texas.—Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); field south of Chatfield (7569); 2½ miles north of Corsicana (14114); vicinity of Corsicana (763); north edge of Corsicana (518).

#### NOSTOCERAS HELICINUM HUMILE Stephenson, n.var.

### Pl. 81, figs. 4-6

Two shells in the collections are similar to the variety *crassum*, but differ in the following features: The spire is lower and more open at the apex, the first volution of the spire is more slender, and the nodes of the two rows differ markedly in size, those of the upper row being prominent and strong, in contrast to small weak ones in the lower row. The holotype appears to be a young individual for the aperture is partly preserved, and the shell has not reached the uncoiled gerontic stage; the living chamber takes up about two-thirds of the largest volution. The other specimen, though about the same size, is an incomplete older individual, for a septum is present at the large end. The gerontic stage is unknown. In features other than those mentioned this variety appears to be essentially like the variety crassum.

The greatest diameter of the holotype is 29.3 mm., and the height of the spire is 15 mm.; the dorso-ventral diameter at the aperture is about 10 mm., and the transverse diameter about the same. The opening at the apex has a diameter of about 8 mm., and the umbilical opening a diameter of 12 mm. The smallest diameter of the shell as preserved is about 1.5 mm.

Types.—Holotype, U.S.N.M. no. 77263; 1 unfigured paratype, U.S.N.M. no. 77264.

Distribution in Texas.—Navarro group, Nacatoch sand: Field 3/5 mile west of Kaufman (14103, holotype); vicinity of Kaufman (761, paratype).

### NOSTOCERAS COLUBRIFORMIS Stephenson, n.sp.

#### Pl. 81, figs. 1-3

The spire is tall and consists of 5 or 6 volutions; the free portion of the conch forms a short, sharply turned retroversal volution. Two or 3 of the apical volutions

of the holotype are broken away and the terminus of the retroversal volution is imperfect. Spiral angle 40 degrees. The conch is broadly subovate in cross section and the diameters of the retroversal volution near its terminus are respectively 7.5 and 9 mm. The paratypes show that the initial volution may have a diameter of 3 mm. or less, and the smallest diameter of the conch is 1 mm. or less. The spire of the holotype is sinistral; 2 of the paratypes are sinistral and 7 dextral. The total height of the incomplete holotype is 31.4 mm., and the greater diameter of the spire 16 mm. The surface of the shell, with the exception of the earliest volution, seen on one of the paratypes, is ornamented with approximately regular, narrow, subangular ribs which number 12 or more to the centimeter. At widely spaced intervals an intercostal space is markedly wider and deeper than the others, and is bordered on either side by a slightly thicker and higher rib; there is a tendency, manifested on several of the specimens, for these deeper interspaces to align themselves one above the other on successive volutions, but they may occur anywhere on the shell: the ribs become regularly smaller on the successively smaller volutions and the earliest volution is nearly smooth. On the smaller volutions of the spire bifurcation of the ribs is rare, but this feature is more common on the largest whorl and on the retroversal volution. Two rows of small weak to obscure nodes parallel each other 2 mm. or less apart on the ribs low on the sides of the volutions of the spire; these are practically wanting on the smaller whorls of the holotype and of several of the paratypes, but are present on others; the nodes are elongated in the direction of the ribs, and in places mark the point of bifurcation of ribs; nodes are wanting on the retroversal volution. The sutures are not discernible on the available material. The fine, closely crowded ribbing and the weak nodes of this species serve to distinguish it from the other species of Nostoceras.

Types.—Holotype, U.S.N.M. no. 77265; 9 unfigured paratypes, U.S.N.M. no. 77266.

Distribution in Texas.--Navarro group, Nacatoch sand:  $2\frac{1}{2}$  miles west by south of Corsicana (17368).

### NOSTOCERAS? DRACONIS Stephenson, n.sp.

#### Pl. 82, figs. 5-9

Shell of medium to large size, coiled in the ephebic stage in a very low spiral with, however, the volutions slightly separated, passing in the gerontic stage into a large. well developed retroversal volution. Umbilicus wide and shallow. Couch subcircular in outline, increasing rather rapidly in diameter, and becoming broadly subovate in the larger stages. Surface covered with numerous. rather sharpcrested ribs of nearly uniform size, which pass with slight sinuosity entirely around the shell; these number about 5 to the centimeter on the large end of the holotype, increasing to 8 or 9 on the smallest part preserved, but showing some variation in the coarseness of the spacing; occasional bifurcations appear, generally at the nodes. There are two rows of round or slightly elongated ventral nodes which vary in size on the holotype from very obscure to quite prominent; the coiling is such that on the larger parts of the shell the upper row of nodes lies at the line of near-contact, some of the nodes actually touching the adjacent volution, causing slight indentations, and the lower row is submerged: toward the apex the shell rises a little and becomes more loosely coiled. so that both rows of nodes are in view. though the nodes are weakly developed here; the upper row of nodes becomes very weak and practically disappears toward the large end of the holotype.

One large specimen (17365), which is believed to belong to this species, includes about the last third of the largest whorl of the spire and all of the retroversal whorl (pl. 82, figs. 8, 9); a contact groove is present on the inner curve of the conch just before the free stage is reached. The conch increases rapidly in size as it separates from the spire, and becomes markedly more coarsely ribbed; the ventral nodes also increase in size, both the nodes and the ribs becoming very coarse and irregular in strength and spacing around the main bend of the retroversal whorl; the nodes quickly fade out on the nearly straight terminal limb of this whorl. One small paratype (16170) forms one complete volution representing a younger stage than the youngest part of the incomplete holotype; it is referred to this species because of similarity of ribbing and similarity in degree of coiling and of spiral flattening; the nodes are weakly developed but the two rows are distinguishable.

The height of the incomplete spire of the holotype is  $30 \pm \text{mm.}$ , and the maximum diameter of the shell as a whole is 60 mm.; the dorso-ventral diameter of the large end of the conch itself is 22.5 mm., and the transverse diameter is 24 mm.; the diameter of the smallest part of the shell preserved is 7 mm. The large retroversal whorl is subcircular in cross section ranging in diameter from 25 to 28 mm. One large fragment among the paratypes attains a maximum diameter in cross section of 32 mm.

*Types.*—Holotype, U.S.N.M. no. 77267; 1 figured paratype, U.S.N.M. no. 77268; 6 unfigured paratypes, U.S.N.M. no. 77269; 2 unfigured paratypes, U.S.N.M. no. 77270.

Distribution in Texas. Navarro group, Neylandville marl: 3½ miles west-northwest of Corsicana (16166, holotype and 6 paratypes); 4 miles west by north of Corsicana (17369); 2½ miles north of Corbet (16170, 2 unfigured paratypes; 17365, 1 large figured paratype; Tex. Bu. 17300); ½ mile north of Cooper (14062).

### NOSTOCERAS sp.

A large retroversal coil, including the complete living chamber (pl. 81, fig. 13) from the Neylandville marl on the Dallas highway, 3 7/10 miles west of Kaufman, Kaufman County (14101), is like *Nostoceras* except that ventral nodes are wanting; the ribbing is coarse and, aside from the absence of nodes, is practically identical with that of *N. hyatti*. U.S.N.M. no. 77271.

#### Genus ANAKLINOCERAS Stephenson, n.gen.

Type species. - Analdinoceras reflexum Stephen-

Etymology,  $-\dot{a}\gamma\dot{a}$ , up; κλίγω, slope against; κεραs, horn.

This new genus is related to *Nostroceras* but differs in the growth habit of its gerontic, retroversal whorl; in all specimens completely enough preserved this whorl is bent back up the side of the spire, and in several of the more complete individuals rises to a few millimeters above

the apex, where it bends back down over the opposite side of the spire, reaching halfway to its base, thus embracing the spire in a sort of incomplete archway. A similar habit is exhibited by the Neocomian species, Heteroceras emerichi (D'Orbigny),488 which differs, however. in that the ascending retroversal volution does not hug the spire closely, but surmounts it in a free, nearly circular arch. A similar habit is also seen in a group of Aptian species from western Georgia. Transcaucasia, described by Rouchadzé<sup>159</sup> under the generic and subgeneric names Colchidites (Imerites) Djanelidzé. In these an early spiral portion of the shell is encircled by a later adult portion that ranges in the different species from open to closely coiled in one plane; in some of them the spire is only 2 or 3 centimeters high, and nestles within a surrounding adult shell that reaches an over-all diameter of 10 to 15 centimeters. The spire of Anaklinoceras is proportionately higher and more slender than that of any species of Nostoceras, except N. colubriformis. The shell in its earliest observed stage is free and 1 mm. in diameter, but within a few millimeters it assumes a coiled attitude with an umbilical opening 3 mm. more or less in diameter.

The shell is transversely ribbed as in *Nostoceras*, the ribs being notably variable in strength and spacing on different individuals. The shell averages smaller than any of the known species of *Nostoceras*.

## ANAKLINOCERAS REFLEXUM Stephenson, n.sp.

#### Pl. 83, figs. 1-5

Shell small, with a small uncoiled initial stage of undetermined length, a rather high. closely coiled spiral ephebic stage of 4 to 6 volutions, and a gerontic stage in which the shell is reflected back up one side of the spire to a few millimeters beyond the apex, where it bends over and extends about halfway down the opposite side of the spire. In one of the paratypes (pl. 83, fig. 5) the shell at its smallest

<sup>485</sup>D'Orbigny, M. Aleide, Jour, Conch. (Paris) 1851, p. 217, pl. 3, fig. 1, 1851.

<sup>&</sup>lt;sup>459</sup>Rouchadzé, J., Les Annuonites Apt'ennes de la Géorgie Occidentale: Bull. de l. Inst. Géol de Géorgie, vol. I. fase, 3, pp. 237-266, pls. 14-22, 1933, Idem, vol. 3, fase, 2, pp. 183-186, pls. 4-6, 1938.

preserved portion is about 1 mm. in diameter, and is bent up free from the volution below for a distance of about 3.5 mm.; the smallest complete volution is about 5.5 mm, in diameter with an umbilical opening about 3 mm. in diameter. In this shell the second volution is only a little larger than the first, but the next two volutions below expand and enlarge rapidly; there is a rapid increase in size in the early part of the gerontic stage. In another shell the smallest volution is only about 4 mm. in diameter. The shells exhibit considerable individual variation in the diameter of the smallest volution, and in the height of the spire; the sides of the spire diverge at an angle of approximately 45 degrees. Among about 32 specimens complete enough to show the direction of coiling of the spire 20 are dextral and 12 sinistral. The rest of the material is fragmental.

Ribs are numerous, rather sharpcrested, and are present over the whole of the shell as preserved; they are, however, weak on the earliest stage; in general the ribs are narrower than the interspaces. At widely spaced intervals an interspace is wider and deeper than the intervening ones, and each of these is bordered on either side by a higher more prominent rib; this appears to be a characteristic feature of the species. The ribs on the free gerontic stage are wider apart and more irregular in prominence than on the spire; there is a marked individual variation in the coarseness of the ornamentation; an occasional rib may be added by intercalation or bifurcation; ribs thus added are somewhat more common on the early and middle portions of the gerontic stage. The shell is further ornamented by two rows of small nodes on the venter; these are very weak on the earlier volutions, but increase gradually in strength until they become prominent on the gerontic stage; the nodes may be present on successive ribs, or one or two unnoded ribs may intervene. The umbilical opening in the spire varies in size on different individuals but is small, ranging from 2 to 4 mm. in greatest diameter. The sutures are not clearly exposed.

Dimensions of the holotype: Total height of shell, including the retroversal volution, 38.7 mm.; diameter of largest volution of spire about 15 mm.; dorsoventral diameter of large end, which is probably near the aperture, about 13 mm.; transverse diameter at the same place 12 + mm. The largest specimen in the collections, a poorly preserved gerontic whorl, has a height over all of 53 mm.; it has a dorso-ventral diameter of 15 mm., and a transverse diameter of 16 mm.

*Types.*—Holotype, U.S.N.M. no. 77272; 1 figured paratype, U.S.N.M. no. 77273; 1 figured paratype, U.S.N.M. no. 77274; 11 unfigured paratypes (and fragments), U.S.N.M. no. 77275.

Distribution in Texas.—Navarro group, Neylandville marl:  $\frac{1}{2}$  mile north of Cooper (14062); 2/5 mile north of Cooper (14063); 2 $\frac{1}{2}$  miles north of Corbet (16170, 1 figured and 11 unfigured paratypes; 17365; Tex. Bu. 17300, holotype and 1 figured paratype); 3 miles northeast of Drane (16164).

#### Genus TURRILITES Lamarck

## TURRILITES SPLENDIDUS Shumard

## Pl. 82, figs. 1-4

1861. Turrilites splendidus Shumard, Boston Soc. Nat. Hist. Proc., vol. 8, p. 191.

1893. Turrilites splendens Shumard (error in spelling of specific name). Boyle, U.S. Geol. Survey Bull. 102, p. 293.

Shumard described this species as follows:

Shell turreted, spire sinistral and dextral, very much elevated; spiral angle 23°; volutions about ten, strongly rounded, contiguous; suture deeply excavated; umbilicus small, occupying a very small part of the diameter of the last volution: aperture subcircular. A short distance behind the aperture is a prominent ring, anterior to which the diameter becomes suddenly contracted to the margin; surface elegantly ornamented with prominent rounded, simple and bifurcating ribs, which on the body volution commence at the margin of the umbilicus, and pass in an oblique upward and backward curve, until they get near the suture, where they are suddenly bent forwards. The number of ribs on the last volution varies from twenty-four to twenty-eight, and they are here wider apart and not so regular as on the turns of the spire. Ribs bearing each two small elongated tubercles, one situated near the inferior edge and the other near the middle.

Length, twenty-one lines; diameter of last volution seven lines. In form and general appearance this beautiful Turrilite is similar to T. *catenatus*, D'Orb., but differs in having a smaller unbilicus, in the different position of the tubercles, and their smaller size.

In a later collection from near Chatfield, Navarro County, are 16 more or less incomplete individuals (U.S.N.M. no. 21091) one of which, in lieu of the original types, is designated neotype. These specimens (topotypes) exhibit noticeable differences in form and ornamentation, which, however, are probably individual variations. Most of the specimens are smaller than the one measured by Shumard, but in one fragment the diameter of the largest volution is 22.5 mm. (== nearly 11 lines).

If the specimen just mentioned is correctly identified, it shows that the ornamentation becomes proportionately coarser in large individuals, the nodes and costae both being more prominent. With the exception of this one large specimen the costae and nodes are rather small and fine; the two rows of nodes are low down on the side of the volution. and on some specimens the lower row is at the line of contact between the volutions, or may even be slightly concealed. There may be considerable variation on the same individual in the prominence and spacing of the ribs. At widely spaced intervals an interspace is deeper and wider than the others, and generally one or both of the inclosing ribs are larger, forming varices of different degrees of prominence; prominent "ring" the described by Shumard is one of these varices. Most of the ribs are simple, but an occasional one is seen to bifurcate, generally at a node.

The spire is high, and the number of volutions may be as many as 14 or more. The diameter of the smallest volution preserved is 2 mm., and it bears a contact groove nearly, but not quite, to its end; the diameter of the smallest part of the conch on this specimen is 0.8 mm.; the uncoiled initial stage, if any, must, therefore, have been very small and short. Although the larger volutions are more loosely coiled than the earlier ones there

is no indication of an uncoiled senile stage.

The dimensions of the neotype are: Height of incomplete spire 32 + mm., diameter of largest volution 15 mm.; the apical angle is, as originally indicated, about 23 degrees, but the sides of the spire below widen out to 30 to 35 degrees; the umbilicus is very small, not exceeding 1 or 2 mm.

Types.—Shumard's types are lost; they are recorded as having come from near Chatfield and near Corsicana, Navarro County, Texas. Sixteen more or less incomplete individuals (topotypes) were collected by Dr. T. W. Stanton near Chatfield in 1390, and identified by him as *Turrilites splendidus* Shumard. The neotype and two figured examples were selected from this lot. Neotype, U.S.N.M. no. 77276; 2 figured topotypes, U.S.N.M. no. 77277; 13 unfigured topotypes, U.S.N.M. no. 21091.

Distribution in Texas.--Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); 1 1/10 miles northnortheast of Chatfield near a Negro cemetery (Tex. Bu. 17307); 4 miles north of Corsicana (17366); 5 miles northeast of McClanahan (17371).

## TURRILITES SAUNDERSORUM Stephenson, n.sp.

## Pl. 83, figs. 6-8

Shell of medium size, dextral or sinistral; spire high and closely coiled;  $4^{1/2}$ volutions preserved in the holotype; spiral angle about 37 degrees. Line of contact between volutions moderately impressed. Sides of volutions very broadly Umbilicus small, diameter rounded. about 6 mm. The holotype is a dextral internal mold with more or less badly corroded shell substance covering much of it. Surface covered with numerous. low, rounded costae of somewhat irregular prominence and spacing: on the sides the costae are arched broadly backward and on the base of the last volution arched forward; at about every half volution there is a deep wide interspace bordered on the rear by a wide, rounded, prominent rib, and on the front by a similar but less prominent rib; these prominent ribs

have the appearance of varices and tend to align themselves one below the other in two vertical rows on opposite sides of the spire. The ribbing on the paratype is a little coarser than on the holotype. Low on the side of the largest volution of the holotype is a row of weak nodes which can be traced around near the lower edge of the next to the largest volution, gradually fading out in the backward direction; there is no indication of a second row which, if present, would probably be above the first. The paratype, a similar but less complete individual, is sinistral and exhibits two rows of weak nodes. the lower one the stronger. The sutures are not clearly exposed.

The spire of the incomplete holotype is 53 + mm. high; the diameter of the largest volution is 32 mm., and of the smallest one preserved 12.6 mm.; the greatest diameter of the conch itself is about 19 mm.

Types.—Holotype, U.S.N.M. no. 77278; unfigured paratype, U.S.N.M. 1 no. 77279. Named in honor of the collectors, Mr. and Mrs. D. A. Saunders.

Distribution in Texas.-Navarro group, Kemp clay: 12 miles southeast of Greenville (11247); the specimens were found mechanically reworked in the base of the Paleocene deposits overlying the Kemp clay.

# Unidentified specimens of TURRILITES

Fragments of three medium-sized, badly crushed, incomplete, internal molds of Turrilites, with some shell substance adhering, were found in the Nacatoch sand in a cut on the Clarksville road on the northward-facing slope of Cuthand Creek valley, 41/2 miles east by north of Rosali, Red River County (14061). The ribs are numerous and of moderate strength, and two rows of rather weak nodes are present low down on the side of each volution. U.S.N.M. no. 77280.

A fragment of a small spiral ammonite with fine ribs and constrictions at wide intervals, questionably a Turrilites, was ob- tained in the Neylandville marl on the Dallas highway, 21/2 miles northeast of Royce City, in Collin County (16157). U.S.N.M. no. 77281.

## Genus HELICOCERAS D'Orbigny

## HELICOCERAS NAVARROENSE Shumard

## Pl. 83, figs. 9-13

1861. Helicoceras navarroensis Shumard, Boston

Soc. Nat. Ilist. Proc., vol. 8, p. 190. 1926. *Helicoceras navarroense* Shumard. Wade, U.S. Geol. Survey Prof. Paper 137, p. 184, pl. 61, figs. 8 11; pl. 62; figs. 1, 2.

Shumard's description of the species is as follows:

Shell large, dextral and sinistral, composed of distant, free, convex volutions; last volution rounded, gradually enlarging to within a short distance of the aperture, where it becomes suddenly expanded and flattened above and below; dorsum [venter] ornamented with two revolving series of prominent nodes, one series situated near the middle and the other at the base of the volution. On the anterior third of the volution the nodes are flattened, and the inferior ones project obliquely downwards and forwards. The nodes of one series usually alternate with those of the other, but sometimes they are nearly opposite. The surface is likewise marked with prominent, rounded, oblique annular costae, which are indistinct on the ventral [dorsal] side, and frequently bifurcate at the nodes. The diameter of the last volution, a short

distance from the expanded aperture is about 15 lines [12 lines = 1 inch]; diameter of base 31/2 inches.

Of this fine species, I have seen only the last and a portion of the succeeding volution of an apparently mature shell, from which the entire height may be estimated at not less than six inches.

Four incomplete individuals in the National Museum are from the type locality near Chatfield (762), and one of them is selected as neotype; two are dextral and two sinistral. The neotype, the largest of the four, is a dextral shell; it is not quite as large as the one measured by Shumard, but most of the living chamber is broken away.

The sutures are incompletely exposed on the available Texas material, but a complete suture of a specimen from Coon Creek, McNairy County, Tennessee (drawn by Dr. J. B. Reeside, Jr.), is figured by Wade (his plate 61, figure 11). The available material gives no indication of the initial stages of growth. The specimens exhibit considerable individual variation in respect to the closeness of coiling, the amount of stretch in the spiral coiling, and in the coarseness of the costal ornamentation. There seems, however, to

be no sufficient basis for recognizing more than one species.

Among the specimens from Chatfield the greatest measurable diameter is 32 mm., and the smallest diameter 8.8 mm. One fragment from the Neylandville marl, near Ben Hur, Limestone County (15543), apparently part of the living chamber of a very large shell, has a maximum diameter of 52 mm. In the same collection are fragments, thought to be the young stages of this species, the smallest of which has a minimum diameter of 3 mm.

Types.--Shumard's original material is lost; it was collected near Chatfield, Navarro County. Neotype sclected from four specimens in the United States National Museum, collected by Dr. T. W. Stanton near Chatfield, and identified by him as *Helicoceras navarroense* Shumard, U.S.N.M. no. 77282; 1 figured topotype, U.S.N.M. no. 77283; 2 unfigured topotypes, U.S.N.M. no. 21082; 1 plesiotype, U.S.N.M. no. 77284.

Distribution in Texas. – Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles south of Ben Hur (15543);  $2\frac{1}{2}$  miles north of Corbet (17365).

Navarro group, Nacatoch sand: Vicinity of Chatfield (762, type loc.); 2½ miles north of Corsicana (14114); 3 3/10 miles west-southwest of Corsicana (16163, figured); 5 miles northeast of McClanahan (17371).

Range.-Neylandville marl and Nacatoch sand of Navarro group.

## HELICOCERAS? sp.

A small ribbed fragment with a double row of nodes, from the Neylandville mart on the Dallas Highway, 2½ miles northcast of Royce City, in Collin County (16157), is questionably referred to *Helicoceras*. U.S.N.M. no, 77285.

#### Family DESMOCERATIDAE

# Genus PARAPACHYDISCUS Hyatt

The shells here referred to Parapachydiscus were commonly referred to Pachydiscus Zittel prior to the introduction of the former name by Hyatt in the first English edition of Zittel's Text-Book of Paleontology of 1900. Hyatt designated Ammonites gollevillensis D'Orbigny<sup>490</sup> ( = Ammonites lewesiensis D'Orbigny, not Sowerby) as the genotype.<sup>491</sup> This species is from the Upper Chalk (Senonian) of France, England, and other countries.

## PARAPACHYDISCUS ARKANSANUS Stephenson, n.sp.

Pl. 84; pl. 85, figs. 1-3; pl. 86, figs. 1-5; pl. 87, figs. 1-3

Shell of medium size, strongly involute; sides slightly flattened, diverging a little inwardly; venter broadly arched. Umbilicus deep and of moderate width; umbilical shoulder rather sharply rounded, descending steeply into the umbilicus. The living chamber is not preserved on the few available specimens. A shallow, ventral groove 1 to 1.5 mm. wide on the internal mold reflects the siphuncle which immediately underlies the ventral surface. Surface ornamented with somewhat variable, moderately strong, rounded ribs spaced at intervals of 4 to 13 mm.; the ribs number about 40 on the largest volution of the holotype. The ribs on the vounger stages show a tendency to develop elongate nodes on the umbilical shoulder, but these nodes become obscure on the larger stages. The ribs curve slightly backward on the shoulder, become nearly direct to the middle of the side, and finally curve slightly forward as they pass up over the venter, indicating a slight ventral crest. The sutures are deeply and intricately digitate. The siphonal lobe is deep and narrow with slender lateral branches which increase in size and intricacy posteriorly; the ventral saddle is about two-fifths as high as the lobe is deep; it is proportionately broad, blunt and cauliflower-like. The elaborately dendritic lateral saddles and lobes decrease in size rapidly toward the line of involution: the saddles are proportionately broad and the lobes very slender and sharply digitate; there are

<sup>&</sup>lt;sup>490</sup>D'Orbigny, Alcide, Prodrome de Paléontologie, vol. 2, p. 212, 1850,

<sup>&</sup>lt;sup>491</sup>D'Orbigny, Alcide, Paléontologie Française, Descrip, des Animaux Invert.: Terrain Crétacé, tome 1, Céphalopodes, p. 336, pl. 1 et pl. 2, figs. 1, 2, 1811.

four lateral saddles, the fourth one followed by several small saddles which form the outer side of a moderately deep hanging lobe at the line of involution.

Maximum diameter of the holotype approximately 183 mm.; maximum radius from the center of the umbilicus to the venter 113 mm.; maximum dorso-ventral diameter 95 mm., and corresponding transverse diameter 75 mm.

The description is based on the holotype which is from the Nacatoch sand of Arkansas. The Texas material identified with this species consists of four incomplete young individuals, the largest and most complete of which has a maximum diameter of 82.3 mm., a maximum radial diameter of 49 mm., a maximum dorsoventral diameter of 46.7 mm., a corresponding transverse diameter (measured between the ribs) of 42.8 mm., and a maximum unbilical diameter of 21 mm.

In its early stages the conch is plumply rounded, the cross section from one line of involution to the other describing a nearly circular curvature; the flattening of the sides takes place gradually as the older stages are reached. The growth lines are curved backward on the umbilical shoulder, straighten out above, and pass nearly directly up over the venter, with a faint suggestion of a crest in the older stages. The ribs number 37 around the venter, and of these 13 are primaries originating on the umbilical shoulder, and the remaining 24 are secondaries arising on the sides of the shell either independently in the interspaces between the primaries, or by the dividing of the primaries; 9 of the primary ribs bear moderately prominent, but unequal, shoulder nodes which are elongated along the crests of the ribs. In the early stages the ribs pass from the sides directly upward over the venter, but in the later stages they curve gently forward on the venter. On a less complete Texas specimen, which has a transverse diameter of about 34 mm., the sutures are well exposed, and are essentially like those on the larger holotype. The blunt upper end of the ventral saddle is rendered trifid by two small slender digitations pointing directly backward: the central subsaddle thus produced is divided by a small relatively broad, shallow, blunt-ended minor lobe. The antisiphonal lobe is about half

as deep as the siphonal lobe; it widens a little downward and is trifid below; between the antisiphonal lobe and the line of involution are three narrow, dorsal saddles which decrease somewhat in size outwardly, and are separated by two slender lobes; the outer side of the third saddle forms the inner side of the hanging lobe on the line of involution.

Types.—Holotype, U.S.N.M. no. 77286, Old Military Road, 2 1/8 miles northeast of Washington, Hempstead County, Arkansas (7472). Paratypes from Texas, U.S. N.M. nos. 21094, 20962.

Distribution in Texas. – Navarro group, Neylandville marl: 3 7/10 miles west of Kaufman (17119).

Navarro group, Nacatoch sand: Vicinity of Kaufman (761, figured); field 3/5 mile west of Kaufman (14103); vicinity of Chatfield (762, figured): 3 1/5 miles north of Corsicana (16168).

Outside distribution.--Arkansas: Nacatoch sand (includes type loc.).

Range.—Neylandville marl and Nacatoch sand of the Navarro group.

## PARAPACHYDISCUS SCOTTI Stephenson, n.sp. Pl. 88

Shell very large, plump, strongly involute; sides plumply rounded in the younger stages, becoming slightly flattened in the older stages. Umbilicus deep and wide; shoulder rounding down steeply into the umbilical depression. The last volution, including the living chamber, is imperfect, part of it having been broken before fossilization, and a considerable part of the surface having been badly corroded by weathering; the rest of the shell. though considerably broken, is fairly well preserved, with the exception of the very small, early stages. A cross section of the shell (reduced in reproduction), drawn where the diameter is about 39 centimeters, is given in text figure 11. The growth lines trend sharply back from the line of involution, curve forward to a nearly direct radial direction on the umbilical shoulder, extend with slight sinuosity to the middle of the side, and curve moderately forward as they pass over the venter, forming a noticeable crest. The surface of all but the living chamber is ornamented with low,



Fig. 11. Incomplete cross section through the center of the holotype of *Parapachydiscus scotti* Stephenson, where the diameter is about 39 centimeters. Reduced, x3/5.

rounded ribs of somewhat unequal development, separated by interspaces 2 to 5 times the width of the ribs; the interspaces increase in width very gradually in the forward direction from a minimum of 3 mm. or less to a maximum of 25 mm. or more; the ribs are approximately parallel to the growth lines. The ribs that originate on the shoulder may be regarded as primaries, but numerous secondaries arise on the sides at different distances from the shoulder. In the early stages up to that at which the transverse diameter is about 40 mm. the ribs tend to form elongated nodes just outside the shoulder, the largest nodes being just back of the diameter mentioned; on all larger stages nodes are obscure or wanting. The living chamber lacks the small ribs just described, but is ornamented with a few large, low, broad undulations each of which is strongest just outside the shoulder, gradually diminishing in strength outwardly and dying out before reaching the venter.

The sutures shown in text figure 12 were drawn from a fragment examined before the specimen was reconstructed; it was necessary to grind off the shell in order to expose the suture lines. The dorsoventral diameter where the sutures were uncovered is 87 mm., and the transverse diameter approximately the same. The lobes and saddles are profound and are intricately digitate. The siphonal lobe has a depth of 62 mm. There are 4 lateral saddles between the venter and the line of involution; these are relatively of moderate width and decrease rapidly in size inwardly. The saddles are separated by slender, intricately branching, sharply digitate lobes. The inner side of the fourth lateral saddle forms the outer side of a hanging lobe on the line of involution, whose depth is about 14 mm. The ventral saddle is of cauliflower-like pattern and is approximately two-fifths as high as the total depth of the siphonal lobe. The dorsal lobes and saddles are not as well preserved as those outside the line of involution; there are three slender saddles which increase in size from the line of involution toward the dorsum; the lobes are slender and the antisiphonal lobe appears to be about 27 mm. deep; the outer side of the outermost dorsal saddle forms the inner side of the hanging lobe on the line of involution.

The diameter of the largest part of the last volution that can be accurately measured is 51 + centimeters (several millimeters corroded from venter on one side). The widest measurable part of the



Fig. 12. Suture of *Parapachydiscus scotti* Stephenson at about dorso-ventral diameter of 87 mm. Drawn before the fragmentary parts of the holotype were cemented together.

umbilicus is 17.3 centimeters. The greatest measurable dorso-ventral diameter is about 23 centimeters, and the corresponding transverse diameter is approximately 20 centimeters.

This species resembles *Parapachydiscus* arkansanus in a general way, but the dorsoventral and transverse diameters are obviously more nearly equal, and this difference continues throughout the larger stages. The ribbing is similar in the two species and the sutures are alike in all essential features.

Holotype.—U.S.N.M. no. 77287. Named in honor of the collector, Dr. Gayle Scott.

Distribution in Texas.---Navarro group, Nacatoch sand: Near Corsicana (17012).

## Unidentified specimens of PARAPACHYDISCUS

One small internal ammonite mold found in the Neylandville marl in a roadside ditch 2½ miles south of Ben Hur, Limestone County (15543), probably belongs to an undescribed species, but is too immature and too poorly preserved to serve as a type. The shell is plumply rounded and has a maximum diameter of 6 mm.; the dorso-ventral diameter is less than the transverse diameter, the dimensions being approximately 2.5 and 3 mm. respectively. No ribs are apparent at this stage. U.S.N.M. no. 77288.

A fragment of a young stage of *Parapachydiscus* from the Nacatoch sand on U.S. Highway 75, 4 miles north of the courthouse at Corsicana, Navarro County (17366), is too incomplete and too immature for satisfactory identification. It is plump and the sutures are well preserved. U.S.N.M. no. 77289.

## Family COSMOCERATIDAE

## Genus AXONOCERAS Stephenson, n.gen.

Type species.--Axonoceras compressum Stephenson.

Etymology.—á $\zeta \omega \nu$ , a wheel;  $\kappa \epsilon \rho \alpha s$ , a horn.

The ammonites included in this new genus, *Axonoceras*, are long slender shells coiled in one plane, with numerous closely spaced ribs and two rows of ventral nodes. The initial coil is hoop-like with an umbilical perforation 3 to 5 mm. in diameter. The shells may be closely coiled,

though not involute, but most of them are more or less loosely and irregularly coiled. Partial uncoiling or humping of the conch away from the inclosed volution may take place in any of the volutions and may occur at 2 or 3 stages in the growth of an individual; where this uncoiling occurs the free part of the conch comes back again to join the inclosed volution in less than half a turn. The humping is common in the gerontic stage, where the width of the opening separating the volutions may reach 3 mm.; in this case death may prevent the conch from bending in again to meet the inclosed volution. The uncoiling is more common and more pronounced among the shells of Axonoceras compressum than it is among the other species of the genus. This habit of growth is suggestive of that seen in Scaphites and Ancyloceras, but is less constant with respect to the magnitude of the humping and the part of the shell affected.

Axonoceras is similar in form and habit of coiling to the Neocomian genus, *Crioceras* Léveillé, but is consistently more closely coiled in all of the numerous shells here referred to it. Representatives of the genus have been found only in the Neylandville marl in Navarro and Delta counties, Texas.

## AXONOCERAS COMPRESSUM Stephenson, n.sp.

## Pl. 89, figs. 1 5

Shell small, slender, coiled in one plane. The smallest stage of the conch observed is less than half a millimeter in diameter and is probably near the protoconch. The first volution is an open hoop-like coil with an umbilical perforation 3 to 5 mm. in diameter. The first 2 or 3 volutions are generally more or less closely coiled though partial uncoiling, or loose coiling may take place at any stage; in the holotype the first indication of loose coiling appears in the earliest third of the initial coil and pronounced uncoiling affects the latest coil The most pronounced at two places. humping generally takes place in the gerontic stage, as seen in the paratype illustrated in plate 89, figure 4; but in
some individuals there is scarcely any humping at any stage, as exemplified in the paratype shown in plate 89, figure 3. The greatest observed gape caused by the partial uncoiling is 3 mm. wide. In the early stages the shell is circular in cross section, but in the later stages, it becomes compressed on the sides, thus producing a subrectangular cross section. In the adult stage the dorsum becomes decidedly flattened. The sutures are not well enough exposed for description. The surface is covered with numerous sharply rounded, somewhat variable ribs; on the smallest stage the ribs may number as many as 4 to the millimeter, but they gradually become fewer until on the gerontic stage they may not exceed 8 or 9 to the centimeter: the ribs become weak where they cross the dorsum, or may even fade out completely there; they are nearly as strong on the venter as on the sides. The venter bears two rows of nodes which increase in prominence toward the aperture; the pairs of nodes are present on most of the ribs, but an occasional rib or even two adjacent ribs, may be nodeless, especially on the larger stages; the nodes are circular in cross section.

The greatest diameter of the coiled holotype is about 17.5 mm.; the small end of the conch, as preserved, is less than half a millimeter in diameter; the large end of the conch is about 5 mm. in its dorso-ventral diameter and 4.5 mm. in its transverse diameter. The dorso-ventral diameter of the largest fragment in the collection is 10.7 mm.

Types.—Holotype, U.S.N.M. no. 77290; 1 figured paratype, U.S.N.M. no. 77291; 1 figured paratype, U.S.N.M. no. 77292; 1 figured paratype, U.S.N.M. no. 77293; 1 unfigured paratype, U.S.N.M. no. 77294; 8 unfigured paratypes and numerous fragments, U.S.N.M. no. 77295; 5 unfigured paratypes and numerous fragments, U.S.N.M. no. 77296.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, 8 + paratypes, 1 figured; 17365, holotype and 5 + paratypes, 1 figured; Tex. Bu. 17300, 1 figured paratype); cut of Texas Midland Railroad,  $\frac{1}{2}$  mile north of Cooper (14062, 1 unfigured paratype).

### AXONOCERAS PINGUE Stephenson, n.sp.

## Pl. 89, figs. 6 8

This species is similar to, and is a close relative of, Axonoceras compressum but is larger, plumper on the sides, and lacks the pronounced humping of the gerontic portion of the shell; in the gerontic stage there is only a slight tendency for the shell to uncoil. On the smallest stage preserved the ribbing is of about the same degree of fineness as on compressum, and relatively fine ribbing continues to the beginning of the gerontic stage, where the sculpture becomes markedly coarse; on the large end of the conch the ribs may number as few as 5 to the centimeter; on the gerontic portion there is a tendency for the ribs to alternate in size. The ventral nodes are weakly developed on all but the gerontic shell where they become strong and coarse, and with occasional exceptions the pairs occupy every other rib; the nodes are circular in cross section.

Dimensions of the holotype: Greatest diameter 27 mm.; maximum dorso-ventral diameter 8.5 mm.; maximum transverse diameter 9.7 mm.; diameter of the smallest stage preserved 1.2 mm.

*Types.*—Holotype, U.S.N.M. no. 77297; 1 figured paratype, U.S.N.M. no. 77298; 25 unfigured, incomplete and fragmentary paratypes, U.S.N.M. no. 77299.

Distribution in Texas.—Navarro group, Neylandville marl: 2½ miles north of Corbet (16170, paratypes; 17365; Tex. Bu. 17300, holotype and 1 figured paratype).

### AXONOCERAS MULTICOSTATUM Stephenson, n.sp.

#### Pl. 89, figs. 9 11

Shell small, slender, coiled in one plane. The smallest stage is an open coil with an umbilical perforation about 2.8 mm. in diameter. The small broken end of the conch, which must be near the initial stage, is slightly less than half a millimeter in diameter. The 3 volutions are closely coiled except toward the large end of the conch where the gerontic stage shows a

slight tendency to become humped. In the first two volutions the cross section of the shell is nearly circular but the largest volution becomes slightly compressed. The surface over all but a few millimeters of length at the small end of the shell is covered with numerous fine, narrow, sharply round-crested ribs of irregular strength and spacing, which cross the venter without marked change in size; an occasional interspace is noticeably wider than the others; on the venter at the large end the ribs number about 13 to the centimeter. The venter is flattened and bears two rows of small nodes, the pairs of which may occupy either every rib or every other rib; these nodes are slightly flattened laterally and are smaller and more numerous than those on Axonoceras compressum, and the rows are proportionately closer together.

Dimensions of the holotype: Greatest diameter of the coiled shell 19.5 mm.; maximum dorso-ventral diameter 6.5 mm.; maximum transverse diameter 6 mm.

Holotype.—U.S.N.M. no. 77300; 8 unfigured incomplete and fragmentary paratypes, U.S.N.M. no. 77301.

Distribution in Texas.—Navarro group, Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (Tex. Bu. 17300, holotype; 17365, paratypes).

#### AXONOCERAS MULTICOSTATUM ROTUNDUM Stephenson, n.var.

## Pl. 89, figs. 12-14

Shell small, slender, coiled in one plane. The early stages are wanting, the smallest diameter of the conch in the available material being 3 mm. Although not seen in a sufficiently complete specimen, the holotype suggests close coiling of the volutions. A contact groove is present on the dorsum of some fragments. In the earlier stages the cross section of the shell is nearly circular, but becomes slightly compressed on the sides in the later stages; the venter is broadly rounded except toward the large end where it becomes slightly flattened, and the dorsum becomes flattened in the later stages. Surface covered with numerous, closely spaced, sharply rounded costae which number 9 or 10 to the centimeter on the large end of the shell, and about 20 to

the centimeter on the fragment whose The costae smallest diameter is 3 mm. become weak or disappear on the flattened dorsum. Here and there a new rib is intercalated low on the side. The venter bears two rows of weak nodes which become a little stronger toward the aper-The nodes are slightly elongated ture. laterally and may be present either on successive costae or on alternate costae. The sutures are rather poorly exposed on one medium sized fragment; they include six saddles and six lobes. The ventral lobe is of medium width, rather deep, and is rendered bipartite by a low, broad, saddle whose squarish top is slightly The first lateral saddle is large, wavy. broad, moderately digitate, and is divided centrally by a small narrow sublobe: each of the subsaddles thus formed is bipartite. The first lateral lobe is deep and is much narrower than the first lateral saddle; it is moderately digitate. The second lateral saddle is similar in size and outline to the first. The second lateral lobe is similar to the first, but is smaller. The dorsal saddle is small and moderately digitate. The antisiphonal lobe is small, narrow, and only slightly digitate.

Dimensions of the holotype: Maximum dorso-ventral diameter, 7.5 mm.; maximum transverse diameter 7.6 mm.; corresponding dimensions of the small end 4.7 mm. and 4.3 mm. Maximum diameter of the coiled shell 24 mm.

This variety differs from the typical species in its greater plumpness, its more rounded venter, and the much weaker development of the ventral nodes.

*Types.*—Holotype, U.S.N.M. no. 77302; 5 unfigured paratypes (fragments), U.S.N.M. no. 77303.

Distribution in Texas.—Navarro group. Neylandville marl:  $2\frac{1}{2}$  miles north of Corbet (16170, type loc.);  $\frac{1}{2}$  mile north of Cooper (14062).

## AXONOCERAS? sp.

A small fragment of an ammonite shell questionably representing the young stage of *Axonoceras* is recorded from the Nacatoch sand in a public road cut east of the Houston & Texas Central R.R. near a section house, 2<sup>1</sup>/<sub>2</sub> miles north of Corsicana, Navarro County (14114). The specimen is about 6 mm. long and is nearly circular in cross section, having minimum and maximum diameters of 1.5 and 2 mm. The shell is ornamented with about 15 rather weak, rounded, annular ribs with two marked constrictions about 4 mm. apart. U.S.N.M. no. 77304.

## Family SCAPHITIDAE

Much uncertainty exists as to the family relationships of the Scaphites-like ammonites. Difficulty is experienced in determining criteria that can be relied upon in making the family assignments. Neither differences in form, in suture pattern, nor in ornamentation have proved wholly satisfactory as criteria, when the group is considered as a whole. Even Reeside<sup>492</sup> who, as late as 1927, attempted to refer the known species of the group to one or other of the families Stepheoceratidae ( = Stephanoceratidae), Desmoceratidae, and Cosmoceratidae, n o w states493 that he is not satisfied with the classification suggested in the paper cited. In view of the existing unsettled state of knowledge of this group it seems convenient, for the present at least, to continue grouping the genera under the old family heading Scaphitidae.

## Genus SCAPHITES Parkinson, sensu lato

The species here included under *Scaphites* would, according to Reeside's<sup>494</sup> 1927 classification, be referred to *Acanthoscaphites* Nowak's genus is founded on *Scaphites tridens* Kner, which is characterized by a central row of strong ventral nodes in addition to the two rows of marginal ventral nodes. Assuming that the typical *Acanthoscaphites* is a valid genus, the total absence of a central row of ventral nodes on the American species here under consideration

would seem to afford reasonable grounds for doubting the correctness of their reference to that genus. For the present they will be retained under *Scaphites*.

## SCAPHITES RUGOSUS Stephenson, n.sp.

## Pl. 89, figs. 15-18

Shell of medium size, plump, with ventrodorsal diameter shorter than the transverse diameter, closely but somewhat irregularly involute in the early stages, opening out moderately in the last volution. The umbilicus in the early involute stage is small and deep. At least 4 Scaphites-like stages are developed in a single individual. The first two stages may be seen in the young specimen shown in plate 89, figure 18, which exhibits two distinct straightening-out and doublingback stages in its largest volution; in large shells these first two stages are almost completely enveloped by the later stages. The third stage appears in the first half of the last volution of the holotype; the conch shows a distinct subangulation in trend just below the overhanging aperture, beyond which the conch becomes noticeably straighter. The fourth stage is that represented by the living chamber, which presents the usual Scaphites-like form, with the outer portion of the conch free, but doubling back again toward the inclosed volution. The living chamber becomes noticeably constricted near the aperture. The venter is wide and is flattened down to a very broad arch. The surface is ornamented with narrow sharply rounded ribs of variable strength, separated by pronounced, much wider, broadly concave interspaces: the ribs curve slightly forward as they cross the venter. Less than half of the ribs are primaries originating within the umbilicus; the secondaries originate either by subdivision on the flanks or at nodes, or independently on the flanks within the interspaces. On the early stages the ribs cross the shell nearly directly though with a slight forward curve on the side; toward the aperture of adults they become inclined strongly forward. There are two widely separated rows of marginal ventral nodes which are rather distantly spaced; the nodes surmount ribs which may be separated by one, two, three or four unnoded ribs; the nodes gradually increase in size

<sup>&</sup>lt;sup>402</sup>Reeside, J. B., U. S. Geol. Survey Prof. Paper 150-B, pp. 21-40, pls, 9-11, 1927.

<sup>493</sup>Oral communication.

<sup>&</sup>lt;sup>494</sup>Reeside, J. B., U. S. Geol. Survey Prof. Paper 150-B, pp. 21-40, pls. 9-11, 1927.

<sup>&</sup>lt;sup>405</sup>Nowak, Jan, Untersuchungen uber die Cephalopoden der oberen Kreide in Polen, pt. 2, Die Skaphiten: Acad. sci. Cracovie Bull. internat., année, sér. B, p. 570, pl. 32, fig. 4; pl. 33, figs. 27, 29, 1912.

becoming quite coarse on the middle of the living chamber, beyond which toward the aperture they become gradually smaller again. A similar row of nodes surmounts the umbilical shoulder; these may or may not show clongation along the crest of the ribs. Only small glimpses can be had of the sutures. The living chamber takes up about 0.7 of the length of the last volution.

The maximum diameter of the holotype is 76 mm. The outer three-fifths of the living chamber is mechanically crushed but the aperture does not appear to be seriously distorted; here the dorso-ventral diameter is about 32 mm. and the corresponding transverse diameter about 36 mm.

This species is closely related to Scaphites nodosus Owen, 496 from the Pierre shale of the Western Interior. The holotype of Owen's species is lost. Compared with his original figure the straightened portion of the living chamber of S. rugosus is shorter, the dorso-ventral diameter is shorter, the space between the inner row of nodes and the umbilicus is much narrower, and the sculpture is in general coarser and more rugged. Compared with Scaphites nodosus quadran-gularis Meek and Hayden,407 S. rugosus is similar in the degree of coiling but is much thicker in the direction of the transverse diameter and is much more coarsely sculptured. The type lot includes three adults, all more or less crushed, and two young individuals.

*Types.*— Holotype, U.S.N.M. no. 77305; 1 figured paratype, U.S.N.M. no. 77306; 3 unfigured paratypes, U.S.N.M. no. 21113.

Distribution in Texas.--Navarro group, Neylandville marl: ?2½ miles south of Ben Hur (15543); ?2½ miles north of Corbet (Tex. Bu, 17300).

Navarro group, Nacatoch sand:  $4\frac{1}{2}$  miles east by north of Rosali (14061); vicinity of Chatfield (762, type loc.).

Outside distribution.---Arkansas: Nacatoch sand (a young individual, 7470).

Range.—Questionably in the Neylandville marl of Texas and in the Nacatoch sand of Texas and Arkansas.

## SCAPHITES BREVIS Meek

Pl. 90, figs. 7, 8

- 1876. Scaphites nodosus var. brevis Meek, Rept. U.S. Geol. Survey Terr., vol. 9, p. 426, pl. 25, figs. 1a-c.
- 1880. Scaphites nodosus var. brevis Meck. Whitfield, Rept. Black Hills of Dakota, p. 443, pl. 13, figs. 8, 9.
- 1898. Scaphites nodosus var. brevis. Meek. Logan, Univ. Geol. Survey Kansas, vol. 4, p. 511, pl. 108, fig. 3.
- ?1905. Scaphites nodosus var. brevis Meek. Smith, Jour. Geology, vol. 13, no. 7, p. 640, text fig. 1 on p. 641, nos. 2, 4 7, 9-18; fig. 3 on p. 645, nos. 1-3, 5, 6, 9.
- 1910. Scaphites nodosus var. brevis Meck. Grabau and Shimer, North American Index Fossils, vol. 2, p. 177, fig. 1428.

One incomplete crushed internal mold from the Nacatoch sand exhibits sculpture which appears to be essentially identical with the shell which Meek described under the name *Scaphites nodosus* var. *brevis*. The compressed form of Meek's holotype, together with the fineness of its sculpture, amply justifies raising it to the rank of species. The Texas specimen is an adult smaller than Meek's type. It includes all of the living chamber and two of the septal chambers badly crushed. The ribbing is very fine and the ventral and umbilical nodes are well developed and essentially like those on the type.

Types.—Holotype, U.S.N.M. no. 367, from the upper part of the Pierre shale on Yellowstone River, "150 miles above its mouth" (near Glendive, Montana). Plesiotype from Texas, U.S.N.M. no. 77307.

Distribution in Texas.—Navarro group, Nacatoch sand:  $4\frac{1}{2}$  miles east by north of Rosali (14061).

Outside distribution.—Western Interior, upper part of Pierre shale.

Range.—Known in Texas only from the one locality in the Nacatoch sand. Common in the upper part of the Pierre shale of the Western Interior.

## SCAPHITES PUMILUS Stephenson, n.sp.

Pl. 90, figs. 10-12

Shell small, closely coiled, and plumply rounded in early stages, straightening out and becoming strongly flattened on the sides and on the venter in the living chamber; the flattened sides diverge a little inwardly. Umbilicus small and deep, the

 <sup>&</sup>lt;sup>496</sup>Owen, D. D., Rept. U. S. Geol. Survey Iowa,
 Wisconsin, and Minnesota, p. 581, tab. 8, fig. 4, 1852,
 <sup>497</sup>Meck, F. B., Rept. U. S. Geol. Survey Terr., vol. 9,

p. 428, pl. 25, figs. 3a-e, 1876.

maximum diameter to the beginning of the free living chamber being 4 mm. Four volutions can be counted back of the living chamber. The shell is incomplete at the aperture. The sides of the living chamber are flattened, becoming slightly concave in an undulating fashion toward the large end; the venter is almost flat on the living chamber, and makes nearly a right angle with the sides. The living chamber is quadrangular in cross section; it expands rapidly toward the aperture, and the dorsum becomes very broad and flat on the free portion. The surface of the exposed portion of the shell back of the living chamber is covered with low, narrow ribs of only moderate strength, separated by broader interspaces with broadly concave bottoms; the ribs run nearly directly up over the venter, with, however, a very gentle curvature toward the front. Of the 37 ribs that can be counted only 7 or 8 originate at the umbilical shoulder as primaries, all the others arising on the sides by forking or by intercalation in the interspaces. A few rather coarse, elongated, widely spaced nodes appear on primary ribs at the umbilical shoulder; back of the living chamber ventral nodes are wanting or only feebly developed. A row of 7 or 8 feebly developed nodes appears on the flanks of the larger part of the volution immediately posterior to the living chamber; these nodes fade out both posteriorly and anteriorly; they appear to be too low down on the sides to represent the continuation of the ventral nodes backward from the living chamber. Two rows of strong ventral nodes are present on the living chamber, ornamenting the angles separating the flattened venter from the flattened sides; these are slightly elongated in the linear direction of the shell. Except for the ventral nodes and the nodes on the umbilical shoulder the surface of the living chamber is smooth.

The suture of the fourth septum back of the living chamber is well exposed on one side from the venter to and slightly over the umbilical shoulder. The ventral lobe is large and broad and is divided below by a broad, blunt ventral saddle which rises about three-tenths as high as the lobe is deep; there are 4 branches on either side of the ventral lobe, the two lower ones bifid, and the two upper ones short and simple. The first lateral saddle is broad and large, and is divided above by a short, trifid sublobe. The first lateral lobe is much smaller than the ventral lobe and is bifid below, with all digitations rounded on their ends. The second lateral saddle is bifid and is much smaller and simpler than the first. The second lateral lobe is small and trifid. The third lateral saddle is small and simply bifid. Two more lateral lobes and two more saddles are small and quite simple.

The greatest diameter of the shell is 31 mm.; the diameter just posterior to the living chamber is 19 mm. The greatest measurable dorso-ventral diameter is 13.5 mm., and the greatest transverse diameter is 15.6 mm.

The species appears to be closely related to *Scaphites nodusus* var. *quadrangularis* Meck<sup>195</sup> from the upper part of the Fort Pierre group in the Western Interior, but the small size, the smooth flat sides diverging inwardly, the smooth flat venter, and the row of obscure lateral nodes, on the Texas specimen, would seem to warrant its recognition as a separate species. There is some reason to suspect that this may be a dwarfed individual of some larger form.

Holotype.-U.S.N.M. no. 21041.

*Distribution in Texas.*—Navarro group, Nacatoch sand: Vicinity of Chatfield (762).

#### SCAPHITES YORKENSIS Stephenson, n.sp.

#### Pl. 90, fig. 9

This species is based on a single incomplete mold of the exterior. The shell is of medium size and is mechanically flattened on the side in the one available specimen; the undeformed shell was probably moderately stout and, in lateral view, it is broadly subovate in outline. Umbilical shoulder of straight part of shell slightly concave inward. Aperture constricted. Earlier whorls not seen. Back of the living chamber the coiled part of the shell as far as exposed shows irregular umbilical ribs which divide one or more times on the flanks. There are four rows of conical nodes, two appearing on the last half of the last septate whorl, one about one-fourth the way out from the

<sup>&</sup>lt;sup>408</sup>Meek, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 428, pl. 25, figs. 2a-e, 3a-e, and 4, 1876.

umbilicus and another about the middle of the flank; the third, which is present three-fourths of the way out from the umbilicus, and the fourth on the ventro-lateral margin, are already present at the beginning of the last septate whorl. On the living chamber the nodes of the inner row have moved to the umbilical shoulder and become large, those of the two median lateral rows disappear, and the ventrolateral row is conspicuous. The living chamber is covered with fine, even, threadlike ribs, mostly simple, but a few bifur-There appears to have been no cated. swelling of the living chamber. The sutures are unknown. The species is characterized by the four rows of nodes on the septate part, and by the two rows of conspicuous nodes and the fine distinct ribs on the living chamber.

The estimated dimensions of the shell are: Maximum diameter 65 mm., minimum diameter between 55 and 60 mm. Other dimensions can not be accurately measured.

Holotype.- U.S.N.M. no. 77308.

Distribution in Texas.—Navarro group, Kemp clay: Near York Creek 4 miles southeast of Zorn (10877).

### SCAPHITES sp.

One fragment of the living chamber of a large individual of *Scaphites*, from Liveoak Creek at the north edge of Corsicana, Navarro County (518), is specifically unidentifiable, but does not appear to belong to any of the species described above. The fragment is characterized by a row of strong, sharp nodes, which appears to be well down on the side below the margin of the venter. U.S.N.M. no. 77309.

### Genus DISCOSCAPHITES Meek

DISCOSCAPHITES ROANENSIS Stephenson, n. sp.

#### Pl. 90, figs. 1-4

Shell of medium size, involute, strongly compressed on the sides. Umbilicus small and deep. Posterior to the living chamber the coiling is nearly regular; the living chamber straightens out somewhat, expands rapidly in the dorso-ventral diameter, is only moderately elongated, and in the humped portion toward the aperture scarcely rises free from the preceding volution. In the holotype, which is broken across the center, 5 volutions can be

counted back of the living chamber. Venter narrow and flattened. The surface is ornamented with numerous low rounded radiating ribs which curve noticeably forward on the venter where, however, they become obscure, or may even be entirely wanting; on the anterior portion of the living chamber the ribs become strongly oblique in the forward direction. In the adult only 9 or 10 of the 30 or more ribs originate at the umbilical shoulder as primaries, the others arising on the flanks at different distances from the shoulder. either by forking or by intercalation in the interspaces. On the living chamber the surface tends to smooth out, passing into a series of low, widely spaced, broadly rounded undulations which differ markedly in strength on the same and on different individuals. The venter is bordered on each margin by a row of small, closely spaced nodes of fairly uniform size and spacing; although many of these nodes occupy positions corresponding to ribs, many of them are entirely independent of the ribs, and tend to maintain uniformity of spacing independently of the irregularities in rib spacing. These nodes extend well back on the shell but appear to be wanting on the first 2 or 3 volutions. A row of proportionately coarse nodes is present on the umbilical shoulder where they surmount most of the primary ribs, and become coarser toward the aperture. On the holotype 3 rows of lateral nodes are easily recognized on each side of the shell and a fourth inner row is represented by several very obscure nodes: there is great variation in the strength of development of these lateral nodes on different individuals, but in general the row nearest the venter is the most strongly and most regularly developed and other rows become progressively weaker inwardly toward the umbilical shoulder; the two inner rows are generally obscure, and may be practically wanting.

The external suture includes 6 saddles and 6 lobes. The ventral lobe of the suture is proportionately narrow and only moderately deep and moderately digitate; the ventral saddle is broad, blunt-ended and very faintly trifid above. The first lateral saddle is very broad and is rendered asymmetrically trifid by two sublobes, of which the one nearest the venter is small and nearly simple and the other is larger and bifid; the three subsaddles are each bifid. The first lateral lobe is smaller than the ventral lobe and is bifid. The second lateral saddle is bifid and is much smaller and simpler than the first lateral. The third lateral saddle is still smaller but is proportionately broad and is bifid. The third lateral lobe is quite small and simply trifid. The latter is followed by a small broad, simply bifid saddle, a small narrow lobe faintly bifid, a small, broad, simple saddle, a very small simple lobe, and a simple saddle which straddles the line of involution. Any of the simple lobes or saddles may be faintly bifid on other parts of the same shell or on different shells. The inner suture as seen on very small stages consists of an antisiphonal lobe, 2 dorsal saddles and 2 dorsal lobes, the series decreasing in size from the dorsum to the line of involution. The antisiphonal lobe is narrow, about six-tenths as deep as the corresponding siphonal lobe, and is very simply digitate. The dorsal saddles are narrow and simply bifid; the dorsal lobes are narrow and simpler than the antisiphonal lobe; the outer dorsal lobe is much narrower than the saddle which straddles the line of involution.

The holotype, though preserving most of the living chamber, is incomplete at the apertural end. The greatest diameter of the shell as preserved is 45 mm. The greatest measurable dorso-ventral diameter is 23 mm., and the corresponding transverse diameter is about 17 mm. As shown by the inner broken cross sections the dorso-ventral diameter of the first 2 or 3 volutions is a little shorter than the transverse diameter; the greater length of the former becomes easily noticeable in the fourth volution and increases rapidly toward the living chamber. The regular coiling of the main part of the shell, the compressed sides, the flattened venter, and the multiple rows of lateral nodes ally this species with the group for which Meek<sup>499</sup> proposed the name Discoscaphites, naming Scaphites conradi Morton as the type species.

*Types.*—Holotype, U.S.N.M. no. 77310; 1 figured paratype, U.S.N.M. no. 77311; 7 unfigured paratypes, U.S.N.M. no. 77312.

Distribution in Texas. -- Navarro group, Kemp clay: 3½ miles northwest of Bazette (12922, type loc.); branch 6½ miles southwest of Currie (14139, 17377); 4½ miles east-northeast of Cooledge (17374).

Range.—Known only from 3 localities in the Kemp clay within 15 or 20 fect of its top.

### DISCOSCAPHITES ERUCOIDEUS Stephenson, n.sp.

## Pl. 91, figs. 2 4

Shell small, strongly involute, deeply embracing, compressed laterally throughout the exposed portion. Umbilicus very small and deep. Venter broadly rounded. The shell is probably in a median stage of the growth of the individual, and the living chamber is broken away. The form of the preserved portion suggests that the living chamber, if present, would not be greatly elongated. The conch is considerably expanded in the dorso-ventral direction. The surface is covered with numerous low rounded ribs which cross the venter with undiminished strength; on the one exposed volution these number 57 on the venter and only about 15 on the umbilical shoulder where they become somewhat obscure; the ribs increase in number from the umbilieus outward in part by forking and in part by intercala-The ribs trend noticeably forward tion. on the sides of the shell and cross the ventor with a scarcely perceptible forward curve. On the largest part of the shell 2 rows of nodes of 3 nodes each are present, one on each side of the rounded venter; the nodes occupy about every A row of very obscure nodes third rib. is present on each side above the midline between the umbilicus and the venter on the smaller exposed part of the shell up to a diameter of about 19 mm. There is a tendency for obscure nodes to form at the rib forks.

The sutures, though not completely exposed, appear to be essentially like those of *Discoscaphites nicolleti* (Morton) and *D. conradi* (Morton), though differing in detail. The ventral lobe is large, deep and provided with digitate prongs; the

<sup>&</sup>lt;sup>499</sup>Meck, F. B., Rept. U. S. Gcol. Survey Terr., vol. 9, p. 415, 1876.

3 prongs on either side become progressively smaller from rear to front, and the posterior one is divided; the ventral saddle is proportionately broad and extends forward about one-third the length of the ventral lobe. At a diameter of about 15 mm., the first lateral saddle is large, moderately broad, and slightly asymmetrical; of the 3 terminal subsaddles the two nearest the venter are slightly divided and the third more strongly so; the latter is separated from the other two by a proportionately wider and deeper sublobe. The first lateral lobe is large and terminates posteriorly in 4 widely separated, digitate prongs, all of which are divided: the second lateral saddle is proportionately small and bifid; the second lateral lobe is small and appears to terminate in 4 simple digitate prongs.

The greatest diameter of the shell is 23 mm.; the greatest measurable distance from the umbilicus to the venter is 15 mm.; the greatest dorso-ventral diameter, measured from the venter of the penultimate whorl, is 9 mm.; and the maximum width is 10.5 mm.

The compressed sides and the presence of nodes, though poorly developed, seem to place this shell in the genus *Discoscaphites* Meek. It is closely related to *Discoscaphites nicolleti* (Morton).

Holotype.-U.S.N.M. no. 77313.

Distribution in Texas.---Navarro group, Nacatoch sand: 2 1/10 miles northeast of Chatfield (Tex. Bu. 17302).

## Unidentified specimens of DISCOSCAPHITES

Fragments of internal molds, probably representing either 5 or 6 species of *Discoscaphites*, have been collected from the Corsicana marl at six widely separated localities in Texas.

Two of the specimens came from a public east-west road,  $1\frac{1}{1}$  miles south by east of Oak Grove, Bowie County (16160). One of these specimens (U.S.N.M. no. 77314), representing a portion of the shell back of the living chamber (pl. 91, fig. 6), is a strongly compressed form characterized by a narrow venter and by rows of small, closely spaced nodes. The venter bears three rows of nodes of which the central one is much weaker than the

others. At least 2 lateral rows of nodes may be seen on each side closely paralleling the marginal ventral rows; if additional rows of nodes are present lower on the sides, they are not recognizable on account of corrosion. The maximum dorso-ventral diameter measures 17mm., and the corresponding transverse diameter 12.2 mm. The other specimen from this locality (U.S.N.M. no. 77315) is a short fragment back of the living chamber (pl. 90, figs. 5, 6). The flattened venter is very narrow and the 2 rows of ventral nodes are close together. Moderately strong and rather closely spaced ribs are present, and each side bears 4 rows of nodes between the ventral row and the row on the umbilical shoulder; in each row nodes are present on successive ribs. The dorso-ventral diameter measures 16.5 mm., and the corresponding transverse diameter 17.7 mm.

A mechanically compressed, small internal mold, incompletely covered with a thin film of original shell substance, was found in a small branch below a public road 21/2 miles north of Tona siding, 5 miles southwest of Quinlan, in Hunt County (15546). This specimen (pl. 91, fig. 7) exhibits low rounded ribs which become stronger toward the venter. There are 2 rows of marginal ventral nodes; the nodes in the 2 rows form pairs which are joined by 2 small ribs formed by the bifurcation of the lateral ribs at the nodes. The species is closely coiled and the umbilicus is small. Although lateral rows of nodes can not be definitely differentiated, the general form and appearance of the shell suggest that it belongs to Discoscaphites. The shell is about 20 mm. in greatest diameter. U.S.N.M. no. 77316.

The impression of a mechanically flattened *Discoscaphites*, apparently representing most of the shell back of the living chamber, was obtained in the Corsicana marl on the Mexia road 2 4 5 miles east of Cooledge, Limestone County (13832). Faint impressions of sutures may be seen over all the specimen. The shell (pl. 91, fig. 8) is closely coiled and expands rapidly. Moderately strong marginal ventral nodes are present; 2 or 3 rows of lateral nodes may be detected, but are weakly developed. The maximum diameter of the crushed shell as preserved is about 30 mm; the maximum dorso-ventral diameter measures about 21 mm., but this apparent dimension may be an exaggeration caused by mechanical deformation. U.S.N.M. no. 77317.

A poorly preserved fragment of a portion of a living chamber, from the left bank of San Marcos River, ½ mile below Martindale, Caldwell County (7621), represents a medium-sized shell with moderately strong nodes including marginal ventral nodes, nodes on the umbilical shoulder, and at least 3 rows of nodes on each side. The ribs are rather obscurely developed. U.S.N.M. no. 77318.

A fragment of a form with flattened sides, representing a part of the shell back of the living chamber (pl. 91, fig. 5), from a westward-facing bluff on Guadalupe River, 1 3/10 miles north of Mc-Queeney, Guadalupe County (15524), exhibits 2 rows of ventral nodes, the pairs of which are linked by small double ribs formed by the bifurcation of the lateral ribs at the nodes. No lateral rows of nodes are recognizable. The maximum dorso-ventral diameter is 10 + mm. and the corresponding transverse diameter is 8.8 mm. This specimen may belong to the same species as the one described from Hunt County (15546), but the mechanically compressed condition of the prevents certain latter identification. U.S.N.M. no. 77319.

A small, badly crushed specimen from a depth of 1045 feet in Redus No. 1 well of the Witherspoon Oil Company, on the G. A. Harper Survey, Medina County (13844), is ornamented with numerous costae, and by at least 2 rows of obscurely preserved nodes on each side near the venter. U.S.N.M. no. 77320.

The Kemp clay has yielded one incomplete, badly crushed specimen that is specifically unidentifiable, but appears to be a *Discoscaphites*; it came from Elm Creek at the crossing of the Corsicana road,  $2\frac{1}{2}$  miles north-northwest of Angus, Navarro County (9550). The part of the shell back of the living chamber is not greatly elongated. Two or 3 rows of lateral nodes appear to be present. A portion of the living chamber just back of the aperture is preserved and shows an irregular development of ribs, finest near the aperture, and 3 prominent nodes appear on the umbilical shoulder. U.S.N.M. no. 77321.

The Kemp clay has also yielded a very obscure *Discoscaphites* from concretions in a field a mile west of Odds, in Falls County (17373). U.S.N.M. no. 77322.

## Family PLACENTICERATIDAE

Genus PLACENTICERAS Meek

#### PLACENTICERAS MEEKI Böhm

Pl. 91, fig. 1; pl. 92

- 1876. Placenticeras placenta (DeKay). Meek (in part), Rept. U.S. Geol. Survey Terr., vol. 9, p. 466, text fig. 65.
- ?1885. Placenticeras placenta (DeKay). Whiteaves (in part), Geol. and Nat. History Survey Canada, Contributions to Palacontology, vol. 1, pt. 1, p. 53.
- Mistory Survey Canada, Contributions to Palacontology, vol. 1, pt. 1, p. 53.
   ?1889. Placenticeras placenta (Dekay). Whiteavcs (in part), Geol. and Nat. History Survey Canada, Contributions to Palacontology, vol. 1, pt. 2, p. 183.
   1898. Placenticeras meeki Böhm, Zeitschr.
- 1898. Placenticeras meeki Böhm, Zeitschr., Deutsch. Geol. Gesell., Band 50, p. 200 (footnote).
- 1903. Placenticcras whitfieldi Hyatt, U.S. Geol. Survey Mon., vol. 44, p. 22, pl. 45, figs. 3 16; pl. 46; pl. 47, figs. 1 4.
- 1910. Placenticeras whitfieldi Hyatt. Grabau and Shimer, North American Index Fossils p. 218, figs. 1493, 1494.
- 1926. Placenticeras meeki Böhm. Reeside, U.S. Geol. Survey Prof. Paper 147-A, pp. 1-5, pl. 1, figs. 1-7, 13; pl. 2, figs. 1-5.
- ?1927. Placenticeras whitfieldi Hyatt. Böse, Univ. Texas Bull. 2748, p. 276, pl. 13, figs. 1–3.
- 1927. Placenticeras mecki Böhm. Reeside, U.S. Geol. Survey Prof. Paper 151, p. 29, pl. 22, figs. 5-7; pls. 23, 24; pl. 25, figs. 1, 2.
- ?1930. Placenticeras meeki Böhm. Williams, Canada Dept. Mines, Nat. Mus. Bull, 63, Geol. Ser. 51, p. 6.
- ?1931. Placenticeras meeki Böhm. Link and Childerhose, Bull. Amer. Assoc. Pet. Geol., vol. 15, no. 10, pp. 1238, 1241. text figs. 9, 11.

Shell of adult very large, compressed, strongly involute, with greatest transverse diameter near the umbilical shoulder. Venter narrow for the genus, flat with sharp marginal angles in all earlier stages, becoming rounded in adults. Umbilicus proportionately small, with sides which do not overhang. steep Umbilical shoulder rounded. Surface smooth at all stages observed. A cross section at a diameter of about 227 mm. is shown in text figure 13. The sutures are characterized by elongated intricately branching saddles and digitate lobes. The siphonal lobe is both deep and wide and may be a little off center. The ventral saddle is fully one-third as high as the lobe is deep; at a medial stage of growth it is subdivided above into 5 subsaddles, of which the two pairs on either side rise higher than the broad, blunt central one; this saddle becomes more complicated in the later stages. The two main lower branches of the siphonal lobe are deep. trend obliquely away from the venter, and are intricately branching. The first three lateral lobes are narrow and deep, the third one being wider and deeper than the others. The fourth lateral lobe is much shorter and smaller than the third, and the succeeding lobes and saddles become successively smaller. At the stage where the dorso-ventral diameter is about 100 mm., the lateral saddles number 10 and the intervening lobes 9, to the line of involution; with increase in size lobes and saddles are added from within, and on large individuals may reach a dozen or more of each to the line of involution. The inner sutures are not uncovered.

The greatest measurable diameter from venter to venter, of the largest specimen from Texas, found in a cut of the Dallas highway 3 7/10 miles west of Kaufman, is approximately 530 mm. The body chamber is wanting, so that with this chamber added the shell must have been one of the largest recorded examples of the genus. The greatest measurable radial dimension is about 334 mm. At the stage where the diameter of the shell is 400 mm. the radial dimension is approximately 241 mm., and the corresponding maximum width 105 mm.

The best preserved shell from Texas (pl. 92) from the same locality as the preceding one has most of the living chamber broken away; the shell measures 471 mm. in greatest over-all diameter, and



Fig. 13. Cross section of *Placenticeras meeki* Böhm where the diameter is about 227 mm.; constructed from an incomplete specimen (U.S. G.S. Coll. 14101; U.S.N.M. no. 77323). Reduced, x7/9.

bears sutures to within 40 to 100 mm. of the broken edge of the living chamber. At the same diameter the height of the whorl from the umbilical center to the venter is 294 mm.; the height from the line of involution to the venter is 270 mm., and the maximum width is 145 mm.; the diameter of the umbilicus at the greatest over-all diameter, measured at the umbilical suture, is 45 mm. The shells referred to this species are characterized by their large size, compressed sides, narrow venter, and narrow, greatly elongated saddles and lobes. The measurements given above can only be approximately correct owing to the imperfections of the specimens and the mechanical deformations to which they have been subjected. It is estimated that if the living chamber (half a volution) were added to the largest shell measured, and if the shell maintained the same rate of increase in size, the maximum diameter would be not less than 780 mm. ( - approximately 2 ft. 7 in.).

Types.—Holotype, U.S.N.M. no. 3680. From North Red River, Minnesota. Two plesiotypes from Texas, U.S.N.M. nos. 77323, 77324.

Distribution in Texas.—Navarro group, Neylandville marl: 1/2 mile north of Cooper (7509, 14062); ?5 miles southwest of Caddo Mills (14091); ?21/2 miles northeast of Royce City (13834); 3 7/10 miles west of Kaufman (14101, 1 specimen figured; 17119, 1 figured specimen); ?2 7/10 miles northwest of Cooledge (16169).

Outside distribution.—Western Interior: Pierre shale and formations of equivalent age.

Canada: The species has been reported from the Bearpaw shale (Pierre age) at numerous localities in western Canada.

Range.—Known in Texas only from the Neylandville marl of the Navarro group. Reported as ranging throughout the Pierre shale and formations of Pierre age in the Western Interior and western Canada.

#### PLACENTICERAS INTERCALARE Meek (variety)

## Pl. 94, figs. 3, 4

small, stout for the Shell genus, strongly involute, with flattened flanks diverging inwardly. Umbilicus small and deep with steep slopes. Umbilical shoulder rather broadly rounded. Venter at early stage narrow and flat or slightly concave; in later stages the venter is flat and widens more rapidly than on the holotype of the species which, though much larger, possesses a narrower venter at its largest stage; width of venter at largest stage on this specimen about 5 mm. A row of coarse, strong nodes is present on the umbilical shoulder, and a second row not quite so coarse on the flank about two-thirds the distance from the first row to the venter. The venter bears two marginal rows of nodes which are rather small and closely spaced, but which are stouter and much less elongated in the direction of the venter than the corresponding nodes on the holotype. The suture is essentially like that of P. intercalare. The siphonal lobe is broad with a broad, low ventral saddle and widely diverging lower branches. The first lateral saddle is moderately broad above, becoming very slender and irregular below. The succeeding lobes and saddles to the third lateral lobe are proportionately narrow and increase slightly in size away from the venter. The remainder of the external saddles and lobes are small and decrease in size toward the line of involution. At the maximum dorsoventral diameter there are five interior saddles with four intervening lobes.

The maximum dorso-ventral diameter on the figured specimen is 38 mm. and the corresponding width measured on the tips of prominent nodes is about 30 mm. (estimated); measured between the nodes the width would be about 24 mm.

The description is based on one small septate specimen found embedded in a hard black phosphate nodule at the base of the Neylandville marl. The specimen may or may not have been reworked from the underlying Taylor marl. All the nodes are stouter than those of the typical *P. intercalare*, the venter is noticeably wider and the ventral nodes are smaller and more closely spaced. When more mature specimens are discovered it may be found desirable to give this form a separate varietal, or perhaps a separate specific, name.

Types.—Holotype, U.S.N.M. no. 369; from the upper part of the Pierre shale at the junction of Sage Creek with Cheyenne River in the southwestern part of South Dakota. Plesiotype? from Texas, U.S.N.M. no. 77325.

Distribution in Texas.—Navarro group, base of Neylandville marl: 5 miles west of Kaufman (14102).

Outside distribution.—Western Interior, Pierre shale (upper part).

Range.—This variety is known only from the one locality cited in Texas. Mcek's species is common in the upper part of the Pierre shale in the Western Interior.

## Family ENGONOCERATIDAE

## Genus SPHENODISCUS Meek

The original description of Sphenodiscus<sup>500</sup> is as follows:

In the same way, Ammonites lobatus of Tuomey may be regarded as the type of another group, differing from Placenticeras in having the periphery sharply cuncate all around, and the sinuses or saddles between its numerous lateral lobes (which agree in number and proportional size with those in Placenticeras, presenting very curious obtusely-lobed or uniform outlines. For this type I would propose the name Sphenodiscus, in allusion to its sharply-cuneate periphery.

In 1876, Meek<sup>501</sup> gave a fuller description of Sphenodiscus, treating it as a subgenus of Placenticeras. In this paper Ammonites lobatus Tuomey is placed in the synonymy under Placenticeras (Sphenodiscus) lenticulare (Owen), but Hyatt,<sup>502</sup> in 1903, regarded the two species as distinct.

Tuomey's description of Ammonites lobatus is as follows:

Shell discoid, smooth, thin towards the circumference; dorsal [ventral] lobe finely serrate; lateral lobes [saddles] terminating in large hilobed cells.

This fossil, of which I have only a fragment, resembles  $\Lambda$ . *placenta*, but is distinguished from it by the remarkable cells that terminate the lateral lobes [saddles].

Locality, Noxubie County, Mississippi.

Tuomey's description is inadequate and he did not figure the type, which is believed to be lost.

Hyatt figured two specimens under Tuomey's name, one large one (U.S.N.M. no. 2403) from Pontotoc County, Mississippi, and one small abnormal one (U.S. N.M. no. 20577) from Landers Mill (Ripley formation) in Tippah County, Mississippi. It may never be possible to prove that either one of these two specimens belongs to Tuomey's species, but if the name is to be accepted as valid it will be necessary to select one of them as neotype; since Meek states that he saw the large specimen from Pontotoc County, it would seem appropriate to choose that one. This procedure would necessitate a loose construction of the rule governing the selection of neotypes, namely, that the new type should come from the same locality and horizon as the lost type. Since, however, the upper beds of the Upper Cretaceous are exposed in both Noxubee and Pontotoc counties, there is a reasonable possibility that the Pontotoc specimen does belong to Tuomey's species. In view of the general acceptance of the name, and the designation of the species as the genotype of Sphenodiscus, less confusion would result from fixing the name on this selected neotype than would follow the attempted invalidation of the name.

The whole subject of the proper basis for subdividing the genus *Sphenodiscus* into species and varieties needs reconsideration, with more material for comparison than is now available. Suture patterns alone do not seem to be dependable characters on which to base a subdivision of

<sup>&</sup>lt;sup>500</sup>Meek, F. B., Preliminary Report of the United States Geological Survey of Wyoming and portions of contiguous territories (being a second annual report of progress), pt. 4, p. 298 (footnote), 1871. [Actually this is a fourth annual report; another identical edition bears the date 1872.]

<sup>&</sup>lt;sup>501</sup>Meek, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 463, 476, 1876.

<sup>&</sup>lt;sup>502</sup>Hyatt, Alpheus, U. S. Geol. Survey Mon., vol. 44, p. 66, 1903.

the genus and it would seem necessary therefore to look for consistent differences in form and ornamentation in large suites of specimens.

## SPHENODISCUS TIRENSIS Stephenson, n.sp.

## Pl. 93, figs. 1 3; pl. 94, figs. 1, 2

Adult shell large, smooth, lenticular in cross section, strongly involute, umbilicus small, flanks slightly flattened on the inner half; outer half presenting a scries of faint, widely spaced, broad, low radial swells. Umbilicus small and deep, with broadly rounded shoulder. Venter sharpedged in young stages, with angle 60 degrees or less, becoming wider and acutely rounded in adults.

Septa not unduly crowded. Sutures variable on the same and on different individuals. At a radial dimension of 125 mm, the lobes and saddles number 15 each between the venter and the line of involution. Ventral lobe very broad and of only moderate depth, with the two lower branches diverging strongly: ventral saddle very broad and low, with serrate upper margin, finest in center, ending at each outer corner in a small rounded subsaddle. The first four lateral saddles are in general narrow and only moderately high, but become progressively higher in the larger stages; they are bilobate with the lobate parts either simple or partly subdivided by one or more shallow indentations: the fifth and sixth saddles may be either simple or bilobate and the rest of the saddles to the line of involution are generally simple and broadly lobate, though saddles may be divided as far as the ninth. The lateral lobes increase in size to the third which is quite large; the fourth lobe is much smaller than the third, and the succeeding lobes become progressively smaller and simpler to the line of involution. The large lateral lobes are divided into 3 or 4 thick-stemmed branches. each of which ends in 4 or more dullpointed digitations. A group of internal saddles and lobes at a young stage is shown in plate 94, figure 2. A maximum of 10 simple saddles and 9 lobes appears in the longest suture.

The individual variation in the sutures and the unsymmetrical development of the sutures on the two sides of given individuals are striking features of this species. It is not uncommon for 4 or 5 of the larger saddles on one side to be divided and 6 on the other. On one specimen from the Chapman farm the first lateral saddle is much broader and lower than is typical; on one side of this specimen the first four lateral saddles are divided, the fifth and sixth are simple, the seventh is divided, the eighth simple, and the ninth divided; on the other side of the same specimen the first six saddles are divided. the seventh is simple, and the eighth and ninth slightly divided.

The largest radial dimension of the holotype is about 125 mm., and the corresponding width is 49 + mm. (this specimen is slightly crushed laterally). The largest specimen in the collection from the Kemp clay has a radial dimension of 165 mm.

Sphenodiscus lenticularis (Owen),<sup>503</sup> from the Fox Hills sandstone of the Western Interior is based on a very immature shell which, as figured, does not show the sutures, and is inadequate for specific description. The shell (U.S.N.M. no. 411) described and figured by Meek<sup>504</sup> under that name appears to be more thinly lenticular in cross section than the species under consideration, and the septa are more closely crowded throughout; the specimen is a young stage, the maximum radial dimension of which is 60 mm.

The specimen from the Monmouth formation of Maryland described by Gardner under the name Sphenodiscus lobatus (Tuomey) is a young shell the sutures of which are similar to those of the shells commonly referred to S. lenticularis. The same may be said of the young specimen from the Peedee formation of South described under Carolina the name Sphenodiscus lobatus var. allisonensis Stephenson.505

*Types.*—Holotype, U.S.N.M. no. 77326; 1 figured paratype, U.S.N.M. no. 77327; 2 unfigured paratypes, U.S.N.M. no. 77328; 1 figured example, U.S.N.M. no. 77329.

<sup>&</sup>lt;sup>503</sup>Owen, D. D., Rept. U. S. Geol, Survey Iowa, Wisconsin, and Minnesota, p. 579, tab. 8, fig. 5, 1852.

<sup>&</sup>lt;sup>504</sup>Meek, F. B., Rept. U. S. Geol. Survey Terr., vol. 9, p. 473, pl. 34, figs. 1a-e, 1876.

<sup>&</sup>lt;sup>605</sup>Stephenson, L. W., North Carolina Geol. and Econ. Survey, vol. 5, p. 397, pl. 99, figs. 1, 2, 1923.

Distribution in Texas.—Navarro group, Corsicana marl: ?1¼ miles south by east of Oak Grove (16160); 1 9/10 miles northeast of Quinlan (16924); ?1 4/5 miles N. 20° W. of Tona siding (15545); ?fuller's earth pit 14 miles west of San Antonio (15624); well on C. A. Harper Survey, Medina County (13844, at depth of 1015 feet).

Navarro group, Kemp clay:  $1\frac{1}{2}$  miles southeast of Tira (12930, type loc.); 2 miles south of Tira (12865); 3 miles southeast of Corsicana (17367); branch  $6\frac{1}{2}$  miles southwest of Currie (14139, 1 figured example); 1 mile east of Kimbro store (Tex. Bu. 903); ?3 miles southeast of Manor (16141); near Webberville (1642); ?4<sup>1</sup>/<sub>2</sub> miles northwest of Lockhart (16151); south of McQueeney (7638, 15525).

Range .-- Corsicana marl and Kemp clay.

### SPHENODISCUS PLEURISEPTA (Conrad)

#### Pl. 95, figs. 1-4

- 1857. Ammonites pleurisepta Conrad, U.S. and Mex. Bound. Survey, vol. 1, pt. 2, p. 159, pl. 15, figs. 1a-c.
- 1861. Ammonites pedernalis Binckhorst (in part), Mon. Gast. et Ceph. Craie Super. du Limbourg; Class Cephalopodes, p. 21, pl. 5al, fig. la, b (only).
- ?1898. Snhenodiscus pleurisepta (Conrad). Böhm, Zeitschr. Deutsch. geol. Gesell., vol. 50, pp. 193-197, pl. 7, figs. 1, 1a, 1b.
- 1903. Sphenodiscus pleurisepta (Conrad). Hyat, U.S. Geol. Survey Mon., vol. 44, p. 59, pl. 3, figs. 7-15; pl. 4; pl. 5, figs. 1 3; pl. 6, fig. 6.
- ?1904. Sphenodiscus pleurisepta (Conrad). Lasswitz, Geol. and Palcont. Abhandl., n.s., Bd. 6, Heft 4, p. 11 (231), pl. 2 (14), fig. 3.
- 1924. Sphenodiscus pleurisepta (Conrad). Deussen, U.S. Geol. Survey Prof. Paper 126, pl. 12 (opp. p. 36), figs. 3, 3a. (Figures only.)
- 1927. Sphenodiscus pleurisepta (Conrad). Böse, Univ. Texas Bull. 2748, p. 304, pl. 17, figs. 2-5.

Adult shell medium to large, thinly lenticular in cross section, strongly involute. Umbilicus very small and deep with broadly rounded shoulder, rounding steeply down within and overhanging in lower part of each volution. Greatest width of conch about midway of the flank; inner half of flank flat to slightly concave, sloping gently to the umbilical shoulder; outer half rounding broadly to the venter.

Venter sharply acute in the younger stages, with angle of 60 to 70 degrees, becoming sharply rounded in middle and older stages. The surface is smooth with the exception of two rows of nodes on the flanks; on the holotype one row midway of the flank consists of 11 exposed. distinct, but not prominent, nodes somewhat irregularly spaced 7 to 15 mm. apart; the other row lies a little more than midway between the first row and the venter, and consists of more widely spaced, nonprominent nodes which in the earlier stages are round, but in later stages become radially elongated and in adults become broad, widely spaced undulations; 14 of these nodes and undulations are exposed on the holotype. Septa rather evenly distributed and not closely crowded on the holotype, which has a maximum diameter of 93 mm. Ventral lobe broad and shallow with short, widely divergent, guadripartite lower branches; ventral saddle very low and broad with a serrate upper margin. On the holotype the lateral saddles number 14 to the line of involution. At a radial dimension of 53.5 mm, the first lateral saddle is broadly lobate and undivided above, becoming slightly divided on the sides below; the next 3 lateral saddles on one side are bilobate, and the remaining 10 to the line of involution are single: on the other side the next 3 lateral saddles after the first simple one are bilobate, the fourth is slightly divided, and the 9 remaining ones are single. The lateral lobes are moderately broad and are bluntly digitate, they increase in size to the third. the fourth is much smaller than the third. and the remainder decrease progressively in size and complexity to the line of involution. The inner sutures are not fully exposed on the available material, although it can be seen from plate 95, figure 1, that there are at least 9 saddles and 9 lobes on the largest stage of that specimen.

When the different specimens, which have been referred to this species, mainly on the basis of form and sculpture, are compared, their suture patterns at the same stage are found to differ considerably on different individuals in width, height, and complexity of division; for example, on some the first lateral saddle is simply lobate, and on the others bilobate, or even quadrilobate; similar differences are presented by the other larger saddles. It is apparent, therefore, that suture patterns can not be depended upon as criteria for the differentiation of species.

Dimensions of the holotype: Greatest diameter of shell 93 mm.; greatest radial diameter 53.5 mm.; greatest width 20.4 mm.; maximum umbilical diameter 6 mm.; the largest shell in the collections now under consideration has a diameter of 115 mm., but specimens in the Escondido formation not yet critically studied, which appear to belong to this species, attain diameters of 230 mm. or more.

Types.—Holotype, U.S.N.M. no. 9888; this specimen is recorded as having come from "Jacun, 3 miles below Laredo," Webb County; this is obviously an error because beds of Cretaceous age do not crop out within the borders of this county. The specimen is believed to have actually come from the Escondido formation in Maverick County, which adjoins Webb County on the northwest. Plesiotypes from Texas, U.S.N.M. nos. 77330, 77331.

Distribution in Texas.—Navarro group, Corsicana marl: About 5 miles east by north of Greenville (12924); ?2 miles south of Cliff (16719).

Navarro group, Kemp clay:  $1\frac{1}{2}$  miles southeast of Tira (12930, 2 figured specimens);  $3\frac{1}{2}$  miles northwest of Bazette (12922, 1 figured specimen); branch  $6\frac{1}{2}$ miles southwest of Currie (14139); west of Zuehl (7720).

Navarro group, Escondido formation: The species is common in this formation.

Outside distribution.—Mississippi, Owl Creek formation.

Mexico: Escondido formation.

Range.—Upper part of Navarro group of Texas in Corsicana marl, Kemp clay and Escondido formation; Owl Creek formation of Mississippi.

## Unidentified specimens of SPHENODISCUS

Specimens of *Sphenodiscus* too poorly preserved for specific identification have been collected as indicated below.

One lot from the Nacatoch sand near Kaufman, Kaufman County (761, U.S. N.M. no. 20975), consists of two specimens, one a badly corroded, thinly lenticular shell about 252 mm. in greatest diameter, and the other the living chamber of a smooth lenticular shell having a maximum diameter of about 133 mm. Another very small fragmentary specimen was found along the Dallas highway 3/5 mile west of Kaufman (14098, U.S.N.M. no. 77332). Although poorly and incompletely preserved these specimens demonstrate the presence of *Sphenodiscus* in the Nacatoch sand.

A fragment of a venter of a Sphenodiscus was obtained from the Corsicana marl in the pit of the Corsicana Brick Company, 2 miles south of Corsicana, Navarro County (16167). U.S.N.M. no. 77333.

A fragment of a young individual from the Corsicana marl in a public road 4 miles southwest of Quinlan, Hunt County (17385), has an unusually short and broad first lateral saddle. U.S.N.M. no. 77334.

The Kemp clay has yielded compressed fragments of a specimen of *Sphenodiscus* of medium size from a concretion in a field a mile west of Odds, in Falls County (17373), which has sutures possibly relating it to *S. tirensis*. U.S.N.M. no. 77335.

### Subclass DIBRANCHIATA

## Order BELEMNOIDEA

#### Family BELEMNITIDAE

### Genus BELEMNITELLA D'Orbigny

#### BELEMNITELLA AMERICANA (Morton)

## Pl. 95, figs. 5-8

- 1828. Belemnites subconicus Lamarck. Morton, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 6, p. 91, pl. 5, fig. 7.
- 1830. Belemnites americanus Morton, Am. Jour. Sci., vol. 17, p. 281; vol. 18, pl. 1, figs. 1-3.
- 1830. Belemnites americanus Morton, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 6, p. 190, pl. 8, figs. 1–3.
- 1834. Belemnites americanus Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 34, pl. 1, figs. 1 3a; pl. 17, fig. 2?.
- 1850. Belemnitella mucronata D'Orbigny (in part), Prodrome de Paleontologie, vol. 2, p. 211. (Not B. mucronata Schlotheim.)
- 1858. Belemnitella americana (Morton). Emmons, North Carolina Geol. Survey Rept., Agriculture of the eastern counties, Raleigh, p. 246, text fig. 102.
- 1861. Belemnitella mucronata (Morton). Gabb, Synopsis of the Mollusca of the Cretaceous formations, p. 22. (Also Am. Philos, Soc. Proc., vol. 8, p. 78, 1861.)

- 1864. Belemnitella paxillosa (Lamarck). Meek, Check list of the invertebrate fossils of North America, Cretaceous and Jurassic: Smithsonian Misc. Coll., vol. 7, no. 177, p. 26.
- 1868. Belemnitella mucronata D'Orbigny. Conrad, Geol. Survey New Jerscy (Geology of New Jerscy, by C. H. Cook), p. 375, text fig.
- 1892. Belemnitella americana (Morton). Whitfield, U.S. Geol. Survey Mon., vol. 18, p. 280, pl. 47, figs. 1–11. (Geol. Survey New Jersey, Paleontology, vol. 2, p. 280, pl. 47, figs. 1–11, 1892).
- 1905. Belemnitella americana (Morton). Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 28.
  1907. Belemnitella americana (Morton). Weller,
- 1907. Belemnitella americana (Morton). Weller, Geol. Survey New Jersey, Palcontology, vol. 4, p. 839, pl. 109, figs. 1–4.
- 1911. Belemnitella americana (Morton). Miller, Maryland Geol. Survey, Prince Georges County, p. 96, pl. 5, fig. 2, (Figure only.)
  1916. Belemnitella americana (Morton). Gard-
- 1916. Belemnitella americana (Morton). Gardner, Maryland Geol. Survey, Upper Cretaceous (2 vols.), p. 394, pl. 12, figs. 4 6.
- 1923. Belemnitella americana (Morton). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 398, pl. 99, figs. 3-7; pl. 100, figs. 1-3.
- 1926. Belemnitella americana (Morton). Stephenson, Geol. Survey of Alabama Special Rept. No. 14, p. 248, pl. 91, fig. 12. (Figure only.)
- 1929. Belemnitella americana (Morton). Dane, Arkansas Geol. Survey Bull. 1, p. 136, pl. 24, figs. 5, 6. (Figures only.)

This species is represented in the collections by guards from only five Navarro locaties in central and northeastern Texas, and the specimens are more or less fragmentary and incomplete. The two lots from the Corsicana marl were collected by Mr. and Mrs. D. A. Saunders, who donated them to the United States Geological Survey. The available material indicates elongated, tapering guards typical of the species. The inner end of the slender conical cavity occupied by the alveolus is preserved on several of the specimens, and the lower tip of the ventral furrow may be seen on two of them. The dorso-lateral grooves and the vascular impressions are preserved on several specimens. The largest fragment has a maximum diameter of 12.5 mm.

Compared with *Belemnitella mucronata* (Schlotheim) from the Senonian (upper Campanian and Maestrichtian of Europe the American species is more slender and tapers less abruptly to the papillary tip.

Types.—Morton's types, including the one large typical guard, and the two smaller so-called varieties A and B, which appear to be only individual variants, are preserved in the collection of the Academy of Natural Sciences of Philadelphia; they are recorded as having come "From the calcareous strata of New Jersey especially on Timber Creek, Gloucester County." Three plesiotypes from Texas, U.S.N.M. no. 77336.

Distribution in Texas.—Navarro group, Nacatoch sand: About 2 miles northeast of Quinlan (16930); ?north edge of Corsicana (518).

Navarro group, Corsicana marl: 1 4/5 miles northeast of Quinlan (11248, plesiotypes); Salado Creek, below St. Hedwig road, Bexar County (16670).

Navarro group, Kemp clay: 12 miles southeast of Greenville (11247).

Outside distribution.--Arkansas: Saratoga chalk and Nacatoch sand.

Mississippi: Ripley formation, upper part of Selma chalk (including *Exogyra cancellata* zone), and Prairie Bluff chalk.

Alabama (central and west-central part): Prairie Bluff chalk.

Chattahoochee region (Alabama): Upper part of Ripley formation.

North Carolina: Peedee formation.

Maryland: Monmouth formation.

Delaware: Mount Laurel sand.

New Jersey: Mount Laurel sand and Navesink marl.

Range.—In Texas the species has been recorded from the Nacatoch sand, the Corsicana marl, and the Kemp clay. In the Atlantic and Gulf Coastal Plain in general the range is through the *Exogyra* costata zone.

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# PLATE 3

PAGE

Cliona microtuberum, n.sp.	54
<ol> <li>Holotype (U.S.G.S. coll. 11250; U.S.N.M. No. 76266). Phosphatic casts of borings in shell of <i>Exogyra costata</i>, from the Corsicana marl, cast side of Cedar Creek, 7 miles south, 3 miles east of Greenville, Hunt County.</li> </ol>	
2. Enlarged view (x6) of a selected portion of the holotype.	
<ol> <li>A paratype (U.S.G.S. coll. 13568; U.S.N.M. no. 76268). Phosphatic casts (x3) in shell of <i>Exogyra costata</i>, from the Corsicana marl, east-west public road, 1¼ miles south by east of Oak Grove, Bowie County; shows turnip-shaped casts aligned in rows.</li> </ol>	
4, 5. Views of casts of this species, which preserve the form of <i>Crassatella vadosa</i> Morton, in whose shell the organism bored (U.S.G.S. coll. 6793; U.S.N.M. no. 76270); from the Prairie Bluff chalk, Prairie Bluff, Alabama River, Wilcox County, Alabama.	
Cliona, sp.	55
<ol> <li>Casts of borings (x3) in a shell fragment from the Kemp clay, Webberville, Travis County (U.S.G.S. coll. 7601; U.S.N.M. no. 76269).</li> </ol>	
Lingula aff. L. subspatulata Hall and Meek	70
<ul> <li>Terebratulina noackensis, n.sp.</li> <li>10-12. Holotype (U.S.G.S. coll. 17370; U.S.N.M. no. 76287). Dorsal, ventral, and edge views; from the base of the Kemp clay in branch of Mustang Creek, 3 miles south, 30 degrees west of Thrall, Williamson County.</li> </ul>	70

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# PLATE 4

Serpula cretacea (Conrad)
1, 2. Views of a colony of tubes from the Nacatoch sand near Kaufman, Kaufman County. (U.S.G.S. coll. 761; U.S.N.M. no. 21001.)
3. Operculum (x10) in a tube in the same collection. (U.S.N.M. no. 76294.)
<ul> <li>Serpula? lineata (Weller)</li> <li>4-6. Fragments of tubes (x1½) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County. (U.S.G.S. coll. 518; U.S.N.M. no. 20891.)</li> </ul>
<ul> <li>Serpula bowiensis, n.sp.</li> <li>7. Holotype (U.S.G.S. coll. 16160; U.S.N.M. no. 76271). Tube (x1½) attached t a shell fragment from the Corsicana marl in public road, 1¼ miles south by eas of Oak Grove, Bowie County.</li> </ul>
Hamulus onyx Morton
<ol> <li>Tube (x2) from the Corsicana marl near oil-test well of Morgan Oil Company 2 3/5 miles north by east of Malta, Bowie County. (U.S.G.S. coll. 16159 U.S.N.M. no. 76273.)</li> </ol>
<ol> <li>Operculum (x6) in tube from the Nacatoch sand in field, 3/5 mile west of Kauf man, Kaufman County. (U.S.G.S. coll. 14103; U.S.N.M. no. 76272.)</li> </ol>
Hamulus squamosus Gabb
<ol> <li>Tube (x2) from the Corsicana marl near oil-test well of Morgan Oil Company 2 3/5 miles north by east of Malta, Bowie County. (U.S.G.S. coll. 16159 U.S.N.M. no. 76274.)</li> </ol>
Hamulus? huntensis, n.sp.
11-14. Views of cotypes (U.S.C.S. coll. 12925; U.S.N.M. no. 76275) from the Nacatoc sand on the Guthrie place, 1½ miles west of Campbell, Hunt County.
15. Cross section (x3) of one of the cotypes.

16. Longitudinal section (x2) of one of the cotypes.

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## Plate 4



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# PLATE 5

PACE

Cliona microtuberum, n.sp.	54
<ol> <li>Enlarged view (x3) of selected part of the holotype (U.S.G.S. coll. 11250; U.S.N.M. no. 76266.)</li> </ol>	
2. Casts of this species (x2), which preserve the form of a shell of <i>Turritella</i> sp., in which the organism bored (U.S.G.S. coll. 11247; U.S.N.M. no. 76267); from the Kemp clay (reworked in base of Kincaid formation), 12 miles southeast of Greenville, Hunt County.	
Spine of cidarid echinoid	62
<ol> <li>Spine (x2¼) of a cidarid from the Nacatoch sand near Lewis Ferry on Red River, 8 miles north of New Boston, Bowie County. (U.S.G.S. coll. 12935; U.S.N.M. no. 76278.)</li> </ol>	
Cardiaster leonensis, n.sp.	62
4-6. Views (x3) of the holotype (U.S.G.S. coll, 15522; U.S.N.M. no. 76279), from the Corsicana marl in an abandoned earth tank, north of Castroville road, 1 1/5 miles west of Leon Creek, Bexar County; note associated spines on base in figure 6.	
7 Anical system and adjacent ambulaceal and inter-ambulaceal plates (x114) • pro-	

7. Apical system and adjacent ambulacral and inter-ambulacral plates  $(x4\frac{1}{2})$ ; prepared from figure 6 on plate 6, which is a photograph of the holotype taken under water.

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# PLATE 6

	PAGE
Hemiaster dalli Clark	
1-4. Views (x2) of a specimen from the Corsicana marl on the San Antonio miles east of Castroville, in Bexar County. (U.S.G.S. coll. 15502; U.S.N 76280.)	road, 6 .M. no.
Cardiaster leonensis, n.sp.	
5. Top view (x3) of the holotype (U.S.G.S. coll. 15522; U.S.N.M. no. 76279), and photographed in the usual way; from the Corsicana marl in an aba earth tank north of the Castroville road, 1 1/5 miles west of Leon Creek. County.	coated ndoned , Bexar
6. The holotype immersed in water and photographed (x3) with blue light (V C5 filter). (By courtesy of L. G. Henbest, U.S. Geological Survey.)	Wratten
Hemiaster bexari Clark	
<ol> <li>Top view (x3) of a specimen from the Corsicana marl on the San Antoni 6 miles east of Castroville, in Bexar County. (U.S.G.S. coll. 15502; U.S.N 76281.)</li> </ol>	o road, .M. no.

8. Posterior view (x2) of the same specimen.

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## Plate 6



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# PLATE 7

Micraster	(Plesiaster) americanus, n.sp.	Page 69
1-4.	Views (x2) of the holotype (U.S.G.S. coll. 15502; U.S.N.M. no. 76285) from the Corsicana marl on the San Antonio road, 6 miles east of Castroville, in Bexar County.	
Hemiaster	bexari Clark	65
5, 6.	Side and basal views (x2) of the specimen shown in plate 6, figures 7, 8.	
7.	Side view (x2) of a specimen from the same locality, etched to show ambulacral and interambulacral plates. (U.S.G.S. coll. 15502; U.S.N.M. no. 76281.)	
Hemiaster	benhurensis, n.sp.	67
8–10.	Views (x2) of the holotype (U.S.G.S. coll. 15543; U.S.N.M. no. 76282); from the Neylandville marl in a road ditch, 2 <sup>1</sup> / <sub>2</sub> miles south of Ben Hur, Limestone County.	

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## Plate 7



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I' d' Slowe 2
Linthia variabilis Slocum?
Antonio highway, 2½ miles west of McOueenev, Guadalupe County. (U.S.G.S.
coll. 15523; U.S.N.M. no. 76284.)
2. Top view $(x1\frac{1}{2})$ of a specimen from the same locality.
3-5. Views (x3) of a specimen from the Corsicana marl in the San Antonio road, 6
miles east of Castroville, in Bexar County. (U.S.G.S. coll. 16156; U.S.N.M.
no. (0285.)
Solemya bilix White:
6. View $(x_5)$ of a specifier from the vacable same near Kaufman, Kaufman $(U \le C \le coll + 51 + U \le N M no - 76288)$
Vucula nerovalis Conrad
7. A specimen from the Nevlandville marl on the Corsicana road, 2 <sup>1</sup> / <sub>2</sub> miles north
of Corbet, Navarro County. (U.S.G.S. coll. 16170; U.S.N.M. no. 76290.)
8. Neotype (U.S.G.S. coll. 857; U.S.N.M. no. 76289) from Chattahoochee River, about
2 miles below Eufaula, Barbour County, Alabama.
9. Hinge of neotype (x2).
Nucula ciboloensis, n.sp.
10. Holotype (U.S.G.S. coll, 1/2); U.S.N.M. no. (6291) from the Kemp clay on
Visual chatfoldoneir, n.e.
11 12 Views of the bolytone (USCS coll 762: USNM no 76203) from the Nacatoch
sand near Chatfield, Navaro County.
Nucula microstriata Gardner
13, 14. Views (x3) of a specimen from the Nacatoch sand near Corsicana, Navarro County.
(U.S.G.S. coll. 763; U.S.N.M. no. 20887.)
Nucula waltonensis, n.sp.
15. Left valve (xb) of the holotype (U.S.G. coll, 9545; U.S.N.M. no. 76295) from
the Nacatoon sand on Rock Branch, Walton lease of Houston Oil Company,
16 Dorsal view (x4) of the holotyne
Nucula nacatochana, n.sp.
17, 18. Views (x3) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 21058) from the
Nacatoch sand near Chatfield, Navarro County.
Nuculana corsicana, n.sp.
19. Left valve (x4) of the holotype (U.S.G.S. coll. 763; U.S.N.M. no. 76300) from
20 Dersal view (x3) of the heletune
Nuculara coloradoensis n.sp.
21. Left valve (x3) of holotype (U.S.G.S. coll, 7601; U.S.N.M. no. 76301) from the
Kemp clay on Colorado River at Webberville, Travis County.
Nuculana travisana, n.sp.
22. Right valve (x3), holotype (U.S.G.S. coll. 13910; U.S.N.M. no. 76302), from the
Kemp clay on Colorado River at Webberville, Travis County.
Nucleana houstoni, h.sp. $(USCS)$ coll 761, USNM re 21026) from the
Nacatach sand near Kaufman Kaufman County
Nuculana conhetensis, n.sp.
24. Right valve (x3), holotype (U.S.G.S. coll. 16170; U.S.N.M. no. 76305), from the
Neylandville marl on the Corsicana road, 21/2 miles north of Corbet, Navarro
County.
Nuculana longifrons (Conrad)
25. Right valve of a specimen from the Nacatoch sand in public road, <sup>1</sup> / <sub>2</sub> mile east
Nuculing sp a
26. Right valve from the Nacatoch sand in a field south of Chutfield Navarra County
(U.S.G.S. no. 7569; U.S.N.M. no. 76308.)
Nuculana? sp.b.
27. Right valve (x2) from the Nacatoch sand near public road 3/5 to 4/5 mile northeast
of Chatfield, Navarro County. (U.S.G.S. coll. 7572; U.S.N.M. no. 76309.)
Nuculana sp.c.
28. Left valve (x2) from the Corsicana marl in the Mexia road, 2 4/5 miles east of
Nuculana sp.d
29. Left valve (x3) from the Kemp clay on Colorado River at Webberville Travis
County, (U.S.G.S. coll, 7601: U.S.N.M. no. 76311.)
Nuculana sp.e.
30. Internal mold of right valve (x2) from the Kemp clay on the Thompson estate,
4 miles northeast of Roane, Navarro County. (U.S.G.S. coll. 12922; U.S.N.M.
no. 76312.)



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Nemodon	grandis navarroanus, n.var.
1.	Right valve (x2), holotype (U.S.G.S. coll. 761; U.S.N.M. no. 20979), from the Nacatoch sand near Kaufman, Kaufman County.
Nemodon	bowiei, n.sp.
2, 3.	Right valve (x3), holotype (U.S.G.S. coll. 763; U.S.N.M. no. 20901), from the Nacatoch sand near Corsicana, Navarro County.
Nemodon	adkinsi, n.sp.
4, 5.	Views (x2) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 21044) from the Nacatoch sand near Chatfield, Navarro County.
Nemodon	martindalensis, n.sp.
6.	Left valve (x1½), holotype (U.S.G.S. coll. 7621; U.S.N.M. no. 76322), from the Corsicana marl on San Marcos River, ½ mile below Martindale, Caldwell County.
Nemodon	enfaulensis lineatus, n.var.
7.	Right valve (x2), holotype (U.S.G.S. coll. 16170; U.S.N.M. no. 76324), from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County.
Glycymer	is rotundata kaufmanensis, n.var
8-10.	Views of the holotype (U.S.G.S. coll, 14103; U.S.N.M. no. 76335), a right valve, from the Nacatoch sand in field, 3/5 mile west of Kaufman, Kaufman County.
11, 12.	Views of a paratype (U.S.N.M. no. 76336) from the same locality.
Brevierca	plummeri, n.sp
13.	Left valve (x11/2), holotype (U.S.G.S. coll. 16162; U.S.N.M. no. 76341), from the Nacatoch sand on the Stevens place, 1 4/5 miles northeast of Quinlan, Hunt County.
14.	Hinge of a left valve (x1½), a paratype (U.S.N.M. no. 76342), from the same locality.
Breviarca	nolani, n.sp.
15, 16.	Views of left valve (x4), holotype (U.S.G.S. coll. 7569; U.S.N.M. no. 76345), from the Nacatoch sand in field south of Chatfield, Navarro County.
Breviarca	webbervillensis, n.sp.
17–19.	Views of left valve (x4), holotype (U.S.G.S. coll. 7601; U.S.N.M. no. 76347), from the Kemp clay on Colorado River at Webberville, Travis County.
Breviarca	sp
20.	Squeeze of external mold (U.S.G.S. coll. 16151; U.S.N.M. no. 76350) from the Kemp clay in public road, 3/5 mile west of Elm Creck School, 4½ miles northwest of Lockhart, Caldwell County.
21.	Internal mold (U.S.G.S. coll. 15528; U.S.N.M. no. 76349) from the same locality.

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	PAGE
Idonearca powersi, n.sp.	90
1, 2. Views of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 76352) from the Nacatoch sand near Kaufman, Kaufman County.	
Idonearca kingsensis, n.sp.	91
3, 4. Holotype, a right valve (U.S.G.S. coll. 761; U.S.N.M. no. 76354), from the Naca- toch sand near Kaufman, Kaufman County.	
Linter acutata Stephenson	85
5, 6. Views (x2) of the holotype (U.S.G.S. coll. 7573; U.S.N.M. no. 75974), a right valve, from the Nacatoch sand near public road, 5 miles south-southwest of Corsicana, Navarro County.	
7. Enlarged drawing (x9) of the hinge of the holotype.	
Limopsis meeki Wade	96
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Pecten (	Syncyclonema?) travisanus, n.sp.
1.	Holotype (x2), a left valve (U.S.G.S. coll. 7601; U.S.N.M. no. 76440), from the Kemp clay on Colorado River at Webberville, Travis County.
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Plicatula	sp
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Pro 19		P.
Lima	acutilineata texana, n.var.	
	<ol> <li>Paratype (x1½), a crushed left valve (U.S.G.S. coll. 7665; U.S.N.M. no. 76473), from the Corsicana marl on Medina River, ½ mile below the highway bridge at Castroville, Medina County.</li> </ol>	
	<ol> <li>Holotype (x1½), a right valve (U.S.G.S. coll. 15524; U.S.N.M. no. 76472), from the Corsicana marl in a bluff on Guadalupe River, 1 3/10 miles north of Mc- Queeney, Guadalupe County.</li> </ol>	
Lima	kimbroensis, n.sp.	
	3. Holotype (x2), a right valve (U.S.G.S. coll. 14129; U.S.N.M. no. 76474), from the Corsicana marl, ¼ mile west of Kimbro, Travis County.	9
	4. A paratype (x2), a left valve (U.S.G.S. coll. 16160; U.S.N.M. no. 76475), from public road, 1¼ miles south by east of Oak Grove, Bowie County.	I
Lima	pelagica woolseyi, n.var.	
	<ol> <li>Holotype (x2), a right valve (U.S.G.S. coll. 15526; U.S.N.M. no. 76461). from the Corsicana marl on San Marcos River, ½ mile below Martindale, Caldwell County.</li> </ol>	1
	6. Paratype (x2), a left valve (U.S.G.S. coll. 7621; U.S.N.M. no. 76462), from the same locality.	•
ima	deatsvillensis, n.sp.	
	7. Holotype (x2), a left valve (U.S.G.S. coll. 764; U.S.N.M. no. 76463), from the Kemp clay near Deatsville, Travis County.	•
	<ol> <li>A paratype (x2), a left valve (U.S.G.S. coll. 7637; U.S.N.M. no. 76464), from the Corsicana marl in bluff on Guadalupe River, 1 3/10 miles north of McQueeney, Guadalupe County.</li> </ol>	,
ima	guadalupensis, n.sp.	
	<ol> <li>Holotype (x2), a left valve (U.S.G.S. coll. 15524; U.S.N.M. no. 76469), from the Corsicana marl in bluff on Guadalupe River, 1 3/10 miles north of McQueeney, Guadalupe County.</li> </ol>	•
	<ol> <li>Paratype (x2), a left valve (U.S.G.S. coll. 7637; U.S.N.M. no. 76470), from the same locality.</li> </ol>	,
Lima	geronimoensis, n.sp.	
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Lima	9 sayrei, n.sp.	. 1
2	<ol> <li>Right valve of holotype (Tex. Bu. 53; U.S.N.M. no. 76476), from the Corsicana marl on the San Antonio road, 6 miles east of Castroville, in Bexar County.</li> </ol>	ı

13. Enlargement (x2) of a selected part of the surface of the holotype.



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Anomia argentaria Morton	148
<ol> <li>A left valve (x2), nestled in shell of Exogyra cancellata Stephenson, from the Neylandville marl near Texas Midland R.R., 4½ miles southwest of Cooper, Delta County (U.S.G.S. coll. 7512; U.S.N.M. no. 76489.)</li> </ol>	
<ol> <li>A left valve (x2) from the Neylandville marl on Texas &amp; New Orleans R.R., 4 miles east of Crandall, Kaufman County. (U.S.C.S. coll. 7550; U.S.N.M. no. 76490.)</li> </ol>	
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5. A left valve from the Neylandville marl on Doctors Creek near Texas Midland R.R., 2 miles southwest of Cooper, Delta County. (U.S.G.S. coll. 7511; U.S.N.M. no. 76486).	
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<ol> <li>Holotype (x2), a right valve (U.S.G.S. coll. 15523; U.S.N.M. no. 76465), from the Corsicana marl near the San Antonio highway, 2½ miles west of McQueeney, Guadalupe County.</li> </ol>	
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<ol> <li>Internal mold of left valve (x1½) from the Nacatoch sand on the Dallas highway, 3/5 mile west of Kaufman, Kaufman County. (U.S.C.S. coll. 14098; U.S.N.M. 76482.)</li> </ol>	
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### PLATE 25

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Periploma? edwardsi. n.sp.	
<ol> <li>Views (x1½) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 76511), free Nacatoch sand near Chatfield, Navarro County.</li> </ol>	om the
Laternula? sublevis, n.sp.	
<ol> <li>Holotype (U.S.G.S. coll. 761: U.S.N.M. no. 21009) from the Nacatoch sand Kaufman, Kaufman County.</li> </ol>	d near
Laternula? robusta, n.sp.	
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Slab of coquina-like calcareous sandstone (reduced as indicated by scale), from the Nacatoch sand on the E. A. Stevens place, 1 4/5 miles northeast of Quinlan, Hunt County. The species listed below are recognizable on the surface shown; number marked with asterisk is on opposite side of slab. This specimen was collected and donated by Mr. F. B. Plummer. (U.S.G.S. coll. 16171; U.S.N.M. no. 76344.)

- 1. Nucula sp.
- 2. Nemodon eufaulensis Cabb?
- 3. Breviarca plummeri, n.sp.
- 4. Crassatella quinlanensis, n.sp.
- \*5. Lucina mattiformis, n.sp.
- 6. Lucina sp.
- 7. Cardium (Trachycardium) eufaulense huntanum, n.var.
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- 16. Paladmete corbuliformis, n.sp.
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Leptosolen? quadrilaterus, n.sp.
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Leptosolen? levis, n.sp.
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Leptosolen biplicatus Conrad
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Cymbophora scabellum, n.sp.
<ol> <li>Holotype, a left valve (U.S.G.S. coll. 14103; U.S.N.M. no. 76713), from the Naca- toch sand in a field, 3/5 mile west of Kaufman, Kaufman County.</li> </ol>
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Cymbophora berryi Gardner
<ol> <li>Holotype (x1½), a right valve (U.S.G.S. coll. 761; U.S.N.M. no. 76721), from the Nacatoch sand near Kaufman, Kaufman County.</li> </ol>
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<ol> <li>Left valve (x1<sup>1</sup>/<sub>2</sub>) of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 76715) from the Nacatoch sand near Kaufman, Kaufman County.</li> </ol>
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Solyma? parva, n.sp.
<ol> <li>Left valve (x2) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 76706) from the Nacatoch sand near Chatfield, Navarro County.</li> </ol>

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Cadulus	obnutus (Conrad)
22.	A specimen (x6) from the Nacatoch sand on the Stevens place, 1 4/5 miles north- east of Quinlan, Hunt County. (U.S.G.S. coll. 16162; U.S.N.M. no. 76783.)
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Acmaea?	occidentalis (Hall and Meck)?
1.	A specimen from the Kemp clay on Cibolo Creek, 1½ miles west of Zuehl, in Bexar County. (U.S.G.S. coll. 7721; U.S.N.M. no. 76786.)
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8, 9.	Views (x3) of the holotype (U.S.G.S. coll. 16170; U.S.N.M. no. 76791) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County.
Calliomph	alus microcancelli, n.sp.
10, 11.	Views (x4) of the holotype (U.S.G.S. coll. 16353; U.S.N.M. no. 76793) from the Corsicana marl in a dug well, 7/20 mile south by west of St. Mary's University, Bexar County.
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24, 25.	Views (x1½) of a specimen from the Corsicana marl on San Marcos River, ½ mile below Martindale, Caldwell County. (U.S.G.S. coll. 15526; U.S.N.M. no. 76790.)



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Creonella	whitei, n.sp.
1, 2.	Views (x2) of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 76803) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County.
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Creonella	e deusseni, n.sp
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Creonella	triplicata Wade
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9.	A specimen (x3) from the Nacatoch sand near Kaufman, Kaufman County. U.S.G.S. coll. 761; U.S.N.M. no. 76806.)
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Proscala	americana Wade?
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15, 16.	Views (x2) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 21079) from the Nacatoch sand near Chatfield, Navarro County.
17.	Enlargement (x4) of the holotype.
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19, 20.	Holotype (U.S.G.S. coll. 15502; U.S.N.M. no. 76811) from the Corsicana marl on the San Antonio road, 6 miles east of Castroville, in Bexar County.
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Anchura	sp
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Anchura	sp
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Pinella reticulata, n.sp.	
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12, 13. Views of a specimen (x3) from the Nacatoch sand on Walton lease of Company, 3 miles northeast of Corsicana, Navarro County. (U.S.G.S U.S.N.M. no. 76996.)	Houston Oil . coll. 9545;
Medionapus? sp	
<ol> <li>Squeeze of external mold of a specimen from base of Corsicana marl well of Morgan Oil Company, 2 3/5 miles north by east of Malta, Bo (U.S.G.S. coll. 16159; U.S.N.M. no. 76997.)</li> </ol>	near oil-test owie County.
Sargana stantoni (Weller)	
15-17. Views (x1½) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 2107 Nacatoch sand near Chatfield, Navarro County.	0) from the



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orea marylandica bella, n.var.
1,2. Views (x2) of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 77025) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County.
prea marylandica languida, n.var.
3, 4. Views (x2) of the holotype (U.S.G.S. coll. 17366; U.S.N.M. no. 77027) from the Nacatoch sand near U.S. highway 75, 4 miles north of Corsicana.
orea cancellaria crassa, n.var.
5, 6. Views of the holotype (U.S.G.S. coll. 14114; U.S.N.M. no. 77024) from the Naca toch sand in public road, 2½ miles north of Corsicana.
orea cancellaria corsicanensis, n.var.
7, 8. Views of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 77022) from the Nacatocl sand on Postoak Creek at north edge of Corsicana.
9. Back view of a paratype (U.S.N.M. no. 77023) from the same locality.
ercorhyncus malleiforme, n.sp.
10, 11. Views of the holotype (U.S.G.S. coll. 7721; U.S.N.M. no. 77008) from the Kemp clay on Cibolo Creek, 1½ miles west of Zuehl, in Bexar County.
ercorhyncus coronale, n.sp.
12, 13. Views (x1½) of the holotype (U.S.G.S. coll. 17368; U.S.N.M. no. 77014) from the Nacatoch sand on State Highway 22, 2½ miles west by south of Corsicana Navarro County.
rcorhyncus nodosum, n.sp
14, 15. Views (x1½) of the holotype (Tex. Bu. 17300; U.S.N.M. no. 77011) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarra County.
ercorhyncus mundum, n.sp.
16, 17. Views (x1½) of the holotype (Tex. Bu. 17300; U.S.N.M. no. 77012) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet.
ercorhyncus vadosum, n.sp.
<ol> <li>Views of the holotype (U.S.G.S. no. 761; U.S.N.M. no. 77009) from the Nacatoch sand near Kaufman, Kaufman County.</li> </ol>

20. Back view of a paratype (U.S.N.M. no. 77010) from the same locality.



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Deussenia corbis, n.sp.	-
1,2. Views of the holotype (U.S.G.S. coll. 14128; U.S.N.M. no. 77040) from the Kemp clay near a public road, 2 miles north-northwest of Deatsville, Travis County.	)
Deussenia multilirae, n.sp.	-
3, 4. Views of the holotype (U.S.G.S. coll. 764; U.S.N.M. no. 77038) from the Kemp clay near Deatsville, Travis County.	)
5. Back view of a young paratype (U.S.N.M. no. 77039) from the same locality.	
Seminola? sp.	
6,7. Views (x3) of a small specimen from the Neylandville marl on the Corsicana road 2½ miles north of Corbet, Navarro County. (U.S.G.S. coll. 16170; U.S.N.M. no 77030.)	•
Tryonia valida, n.sp.	
<ol> <li>Views of the holotype (U.S.G.S. coll. 763; U.S.N.M. no. 20890) from the Nacatocl sand near Corsicana, Navarro County.</li> </ol>	1
Busycon? sp.	-
<ol> <li>A squeeze of an external mold of a specimen from the Nacatoch sand on the Stevens place, 1 4/5 miles northeast of Quinlan, Hunt County. (U.S.G.S. coll 16162; U.S.N.M. no. 77070.)</li> </ol>	e

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Seminola crassa Wade 329 1. Back view of a specimen from the Nacatoch sand near Chatfield, Navarro County. (U.S.G.S. coll. 762; U.S.N.M. no. 77029.)

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2. Front view of a specimen from the same locality.

3, 4. Views of a young individual from the same locality.

Deussenia travisana, n.sp. 333

- 5,6. Views of the holotype (U.S.G.S. coll. 14126; U.S.N.M. no. 77037) from the Kemp clay in a public road, 1¼ miles north-northwest of Deatsville, Travis County.
- 7,8. Views (x1½) of a young specimen, a paratype (U.S.G.S. coll. 14128; U.S.N.M. no. 77035), from the Kemp clay near a public road, 2 miles north-northwest of Deatsville, Travis County.

Hydrotribulus asper, n.sp.

9, 10. Views of the holotype (U.S.G.S. coll. 14139; U.S.N.M. no. 77032) from the Kemp clay in a branch 1/2 mile south of McLeod School, 61/2 miles southwest of Currie, Navarro County.





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Ornopsis	sp
1.	ville, Travis County. (U.S.G.S. coll. 7601; U.S.N.M. no. 77081.)
Ornopsis	° sp
2.	An incomplete specimen (x1½) from the Nacatoch sand in a field, 3/5 mile west of Kaufman, Kaufman County. (U.S.G.S. coll. 14103; U.S.N.M. no. 77077.)
Ornopsis	° maxeyi, n.sp
3, 4.	Views (x2) of the holotype (U.S.G.S. coll, 761; U.S.N.M. no. 77075) from the Nacatoch sand near Kaufman.
Ornopsis	solistella, n.sp.
5, 6.	Views (x1½) of the holotype (U.S.G.S. coll. 7637; U.S.N.M. no. 77073) from the Corsicana marl in a bluff on Guadalupe River, 1 3/10 miles north of McQueeney, Guadalupe County.
Ornopsis	pulchra, n.sp.
7, 8.	Views $(x1\frac{1}{2})$ of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 77071) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County.
9.	Back view $(x1\frac{1}{2})$ of a paratype (U.S.N.M. no. 77072) from the same locality.
Ornopsis	sp
10.	Back view (x1½) of a specimen from the Nacatoch sand near Kaufman, Kaufman County. (U.S.G.S. coll. 761; U.S.N.M. no. 21014.)
Graphidu	la? multicostata, n.sp.
11, 12.	Views of the holotype (U.S.G.S. coll. 7721; U.S.N.M. no. 77086) from the Kemp clay on Cibolo Creek, 1½ miles west of Zuehl, in Bexar County.
Graphidu	la terebriformis, n.sp.
13, 14.	Views (x2) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 77085) from the Nacatoch sand near Chatfield, Navarro County.
Graphidu	la? gabrielensis, n.sp.
15, 16.	Views $(x1!2)$ of the holotype (U.S.G.S. coll. 14130; U.S.N.M. no. 77087) from the base of the Kemp clay on San Gabriel River, 2/5 mile above the San Gabriel-Thorndale road crossing, Milam County.
Graphidu	la sp.
17, 18.	Views (x3) of a specimen from the Nacatoch sand near Terrell, Kaufman County. (U.S.N.M. no. 77121.)



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1	AGE
Drilluta paucicostata, n.sp.	353
1,2. Views (x1½) of the holotype (U.S.G.S. coll. 763; U.S.N.M. no. 77105) from the Nacatoch sand near Corsicana, Navarro County.	
Drilluta crassicostata, n.sp.	352
3, 4. Views of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 77100) from the Nacatoch sand on Postoak Creek at north edge of Corsicana.	
Drilluta crassicostata longa, n.var.	353
5, 6. Views of the holotype (U.S.G.S. coll. 763; U.S.N.M. no. 77103) from the Naca- toch sand near Corsicana.	
Drilluta brevispira, n.sp.	354
<ol> <li>Back view of the holotype (U.S.G.S. coll. 16166; U.S.N.M. no. 77107) from the Neylandville marl in a field, 3½ miles west-northwest of Corsicana.</li> </ol>	
Drilluta? sp	355
<ol> <li>A specimen (x1½) from the Kemp clay on Cibolo Creek, 1½ miles west of Zuehl, in Bexar County. (U.S.G.S. coll, 7721; U.S.N.M. no. 77114.)</li> </ol>	
Liopeplum leioderma brere, n.var.	351
9,10. Views of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 77097) from the Nacatoch sand near Kaufman County.	
Liopeplum leioderma longum, n.var.	350
11, 12. Views of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 77095) from the Nacatoch sand near Kaufman.	
Liopeplum leioderma tabulatum, n.var.	351
13, 14. Views of the holotype (U.S.G.S. coll. 14099; U.S.N.M. no. 77099) from the Nacatoch sand in public road, 2 miles southwest of Kaufman.	
Piestochilus? leris, n.sp.	350
15, 16. Views of the holotype (U.S.G.S. coll. 7721; U.S.N.M. no. 77092) from the Kemp clay on Cibolo Creek, 1½ miles west of Zuehl, in Bexar County.	
17. Back view of a paratype (U.S.N.M. no. 77093) from the same locality.	
Lomirosa cretacea (Wade)	348
18, 19. Views (x1½) of the holotype (U.S.C.S. coll. 762; U.S.N.M. no. 77088) from the Nacatoch sand near Chatfield, Navarro County.	0.10
Lomirosa? sp.	349
<ol> <li>Squeeze of incomplete external mold of a specimen from the Nacatoch sand in the Clarksville road, 4½ miles east by north of Rosali, Red River County. (U.S.G.S. coll. 14061; U.S.N.M. no. 77089.)</li> </ol>	

21. Internal mold of the same specimen.



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Volutomor	pha retifera	Dall						·····				355
1, 2.	Views of the	lectotyp	e (U.S.C	S.S. coll.	761;	U.S.N.M.	no.	20996a)	from	the	Naca-	
	toch sand	near Ka	aufman,	Kaufmai	n Coi	inty.						

3. One of the original cotypes from the same locality.

4. Front view of a young specimen from the same locality. (U.S.N.M. no. 77116.)

Volutomorpha? sp. 356

- 5, 6. Views of a questionably identified specimen from the base of the Corsicana marl near oil-test well of Morgan Oil Company, 2 3/5 miles north by east of Malta, Bowie County. (U.S.G.S. coll. 16159; U.S.N.M. no. 77119.)
  - Back view of a specimen from the same locality. (U.S.G.S. coll. 5310; U.S.N.M. no. 77118.)



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	PACE
Lupira pyriformis, n.sp	360
1, 2. Views (x2) of the holotype (U.S.G.S. coll. 763; U.S.N.M. no. 20895) from the Nacatoch sand near Corsicana, Navarro County.	
Lupira variabilis (Wade)	361
<ol> <li>A specimen (x1½) from the Coon Creek tongue of Ripley formation on Coon Creek, McNairy County, Tennessee; inserted to show folds on the columella. (U.S.G.S. coll. 10198; U.S.N.M. no. 77125.)</li> </ol>	
Cancellaria? matsoni, n.sp.	362
4,5. Views (x6) of the holotype (U.S.G.S. coll. 13132; U.S.N.M. no. 77128) from the Kemp clay at a depth of 730 feet in a well 2 miles west of Groesbeck, Limestone County.	
Cancellaria? sp.	363
6,7. Views (x3) of a specimen from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County. (U.S.C.S. coll. 17365; U.S.N.M. no. 77129.)	
Eoancilla acutula, n.sp.	361
8, 9. Views (x4) of the holotype (U.S.C.S. coll. 7601; U.S.N.M. no. 77126) from the Kemp clay on Colorado River at Webberville, Travis County.	
Volutoderma (Longoconcha) navarroensis (Shumard)	357
10, 11. Views of the neotype (U.S.G.S. coll. 761; U.S.N.M. no. 20992a) from the Naca- toch sand near Kaufman, Kaufman County.	
Parafusus? sp.	359
12,13. Views (x4) of a specimen from the Nacatoch sand near Kaufman. (U.S.G.S. coll, 761; U.S.N.M. no. 77122.)	
Parvivoluta? sp.	359
14, 15. Views (x2½) of a specimen from the Nacatoch sand near U.S. Highway 75, 4 miles north of Corsicana, Navarro County. (U.S.G.S. coll. 17366; U.S.N.M. no. 77123.)	
Volutomorpha? sp.	356
<ol> <li>Internal mold with sculpture impressed upon it, from the Kemp clay, 3½ miles east of Manor, Travis County. (U.S.G.S. coll. 15534; U.S.N.M. no. 77120.)</li> </ol>	ne sear 12



Mataxa i	valida, n.sp.
1, 2.	Views (x3) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 77134) from the Nacatoch sand near Chatfield, Navarro County.
3.	Back view $(x2)$ of a paratype (U.S.N.M. no. 77135) from the same locality.
Mataxa s	ubteres, n.sp.
4, 5.	Views (x3) of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 77138) from the Nacatoch sand near Kaufman, Kaufman County.
Mataxa 1	alida multilira, n.var.
6,7.	Views (x3) of the holotype (U.S.G.S. coll. 16168; U.S.N.M. no. 77137) from the Nacatoch sand near U.S. Highway 75, 3 1/5 miles north of Corsicana, Navarro County.
Careola	acuta (Wade)?
8, 9.	Views (x6) of a specimen from the Neylandville marl on the Corsicana road, $2\frac{1}{2}$ miles north of Corbet, Navarro County. (U.S.G.S. coll. 16170; U.S.N.M. no. 77130.)
10.	Back view (x6) of a specimen from the same locality.
Caveola	producta, n.sp.
11, 12.	Views (x5) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 77131) from the Nacatoch sand near Chatfield, Navarro County.
Volutode	rma (Longoconcha) dalli, n.sp.
13, 14.	Views of the holotype (U.S.G.S. coll. 764; U.S.N.M. no. 21183) from the Kemp clay near Deatsville, Travis County.
Parvivolu	<i>uta?</i> sp.
15, 16.	Views (x4) of a specimen from the Nacatoch sand near Chatfield, Navarro County. (USCS call $-762 + USNM$ pp $-77124$ )



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Amuletum curvocostatum, n.sp.	370
1, 2. Views (x3) of the holotype (U.S.G.S. coll, 16170; U.S.N.M. no. 77146) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County.	
Amuletum boylei, n.sp.	370
3,4. Views (x4) of the holotype (U.S.G.S. coll, 518; U.S.N.M. no. 77145) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County.	
Amuletum renustum, n.sp.	371
5, 6. Views (x4) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 77149) from the Nacatoch sand near Chatfield, Navarro County.	
Fulgerca venusta, n.sp.	372
7, 8. Views (x3) of the holotype (U.S.G.S. coll. 16170; U.S.N.M. no. 77152) from the Neylandville marl on the Corsicana road, 212 miles north of Corbet, Navarro County.	
Paladmete corbuliformis, n.sp.	366
9,10. Views (x2) of the holotype (U.S.G.S. coll, 761; U.S.N.M. no. 77139) from the Nacatoch sand near Kaufman, Kaufman County.	
11. Back view (x2) of a paratype (U.S.N.M. no. 77140) from the same locality.	
Paladmete alta, n.sp.	367
12,13. Views (x2) of the holotype (U.S.G.S. coll. 14128: U.S.N.M. no. 77141) from the Kemp clay in public road, 2 miles north-northwest of Deatsville, Travis County.	
Paladmete inaequalis, n.sp.	368
14, 15. Views (x2) of the holotype (U.S.G.S. coll. 763; U.S.N.M. no. 77142) from the Nacatoch sand near Corsicana, Navarro County.	
Paladmete clegans, n.sp.	368
16, 17. Views (x6) of the holotype (U.S.G.S. coll. 13910; U.S.N.M. no. 77144) from the Kemp clay on Colorado River at Webberville, Travis County.	
Lutema munda, n.sp.	374
18, 19. Views (x3) of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 77158) from the Nacatoch sand near Kaufman, Kaufman County.	
Lutema geniculata, n.sp.	374
20,21. Views (x3) of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 77159) from the Nacatoch sand near Kaufman.	
Lutema simpsonensis, n.sp.	373
22,23. Views (x3) of the holotype (U.S.G.S. coll. 7546; U.S.N.M. no. 77154) from the Nacatoch sand on a public road. 2 miles southwest of Kaufman.	
Lutema hubbardi, n.sp.	373
24,25. Views (x2) of the helotype (U.S.G.S. coll. 518; U.S.N.M. no. 77156) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County.	
Lutema sp.	375
26. A squeeze (x3) of the external mold of a specimen from the Kemy clay on the Thompson estate, 4 miles northeast of Roane, Navarro County. (U.S.G.S. coll. 12922; U.S.N.M. no. 77160.)	
#### Plate 71



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Troostella sublinearis, n.sp.
1, 2. Views (x1½) of the holotype (U.S.G.S. coll. 518: U.S.N.M. no. 77177) from the Nacatoch sand near Corsicana, Navarro County.
Troostella? brevispira, n.sp.
3, 4. Views (x3) of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 77179; from the Nacatoch sand near Corsicana.
Acteon? throckmortoni, n.sp.
5, 6. Views (x4) of the holotype (U.S.G.S. coll. 16170;, U.S.N.M. no. 77174) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County.
Acteon? nitidus, n.sp.
7,8. Views (x3) of the holotype (U.S.G.S. coll. 14125; U.S.N.M. no. 77175) from the Kemp clay near Deatsville, Travis County.
Beretra ornatula, n.sp.
9, 10. Views (x2) of the holotype (U.S.G.S. coll. 17366; U.S.N.M. no. 77168) from the Nacatoch sand near U.S. Highway 75, 4 miles north of Corsicana, Navarro County.
Beretra? elongata, n.sp.
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13, 14. Views of the holotype (U.S.G.S. coll. 518; U.S.N.M. no. 77161) from the Nacatoch sand on Postoak Creek at north edge of Corsicana, Navarro County.
Beretra striata, n.sp.
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Beretra contracta, n.sp.
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Remnita biacuminata (Wade)
19, 20. Views (x4) of the holotype (U.S.G.S. coll. 17366; U.S.N.M. no. 77173) from the Nacatoch sand near U.S. Highway 75, 4 miles north of Corsicana, Navarro County.
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21, 22. Views of the holotype (U.S.G.S. coll, 761; U.S.N.M. no. 77170) from the Nacatoch sand near Kaufman, Kaufman County.
23. Back view of a paratype (U.S.N.M. no. 77171) from the same locality.

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Ringicula	culbersoni, n.sp.
1, 2.	Views (x1½) of the holotype (U.S.G.S. coll. 764; U.S.N.M. no. 77198) from the Kemp clay near Deatsville, Travis County.
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6, 7.	Views (x4) of the holotype (U.S.G.S. coll. 13910; U.S.N.M. no. 77200) from the Kemp clay on Colorado River at Webberville, Travis County.
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8, 9.	Views (x3) of the holotype (U.S.G.S. coll. 15537; U.S.N.M. no. 77202) from the base of the Kemp clay in a branch 3 miles south, 30° west, of Thrall, Williamson County.
Oligoptyc	ha americana (Wade)?
10, 11.	Views (x6) of a specimen from the Kemp clay at a depth of 800 feet in a well, 2 miles west of Groesbeck, Limestone County. (U.S.G.S. coll. 13124; U.S.N.M. no. 77206.)
Tornatell	aca cretacea hobes, n.var
12, 13.	Views (x4) of the holotype (U.S.G.S. coll. 16170; U.S.N.M. no. 77190) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County.
Tornatell	aeu cretacea appressa. n.var.
14, 15.	Views (x3) of the holotype (U.S.G.S. coll. 7573; U.S.N.M. no. 77192) from the Nacatoch sand near a public road. 5 miles south-southwest of Corsicana, Navarro County.
Tornatell	aea scatesi, n.sp
16, 17.	Views (x3) of the holotype (U.S.G.S. coll. 761; U.S.N.M. no. 77189) from the Nacatoch sand near Kaufman, Kaufman County.
Tornatell	aea grandis, n.sp
18, 19.	Views (x2) of the holotype (U.S.G.S. coll. 14125; U.S.N.M. no. 77194) from the Kemp clay near Deatsville, Travis County.
Nonacteo	nina? triticea. n.sp
20, 21,	Views (x3) of the holotype (U.S.G.S. coll. 17366; U.S.N.M. no. 77186) from the Nacatoch sand near U.S. Highway 75, 4 miles north of Corsicana, Navarro County.
Nonacteo	nina tensa, n.sp
22, 23.	Views (x3) of the holotype (U.S.G.S. coll, 16170; U.S.N.M. no. 77185) from the Neylandville marl on the Corsicana road, 2½ miles north of Corbet, Navarro County.
Nonacteo	nina graphoides. n.sp.
24, 25.	Views (x2) of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 77181) from the Nacatoch sand near Chatfield, Navarro County.
Nonacteo	nina deflexa, n.sp.
26, 27.	Views (x4) of the holotype (U.S.G.S. coll. 17366; U.S.N.M. no. 77183) from the Nacatoch sand near U.S. Highway 75, 4 miles north of Corsicana, Navarro County.
Nonacteo	nina sp.
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Baculites claviformis, n.sp.

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- 1. View of the holotype (U.S.G.S. coll. 7472; U.S.N.M. no. 77286) from the Nacatoch sand on the old Military Road, 2 1/8 miles northeast of Washington, Hempstead County, Arkansas.
- 2, 3. Views of a paratype (U.S.G.S. coll. 762; U.S.N.M. no. 21094) from the Nacatoch sand near Chatfield, Navarro County.





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1.	View $(x1\frac{1}{2})$ of the holotype (U.S.G.S. coll. 17365; U.S.N.M. no. 77290) from the Neylandville marl on the Corsicana road, $2\frac{1}{2}$ miles north of Corbet, Navarro County.	
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12-14.	Views $(x1\frac{1}{2})$ of the holotype (U.S.G.S. coll. 16170; U.S.N.M. no. 77302) from the Neylandville marl on the Corsicana road, $2\frac{1}{2}$ miles north of Corbet, Navarro County.	
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15 17.	Views of the holotype (U.S.G.S. coll. 762; U.S.N.M. no. 77305) from the Naca- toch sand near Chatfield, Navarro County.	
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1,2. Views of the holotype (U.S.G.S. coll. 12922; U.S.N.M. no. 77310) from the Kemp clay on the John A. Thompson estate, 4 miles northeast of Roane, Navarro County.	)
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<ol> <li>A specimen from the Neylandville marl on the Dallas highway, 3 7/10 miles west of Kaufman, Kaufman County. (U.S.G.S. coll. 14101; U.S.N.M. no. 77323.)</li> </ol>	
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Discoscaphites sp.	430
<ol> <li>Fragment of an internal mold (x1½) from the Corsicana marl on a public road, 1¼ miles south by east of Oak Grove, Bowie County. (U.S.G.S. coll. 16160; U.S.N.M. no. 77314.)</li> </ol>	
Discoscaphites sp.	430
<ol> <li>A specimen (x1½), badly crushed, from the Corsicana marl in a branch near a public road, 2½ miles north of Tona siding, in Hunt County. (U.S.G.S. coll. 15546; U.S.N.M. no. 77316.)</li> </ol>	
Discoscaphites sp.	430
<ol> <li>A mechanically compressed specimen from the Corsicana marl in the Mexia road, 2 4/5 miles east of Cooledge, Limestone County. (U.S.G.S. coll. 13832; U.S.N.M. no. 77317.)</li> </ol>	

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Placenticeras meeki Böhm	
A large specimen (reduced as sho marl on the Dallas highway, 3 7 (U.S.G.S. coll, 17119; U.S.N.M.	wn by scale in inches) from the Neylandville /10 miles west of Kaufman, Kaufman County. no. 77324.)





Sphenodiscus tirensis, n.sp. 435

- Side view of a paratype (U.S.G.S. coll. 12930; U.S.N.M. no. 77327) from the Kemp clay on the G. W. Chapman farm, 1½ miles southeast of Tira, Hopkins County.
- 2. Cross section at large end of the same specimen.
- 3. Cross section of inner volutions of the holotype (U.S.N.M. no. 77326) from the same locality.



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 Holotype (U.S.N.M. no. 12930; U.S.N.M. no. 77326) from the Kemp clay on the G. W. Chapman farm, 1½ miles southeast of Tira, Hopkins County.

Sphenodiscus tirensis, n.sp.

 View (x2) of inner sutures at a young stage in a fragment from the Kemp clay in a branch, ½ miles south of McLeod School, 6½ miles southwest of Currie, Navarro County. (U.S.G.S. coll. 14139; U.S.N.M. no. 77329.)

Placenticeras intercalare Meek (variety) 433

3,4. Views of a specimen from the base of the Neylandville marl on the Dallas highway, 5 miles west of Kaufman, Kaufman County. (U.S.G.S. coll. 14102; U.S.N.M. no. 77325.)

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Sphenodiscus pleurisepta (Conrad) 436
1, 2. Views of a specimen from the Kemp clay on the G. W. Chapman farm, 1½ miles southeast of Tira, Hopkins County. (U.S.G.S. coll. 12930; U.S.N.M. no. 77330.)

- 3. Side view of a specimen from the same locality.
- Side view (x1<sup>1</sup>/<sub>2</sub>) of a specimen from the Kemp clay on the John A. Thompson estate, 4 miles northcast of Roane, Navarro County. (U.S.G.S. coll. 12922; U.S.N.M. no. 77331.)

Belemnitella americana (Morton) 437

- 5-7. Views of three incomplete guards from the Corsicana marl on the old Greenville road, 1 4/5 miles northeast of Quinlan, Hunt County. (U.S.G.S. coll. 11248; U.S.N.M. no. 77336.)
  - 8. Cross section of the specimen shown in plate 6, which is split in half, revealing structural features.





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Figures in blackface refer to pages where genera and species are described.

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	[14083-7,1 mi, NF, of Choper, [2010-1 mi, NF, of Choper, [2010-1 mi, N, of Choper, 4084, 5318, 7508, 14082-0.5 mi, N. of Choper, 14083-0.4 mi, N. of Choper, [14033-0.4 mi, NV, of Choper, [2512-4, mi, SNV, of Choper, [2512-4, mi, SNV, of Choper.	14080-143 mi, NE, of Greenvilla, 1408853 mi, NE, of Greenvilla, 14088-53 mi, NE, of Greenvilla, 14087-43 mi, NE, of Greenvilla, 57.12 - Nour fulgrounds, Greenvilla, 157.13 - 2018. S. of fungrounds, Greenvilla, 157.13 - 2018. S. of fungrounds, Greenvilla, 157.13 - 2018. S. of Greenvilla, 157.13 - 2018. S. of Greenvilla, 157.13 - 213.23 - 37 mi, NE, of Greenvilla, 138.81 - 23 mi, NE, of Rouse Gity, 138.81 - 23 mi, NE, of Rouse Gity, 138.81 - 23 mi, NE, of Rouse Gity, 138.81 - 13.01 - 37.11. A. ROuse Gity,	(1883) — 25. of Chi-holm. (1884) — 25. of Chi-holm. (1884) — 44. mi, NV, of Tarrell. (1885) — 44. mi, N, of Tarrell. (1879) — 44. mi, N, of Tarrell. (1879) — 45. mi, N, of Cherrell. (1892) — 40. mi, N, of Kaufmenn. (1885) — 4101, (7119) — 37. mi, N, of Kaufmen. (1885) — 4101, (7119) — 37. mi, N, of Kaufmen.	[16]66: -3.5 mi, WNW, of Corsients, 17303-4 mi, W. Joy, N. of Corsients, 16164-3 mi, N. joy, N. of Corsients, 16170, 17305; Tex, Bh. 17300-2.5 mi, N. of Cothet, 14119-1.5 to 2 mi, NW, of Cothet, 188655-618 mi, S.F. of Dunn, 183653-2.5 mi, N. of Cotheller, 16109-2.7 mi, NW of Cotheller, 16109-2.7 mi, NW of Cotheller,	[3849] - 5 art. M. A. M. Martani, (1983) - 1, and N. S. of Burgan, (1984) - 10 and N. of Cameron, (1984) - 10 and N. of Cameron, (1984) - 11 and W. of Petribone Station, (1984) - 10, W. of Petribone Station, (1985) - 10	Tablent state Tablent and (upper). Pecar Gap chark member of Taylor mark. Pecar Gap chark member of Taylor mark. Taylor mark lowerp. American Innectone. Sam Myard formation. Uppon day. Anona chark. Anona chark. Anona chark. Anona chark. Anona chark.	Bonham sund. Bonham clay: Fear tenron of An-tin chalk (lower An-tin).
Vermes: Serpula cretacen (Conmd)				×	× ×	×	
Herminster benhurensis, n. sp. Moflusca: Pelevypoda:							#
Nucula perequalie Conrad N. nacatochana, n. sp. N. sp.				x x			
Nuculana corsicana, n. sp. N. corbetensis, n. sp. Nemodon cufaulensis lineatus, n. var.	?			2 X X		×	Ħ
Nemodon sp. Glycymeris sp. Breviarca nolani, u sp.		×		x		x	
Idonean a murrayi, n. sp. Inoceratnus vanuxemi Meek and Haydon?	×	X				×	++-
I. sp. d Ostrea panda Morton		x	xx	x			
O tecticosta Giabb O tecticosta Morton		┥╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴ ┥╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴ ┥╴╴╴╴╴╴		×	×××		×
O, taleata Morton Gryphaea mutabilis Morton Gryphaeostrea vomer (Morton)				xx			#
Exogyra cancellata Stephen-on E. co-tata Say E. costata -pinifera, n. name							#
Trigonia spp. Pecten (Radiopecten) mississippieusis Conrad? Lima -p.	×			×		× x	#
Anomia tellinoides Morton Anomia argentaria Morton Volsella uddeni, n. sp.	x x x x x			× × ×	xxx		+
Crenella sp. Cymella bella texana, n. var.	x			X X	×		Ħ
Veniella conrudi (Morton) Crassitella vadosa cedarensis, n. var.	×	×	×			< <u> </u> ×?×	
Durania sp. Lucina parvilineata Shumard Cardium (Pachycardium) sp.	xx			×	┥╺┲┙┥╵╴┿╸┥╺╋┙┥╶╴┙ ┥╺╪╴╡╶╌╴╸┥╸┠╺┫╴┥╺╡ ┍╼┽╴┝╼┽╴┥╼┲┫┨╌┾┪	×	
C. (Granocardium) deltanum, n. sp C. (Granocardium) rossae, n. sp C. (Granocardium) spp				x x			
Brevicardium tenne, n. sp. J-ocardia irelandi, n. sp. Asbradina? navarranua, n. sp.							#
Cyprimeria depre-sa Conrad C. coonensis, n. sp.	X		?				++
Teneo parilis Conrad Telina patula, n. p.				x x	? ×	×	
Solyma gardnerae, n. sp. Lepto-olen biplicatus Courad Cymbophora subtilis, n. sp.	×			x x	X ?	×	$\mp$
Corbula crassiplica Gabb C. torta, n. sp. C. tockonsis, n. sp.						×	
С. эрр.			┶┼┼┼╹┼╵ ╍┿┾┼╺┼╎┽				
Scaphopoda: Deutalium vaughani, n. sp. D. margaradium Made and Maydon							$\ddagger$
D. sp. Cadulus obnutus (Conrad)				× ?		×	+
Gastropoda: Acmaea? occidentali=(Hall and Meek) Calhomphalus bellulus, n. sp.							
Urecolabrium tuberenlatum crassum, n. var. Monodonta? cancellosa, d. sp. Eulima clara Wade							
Creonella triplicata Wade Tuba? sp. Mathida cedurenis n sp				x x			#
Architectonica voragifornis, n. sp. Margaritella punula, n. sp.				x	<mark>┥┥╷╧╺╧╋╋┽╸</mark>	╋ <del>╕┊╹┥┊┥╎┣┾┊╵</del>	#
C, sp. 3 Polinices pectilabrum (Cont.d)					×××		$\frac{1}{1}$
P. rectutorum texanus, n. var Gyrades rotundus, n. sp. G. petrosus (Morton)		2					#
Tarritella trilira Contad Tarritella vertebroides tenuispira, n. var. Nudivagu-? cooperensis, n. sp.	×						<u>+</u> +-
Anchura? campbelli, up. A.? sp. Drepanochilus? corbeten-is, np.							
D. trillitatus, o. sp. D. spp. Tomlora tuberculata, n. sp.							Ħ
Pyropsis sp Napulus tuberculatus, n. sp Hornologia undoanna n. an	┠┿┲┿╪┿┿			X X X		R	
H. mundum, n. sp. Sargana stantoni (Weller)	2			×			++-
Seminola? sp. Anomalofusus bellulus, n. sp.						×	11
A. «p. Bellifusus? coronatus, n. «p. B.? «p.				×			H
Remersi nucrostriata, n. sp. R. decora, n. sp. Drilluta brevispira, n. sp.				x			
Volutomorpha? sp. Cancellaria? sp. Cuveola acuta (Wade)?							
Amuletum curvocostatum, n. sp. Fulgerea venusta, n. sp.		<mark>┥┽┽┽┽╎┍╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴╴</mark>					
Nonacteonina graphoides, n. sp. N. tensa, n. sp.							#
Toruatellaea cretacea hebes, n. var. Cylichna incisa, n. sp.				X			#
Cephniopoda: Eutrephoceras planoventer, n. sp. Solenoceras texanum (Shumard)	<b>F</b> ∓∓∓‡‡‡				?		Ħ
S. reesidei, n. sp. Baculites claviformis, n. sp. B. undatus, n. sp.	? X	**************************************	X ?	? X??X		╉┼┽┽┿┿┿┿┿ ╉┤┽╎┿╵╋┽┝╧	Ħ
R. spp. Noetoceras? draconis, n. sp. N. sp.	×		×	XX X	┟╊╪┶┿┽╋╄┾ ╅╅┽┿┿╋╋╋	┫┝┽┼┾┿╡┿┫┼┿┿ ╋┝┿┿┿┿┿┿╋┿╋	#
Anaklinocens reflexum, n. sp. Turrilitæ? sp.	×	×				×	#
H.? ap. Pampachydiacus arkansanus, n. sp.			×	×	┝╏┝┽┥┼╋╹╌╸	┫┼┼┼┼┼┟┼┼	++
F. sp. Axonoceras compressum, u. sp. A. pingue, u. sp.	×	╻╷╼╼╻╴╸╴╪╶┽╶┽┑┥┪ ┥╷┽┍╶┾┽┽┽┙┍╌┿╉┨		X	<u><u></u> <u></u> </u>	╉ <del>╕╷╷╷╷╷╸</del> ╉┽╷╷╷╷	Ħ
A. multicostatum, n. sp. A. multicostatum rotundum, n. sp. Scaphites rugosus, n. sp.	×			x x	<u><u></u> <u></u>                                       </u>	┫┤┼┽┼┼┟┼┼	#
Placenticeras meeki Bohm		┟ <del>╡╎┥╎╎╎╎╎╎╎╎╎╎</del>	× ×	<u>┨╪┽┟┼╁┨┼</u> ╯	┟╉╛╎┽┼╋╄┨╢	┫╎┼┼┼┼┦┼┼┨	++

 TABLE 1.—Distribution and stratigraphic range of fossils of the Neylandville marl
 [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except a-otherwise indicated. Full descriptions of localities are given elsewhere in the text]

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		14083-7.1 ml. NF. of Couper.	140x4-74 mi. NF. of Cooper.	Tail0-1 nit. N. of Cooper.	14065.40.4 mi N of Construct N. 01 Cooper.	7511-2 mi. SW. of Cooper.	7512-4.5 mi. SW. of Cooper.	14089-64 nu. NE. of Greenville.	1 1 1 1 1 1 2 mi NF of Gammeille	16128-3.5 nut. NE. of Greenville.	9717-Near fairgrounds, Greenville.	13336 - Field S. of fairgrounds, Greenville.	9719-21 mi. SE. of Greenville.	11251, 17382 8 mi, SW, of Greenville.	138532 S mi. NF. of Rover City.	13834, 16157-2.5 nd, NE, of Rove City.	13881-2.5 art. SV. of Phylor. CRV.	14104-5 mi. NW. of Terrell.	- [1385] - 4.6 mi, W. of Terrell.	Table 1 and the W. of Lerrell.	7549-1.5 mi. E. of Gastonia.	14102—5 mi. W. of Kaufman. 138564.4 mi. W. of Kaufman.	13852, 14101, 17119-3.7 mi. W. of Kanfuan.	16166 - 3.5 mi. WNW, of Corsiema. 173620-4 mi. W. Iw N. of Cossiema.	Itslift-3 mi. NF. of Dame	[16160, 15366; Yex, Bu, 17309-25 mt, N. of Cothel, [14119-1.5 to 2 mi, NW, of Corbet.	13855-658 mi, SP, of Drane.	16643 - 25 mi, 8, 64 Kai Hur. 16169 - 27 mi, NW, of Cooledge.	13849—5 mi. NF. of McChailan. 14133—1.7 mi S. of Barlineton.	13861-10 mi. N. of Cameron.	14132, 15540 -1 mi, W. of Petilione Station.	boo334 [nut. W. of Petitikone Station. Kenip clay.	E-condido formation.	Corvertes mert. Narestowh sand.	Taylor mad (upper). Pream (tap chalk member of Taylor mart	Wolfe City sand member of Laylor mark. Taylor mark (fower).	Anarau/bo line-tone. Sen Mignel formation.	Upon day. Annue chalk	Anstin chalk.	Раздет токдит от Анстисски К (прет Ансти)   Brownstown marl.	Bl6-som same.	Beter torgue of Austin chalk (lower Austin).
	Vermes : Serpula cretares (Contrad) Echinodermata: Hermineter kenhurensis n en	F			+									+	+		ţ		-							×		×				×	>	x ×			+			+		Ħ
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	N. corbatensis, n. sp. Nemodon enfaulensis lineatus, n. var. Nemodon sp.	-		+	?			+				+		-	-	×	+		-			-		+		λ.			+					Ê			-			+		Ŧ
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i. primes. Watten 1       x	Polinices perilabrum (Conrad) P. reculabrum texanus, n. var. Gynalas rotundus, n. sp	E		-	+				-	-		+				?		+		-	+	-				×	H	×	-	Ì	+-+	X X	×>	× × × ×		+-	×			+		#
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Dergenetider endersen, n. e	Nudivagus? cooperensis, n. sp. Anchuta? campbelli, np.	E		-	>			-	+	ļ		-		-	+	H	Ŧ	-		F				+		x			-		++			+		-+-	<u> </u>			÷		1.
Tanbor tuberealizes ap	Drepanochilus? corbetensis, n. sp. D. trilinatus, o. sp.	E			-			+	+	+		-					+	+		+						X X			+		+			×		t				-		Ŧ
It multipunds male in p. q. It multipunds a problem (Weller)	Tundora tuberculata, n. «p. Perop-is sp.	E		-	+			-	+	Ŧ	F	+	+	+	+	Ħ	Ŧ	-		-	H			×		×		+						×		Ť			H	+		$\pm$
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Anniandour domino, n. sp. A. sp. Bullians? contains, n. sp. Canceloa actu (Wale)? Annibelmu carveestatium, n. sp. Fulgera. venusta, n. sp. Actions? threekmontoi, n. sp. Nonacteming graphides, n. sp. Nonacteming graphides, n. sp. Canceloa catu (Wale)? Annibelmu carveestatium, n. sp. Fulgera. venusta, n. sp. Nonacteming graphides, n. sp. Nonacteming graphides, n. sp. Nonacteming staphides, n. sp. Notations of status at the status of the statu	Morea marylandich bella, n. var. Seminola? sp.	F		-	?	-		-	Ŧ	+		-			+		-	-		-				+		x		-		H		Ŧ		×		+				+		+-
Revera nicrostriata, n. sp. Revera nicrostriata, n. sp. R. diecon, n. sp. Substantia, sp. Valuomorphal, sp. Cancellania, sp. Cancellania, sp. Cancellania, sp. Cancellania, sp. Substantia, n. sp. Fulgene venusta, n. sp. Fulgene venusta, n. sp. Nonactemina graphoides, n. sp. Nonactemina graphoides, n. sp. Nonactemina graphoides, n. sp. Substantia, n. sp. Cephalopola: Fulgene venusta, n. sp. Substantia, n. sp. Cephalopola: Fulgene venusta, n. sp. Cephalopola: Fulgene venusta, n. sp. Substantia, n. sp. Cephalopola: Fulgene venusta, n. sp. Cephalopola: Fulgene venusta, n. sp. Substantia, n. sp. Sub	A nomatoru-us bennus, n. sp. A. sp. Bellifusus? coronatus, n. sp.	Ē		-	+	-			+			-	-	Ŧ		Ħ		-	H	-	H			-		x x x		-		Ħ				+		Ŧ				+		+
Drillita breveniti, b. sp. Volutoorpha" sp. Cancellaria" sp. Ca	B.7 sp. Remera nicrostriata, n. sp. R. decora, n. sp.	E			+	F			+	+	H	+			+	Ħ	Ŧ	-		+				x		×		+	-	H				+		-		H		+		+
Carcela arula (V add?). Anuletam carcovoratatum, a. sp. Fulgere, venusta, n. sp. Action of thirds mortion, n. sp. Nonacteoning graphoides, n. sp. Nonacteoning graphoides, n. sp. Nonacteoning graphoides, n. sp. N. sp. Tornatellane cretaces holes, n. var. Cyclichus incres, n. sp. Cyclichus incres, n. sp. Cyclichus incres, n. sp. Cyclichus incres, n. sp. Solencerast texanum (Shumard) S. greeider, n. sp. Rualities claviformis, n. sp. N. s	Driffuta brevi-pira, <b>a</b> . sp. Volutomorpha? sp. Cancellaria? sp.	E		_	+	Ē			+	ŧ	H	+		7		Ħ	+							-	H	x x x		+			++					+				_	H	+
Action? throckmarton, n. sp. Nonactemina graphoides, n. sp. N, tensi, n. sp. N, sp. Tornatellaen cretaces hebes, n. var. Cylichna incrso, n. sp. Cylialopota: Entrepliceense planoventer, n. sp. Solenceras texauum (Shumard) S, residei, n. sp. B seption: N, sp. N, sp. A undaus, n. sp. N, sp. N, sp. A multicestation, n. sp. N, sp. A concerns compressium, n. sp. A publice statisment conclum, n. sp. A concerns compressium, n. sp. A publice statisment conclum, n. sp. A concerns compressium, n.	Caveola acuta (Wade)? Amuletum curvocostatum, n. sp. Fulgerea venusta, n. sp.	Ē		1	1	F		+	1	1	H	+	T	#	+	Ħ	+	Ŧ		+	H		H	1		×××			Ŧ	H		Ŧ	H	×						+	H	+
N. ep.       Y <td>Acteon? throckmortoni, n. sp. Nonacteonina graphoides, n. sp. N. tensa, n. sp.</td> <td>E</td> <td></td> <td>-</td> <td>+</td> <td>ł</td> <td></td> <td>-</td> <td>+</td> <td>t</td> <td></td> <td>+</td> <td></td> <td>Ŧ</td> <td>-</td> <td>Ħ</td> <td>ļ</td> <td>F</td> <td></td> <td>+</td> <td></td> <td></td> <td>Ħ</td> <td>+</td> <td></td> <td>××</td> <td>Ħ</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>×</td> <td></td> <td>-</td> <td></td> <td></td> <td>Ħ</td> <td>-</td> <td></td> <td>+</td>	Acteon? throckmortoni, n. sp. Nonacteonina graphoides, n. sp. N. tensa, n. sp.	E		-	+	ł		-	+	t		+		Ŧ	-	Ħ	ļ	F		+			Ħ	+		××	Ħ							×		-			Ħ	-		+
Coplational Control Constraints of the constraints	N, sp. Tornatellaen cretacea hebes, n. var. Cylichua incisa, n. sp.	E	H		-+-	F			+	+		+		#	+	Ħ	+			+				-		×	H				+	Ŧ	Ħ	+		+			Ħ	+		Ŧ
S. residic, n. sp.       ?X       ?X       ?Z       X       ?Z       X <td>Cephalopoda: Entrephocerus planoventer, n. sp. Solenocerus texanum (Shumard)</td> <td>E</td> <td>H</td> <td></td> <td>+</td> <td></td> <td></td> <td></td> <td>+</td> <td>+-</td> <td>H</td> <td>+</td> <td>Ħ</td> <td>Ħ</td> <td>+</td> <td>Ħ</td> <td>+</td> <td></td> <td></td> <td>+</td> <td></td> <td></td> <td></td> <td>×</td> <td></td> <td>x</td> <td></td> <td>×</td> <td></td> <td>Ħ</td> <td></td> <td>Ŧ</td> <td></td> <td>? X X</td> <td></td> <td>+-</td> <td>-</td> <td>ŀ</td> <td></td> <td>+</td> <td>Ħ</td> <td>Ŧ</td>	Cephalopoda: Entrephocerus planoventer, n. sp. Solenocerus texanum (Shumard)	E	H		+				+	+-	H	+	Ħ	Ħ	+	Ħ	+			+				×		x		×		Ħ		Ŧ		? X X		+-	-	ŀ		+	Ħ	Ŧ
B. spp. XXX X X X X X X X X X X X X X X X X	S. reesidei, n. sp. Baculites claviformis, n. sp. B. undatus, n. sp.	E	H	-	? >				+	+		+	Ħ	Ħ	?	×		+		×	¢		?	?		x ? ?		? X				#		××				H	Ħ	+		
Anaklinwens reflexum, n. sp.     X     X     X       Turrilites' sp.     X     X     X       Helicoeras navarroense Shumard     X     X     X       H.* sp.     X     X     X       Parpachydiscus arkansanus, n. sp.     X     X     X       Ax onoeras compressum, n. sp.     X     X     X       A, pingue, n. sp.     X     X     X       A, multico-satum, n. sp.     X     X     X       A, multico-satum rotundum, n. sp.     X     X     X       Scaphiter rugsus, n. sp.     X     X     X       Placentieras meski Bolin     X     X     X	B. spp. Nostoceras? dniconis, n. sp. N. sp.	E	Ħ	-	×			H		+	Ħ	+			+	Ħ	+	+		+	t		×	××	Û	×	Ħ	·+		H		Ŧ		-	Ħ	+			Ħ	+		$\pm$
H.? sp. Parapachydiscus arkansanus, n. sp. P. sp. Axonocerus compressum, n. sp. Ax multico-statum, n. sp. Ax multico-statum, n. sp. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Anaklinocens reflexum, n. «p. Turrilites? sp. Helicoceras navarroense Shumard	E			1	+	Ħ	4	+	+		+		Ħ	+	×	+	ŧ	Ħ	+	t	Ħ		+	Ĥ	×		×				Ŧ	Ħ	×		+		₽			Ħ	#
A xonoceras compressum, n. sp.     X       A, pingue, n. sp.     X       A, multico-statum, n. sp.     X       Scaphitter rugoeus, n. sp.     X       Placentierus mecki Bolin     X	H.? sp. Parapachydiscus arkansanus, n. sp. P. sp.	ŧ	H								H		+		+	Ť	+			+			×			+	Ħ	x		Ħ		Ħ	Ħ	×		+			Ħ	+		+
A. multico-tatum rotundum, n. sp. Naphites rugeus, n. sp. Placentierus mecki Bohm	A xonoceras compressum, u. sp. A. pingue, n. sp. A. publicostatum, u. sp.	F	H		×	+	H		f				+	H	+	Ħ	+			+	1-					×××		+					Ħ	+		+			Ħ	+	İ.	+-
	A. multicostatum rotundum, n. sp. Scaphites rugosus, n. sp. Placenticeras mecki Bohm	F	H		×	ł	H	H	-		H		+	H	2	2	+	1		+	+		×		İ	×		×?					Ħ	×		+		Ħ	Ħ	+		+

TABLE 1.—Distribution and stratigraphic range of fossils of the Neylandville marl [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except aotherwise indicated. Full descriptions of localities are given elsewhere in the text]

#### TABLE 2.—Distribution and stratigraphic range of fossils of the Nacatoch sand [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

	Bowie Co.	Rec Rive Coun	Franklin Co.	Hopkins Co.	Hui Cour	it ty	ĸ	aufman 'ounty						Nave	лгто (	Cour	ty				Fulls Co.	Other Navarro formations	-single single s	Tay a equ	lor n nd ite ivale	tarl 5 nts.	rq.	Austi chall and is uival	n ; Ba ents
						-							of Casima	of Constants															
	30-1011			(				<ul> <li>Chatfield</li> <li>Mathematical</li> <li>Kauthuan</li> <li>Mathematical</li> <li>Mathmatical</li> <li>Mathematical</li> <li>Mathematical&lt;</li></ul>	eld	hatfield	hatfield		L. K. L. F.	orskana Oskana	5005		f Coricum Joricum	คนคว	111					arl L			1	funsar	u-tin)
4 <u>pecies</u>	. N. of New	a.	of Rosali unty	ir Bluff (town ser	merce of Greenville modull	E. of Quinlan nhm	of Kautinan Terrell	s, or <b>NW</b> , of al 0.6 mi, W. f Kaufinan SW, of Kauf	NE. of Chatfi	N. of Hester NNW, of C	m. NW. of C I Gali	iter dd Acarfiedd	ld 14116-7	H mit. N. of C		Sichina Sichina	a 3 mi. NE. o	. NE. of Cora	W. of Corriea	of Corvicana of Corvicana	Clunchan			r of Taylor m of Livlor ma			1 11	· mililini sum	halk (lower A
	River 8 mile	- Avery . S. of Annet	mi E, by N.	N. of Sulphu L.SE. of Com	i. W. of Com 8—3.7 mi. F. mi. W. af Can	1 1.8 mi. N	d 0.6 mi. W. 12246-Near	96525 mi. 14098 Run 18 of Kaatina 2 mi. SW. of - Road 2 mi.	30221 mi.	805-0.8 mi. 807-1.1 mi.	0.6 to 0.8 r ty of Chatfield J. F. of Chat	E. of Chatfie F. in street at 0	S. of Chatfie	Bu. 17:304-	N. of Corvie	N. of Cor	Rock Branch	Branch 3 mi	of Coricuna 310-1 mi. S	ni. W. by S. mi. W. SW. mi. W. SW.	i. NE of Mc	ornation arl	e marl (upper)	chaik member surd member	(lower) me-tone	famation n.	turi indini y	nant Linat	y e of Austin el
	1203.5-18+J	13554-Nea 13093-5 m	12031-NW	53223 mi. 12929 - 6 m	58231.5 n 12926, 1554 12926, 1554	16162, 1617 16580 2 m	14103- Fiel [1, S, N, M,	764, 168, 179 764, 12923 764, Viciol 7547—Yichd 7546, 14099	Tex. Bu. 17: 17/36. 7 m	Tex. Bu. 17 Tex. Bu. 17 Tex. Bu. 17	762Vicini 762Vicini 6770-075	7571 - 1 mi	7503 Field	17366, Tev.	8519-3 mi	Distes-3.2	9500-N. 0	9.545-Rock 518-N. edg	763 Vicinity Tex. Bu. 17	17368-2.5 17368-2.5 16163-2.3	1. 1-1787L	Kemp clay Escondido A Corsicana n	Neyhudvill Liylor nur	Pream Gap Wolfe City	Toylor miri Anaracho h	San Miguel Upson chiv	Anstin chal	Brownstown Brownstown	Bouluan els Estor tougu
Vermes: Serpula creta ea (Contad). S º lineata (Weller) Hamilus onyx Morton. 11? huntensis, n. sp.					+ + + + + + + + + + + + + + + + + + +		×						×		×			×				x x x x	×	×	x		×		×
Molluscoidea: Molluscoidea: Liognha aff, L. sub-patubata Hall and Meek Molluscoidea: Liognha aff, L. sub-patubata Hall and Meek	×							×													×	×	x						
Pelecypoda: Solemya bilix White? Nucula perepublis Conrad N. chattieldensiss n. sp. N. microstruta Gardher N. waltomeniss n. sp.				╧┽┾┿		×		X X			××		×					×	×			×	x						
N. macatochana, n. sp. Nuculaną corsiciana, n. sp. N. hou-toni, n. sp. N. corbetensis, n. sp. N. corbetensis, n. sp. N. hongifrans (Conrad)								×			× ? ××			×				×	× ×			x x	x ? 						
N. sp. b Nemodon grandis navarrozouts, u. vat. N. bowici, n. sp. N. adkiusi, n. sp. N. spp.				+ + + + + + + + + + + + + + + + + + + +				x x x			×						?	×	×	×									
Glycymeris rotundata kauluomenists, n. vor. G. sp., Linter aentata Stephenison Breviarea plummeri, n. sp., R. nokon, n. sp., Idomarta rotweesis, n. str.			×		×						+^- 		×	×			*	×					×						
I. kingsensis, n. sp. I. sp. Limopers meeki Wade Greevilliopsis ensitorniis extensa, n. var. Gervillia bryani, n. sp.		+++++++++++++++++++++++++++++++++++++++					×	X									×			×	×××		×						
$\begin{array}{c} \mathbf{h} = \mathbf{p}  \mathbf{b} \\ \mathbf{h} = \mathbf{p} \cdot \mathbf{c} $			×					x			x					, ×		X	××××	X	4	3	x						
Preria? linguaeformis (Evans and Simmard)? Ostrea owenana Shumard O, phunosa: Moton O, falenta Morton O, mesenterica Morton Gweabwa mur ddii Mortoa		1			×														×			x x x x	× × × × × ×	××	?????	××	× X :	××>	
Exogyra costata Say Trigonia stantoni, n. sp. T. enfanlen-is gabbi, n. var. Peeten (Peeten?) vennestus Morton P. (Comptomeetes) kaufinaneusis, n. sp.		2	×				×	x			×			×			×	×	×			? X ? X X X	× 						
P. (Syneychonema?) antipueus vooraat P. (Syneychonema?) antiberi, n. sp. P. (Radiopecten) mississippiensis Contrad? Lina sp. Anomia argentaria Morton. Volsella uddeni, n. sp.							×				x x x	×	×	×		,		×	×	×.		× ×	x x x x ?	××	×	? X			
Crenella -p. Lithophaga carolinereis (Conrad) Concolos topcanos (Conrad) Pholadomya birlei (Gabb Lateranta? subettina (Shumard)? L.; subletis, n. sp.				×				? ××			×			×								× × ×							
Le <sup>2</sup> bartoni, n. sp. Anatimya anteradiata texana, n. yar. Periploma? edwardsi, n. sp. Liopistha protexta (Conrad) L. formosa, n. sp.			×			×	x x x	×××				×	××	×			( x	××	×			×	××		•x	××			
Co-pidaria grovensis, n. sp. Co-pidaria grovensis, n. sp. C. spp. Veniella contadi (Motton) V. lineata (Shumart) Etter copsicana, n. sp.						> X	×	× × ·			×		×			×>>		××	xxx	×		x x	××			?			
<ul> <li>F. pensi, n. sp.</li> <li>E. sp.</li> <li>Crassitelia vadosa chattieldensis, n. var.</li> <li>C. quinkamensis, n. sp.</li> <li>Uidemia texana, n. sp.</li> <li>Titanosarcolites? sp.</li> </ul>				×	×	×	×	×			×							×××											
Lucina parsilineata Shumard L. matthornis, n. sp. L. chathiddana, n. sp. L. seminolis, n. sp. L. oleodorsum, n. sp. L. sub.			×			×	×	× × ×			×		×	×××				×	×										
Scintilla? ramoni, n. sp. Cardium (Pachycardium) walei, n. sp. C. (Ethmocardium) welleri, np. C. (Granocardium) bowenae, np. C. (Granocardium) tholi, n. sp. C. (Granocardium) tholi, n. sp.			×	×		?	×				X X X	× ×	x				×	xx	×		( X								
C. (Trachyserdium) spp. C. (Trachyserdium) spp. Brevicardium sp. Issyardia bulbosa, n. sp. I. hendersoni, n. sp.						x		x			××			×			××	×	×		<								
L shumardi, n. sp. Aphrodina tippona Conrad Cyprimera depresa Conrad C. coonensis, n. sp. Legnuera ellipticum Conrad Tenes aurili Conrad			?	×	×	X X	¥.				××	xx	×	××				xx	×	× ×	(X	? × × × ? ×	X ? X X			*			
Cyclorisme? pumila, n. sp. Tellina munda, n. sp. T.? patula, n. sp. T. spp. Linearta wiesetae, n. sp.						×	×				2 X X X			XX				× × 7	×		Č	?	×						
L. navarovana n. sp. L. spp. Solyma gardnerae, n. sp. S.7 parva, n. sp. Deptosilen hipheatus Conrad. L.2 quadrilaterus, n. sp.							×				××××		×					x x x x	×	×	c	×	? X						
L. 2 levis, n. sp. Cymbophora sabellum, n. sp. C. subtilis, n. sp. C. cancellon, n. sp. C. hervit Gardner C. inflata, n. sp.						x x	×					×	×	×				x	××××			?	×						
C simpsonensis, n. sp. Carbut censophia Gabb C williardi Wade. C nockensis, n. sp. C submidiata texana, n. yar. C linterodea n. so						×	×				××	×	x x x	(X)				x	XXXX	X		××	××	×					
C. woodi, n. sp. C. mfata, n. sp. C. sppe. Parope subplicata Shumard. Gastrochaena riplevana, n. sp. Di J. El.							×	× × × × ?			×					· · ·		×	×			×							
Xylophagelfa whitiwe, 0, sp. Xylophagelfa whitiwe, 0, sp. Gomocha-ma sciphoides, 0, sp. Ramseria whitheldi, 0, sp. Sciphopola: Dentalium navarroi, 0, sp.								X X			×								×	××		? ? X							
D. leve Stephenson Gadulus obmitis (Conrad) G. coorneris, np. Gastropolit; Wieksia lubbocki, n. sp. Psendomalaxis <sup>2</sup> patens, n. sp.						×		x x x							×				x	x		×	?						
Calliomphalus sp. C.? sp. Garramites nitidus_n. <u>p</u> }. Creonella whitei, n. sp. C. triplicata Wade			×			×		×										x x x	?			×	X						
Proceda americana Wade" Proceda americana Wade" Belliscala forshevi (Shumard) B. cradeta a. sp. B. tockensis, u. sp. Tuba" manzareti, u. sp.											×							XX	×										
Architectonica -p Spinnema perryi, np			×					×			×					×			×										
Polimees rectilabrum (Conrad) P. rectilabrum texturus, o. v.t., P. stephensoni Wade Ranis smiformis, n. sp. Gyrades supraplicatus (Conrad) (Contambus n. sp.				× + +			××				×××	×		×					× × × ×		×	2 x x x	× .			×			
G, subcarinatus, n. sp. G, spillmant Gobb Turvitella trilin: Coornel. T, winehell: Shumard T, vertebroides tenuispita, n. v.o.		×	×	×			×	× ×			x x x x x x	xx	×					××	×	×	×		× ×	×	×	×			
T. houstoni, n. sp. T. houstoni, n. sp. Gerithinna simpsonensis, n. sp. Nuditzgue? sp. Anchura hamari, n. sp. A. ' lobata Wade.			×								×	×	×					x											
$ \begin{array}{l} \Lambda_{*}^{(2)} \   \mbox{ bold the meth}, \ n \in Sit, \\ \Lambda_{*}^{(2)} \   \mbox{ below to set}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \mbox{ cardbacusis}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \mbox{ cardbacusis}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \mbox{ cardbacusis}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \mbox{ cardbacusis}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \mbox{ cardbacusis}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \mbox{ cardbacusis}, \ n \in Sp, \\ \Lambda_{*}^{(2)} \   \ $				+		×		×			x								×	×	×								
D.? davisi, n. sp. D. trilinatus, n. sp. Pterocerella poinsettifornois, n. sp. Pugnellus densatus macrochannis, n. var. P. robustus, n. sp. Cyptaer motiforniis, n. sp.							× .		×		× ×							×	×	×		×	×						
C. graedis, n. sp. Medionapus elongatus, n. sp. M.3 sp. Napulus tuberculatus, n. sp. Hercordynenis vadosum, n. sp. Hercordynenis vadosum, n. sp.			2					?			××							×	×	×			X						
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Seminola crossa Wade Tryonia v.dhda, n. sp. Fusus? robertst, n. sp. Anomaloficas bellulus, n. sp. Ahofusus reaging, n. sp.							×				× ++ + ×			×		, , , , ,		×	x				×					++	+
A reagan shound, n. von. A, neagan tunidas, n. von. Bellifinas robustus, n. sp. B, tennetrictus, n. sp. B <sup>*</sup> sp. Omopsis pulcha, n. sp.								×			× ×			×				×	×										
O, mazyevi, n. sp. O, * opp. Graphidali terebrifotnits, n. sp. G. sp. Lemmera creticer (Wade) Le <sup>2</sup> sp.			×				×				+ - - - - - - - - -							×	×										
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La mutola, în speriori La genie dista, în spe Beretra frană, în spe Bi contra fa, în speriori Bi grandule, în speriori Fraindle distatorie etc.							×				××							×	×++			+ +							
Remaint bioacturs (0. sp. Remaint bioacmunata (Wode) Troussella sublinearis, n. sp. T.? Inevispins, n. sp. Nonacteoniana gataphoides, n. sp. N. deflexa, n. sp.											××			× + × ×				×××					X					1.	
85.º Infresa, 0, -p. Tornatellaeu scatesi, 0, -p. T. eretaero appresse, 10, 40. Riogienta pulchella Shumard Elliposcapha striatella (Shumard) Akera constricta, 0, -p.						×	x	x x			x x x x x x	x		++++++++++++++++++++++++++++++++++++++		× ,			× × ×	+ + + ×									
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N. helicinum humile, n. sur. N. colubrifornis, n. sp. Turribies splendidus Shumard. T. sp. Helicoeras navarroense Shumard Parameheksines arkanssinus, n. sp.			×				×			×	x			×		×				×	×		××						
P. scotti, n. sp. P. sp. A xunoversa sp. Scaphite rugasus, n. sp. S. brevis Meek			××								×			×									×						
S. sp. Discocrephites eracoideus, n. sp. Sphenodiscus spp. Belemaitella americana (Morton)	f					×		xx	×									?				XX							

## TABLE 2. — Distribution and stratigraphic range of fossils of the Nacatoch sand [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

	Bowie Co. O X –	Red liver muty	Franklin ('a. Honkins ('a.	Hu Cou	ut nty	Kanfuan Conaty	Navarro County
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	3-Red River	3—5 mi. S. of 14.5 mi. F.	1-NW, corne	<u>9- 6 mi, SF, 6</u> 1.5 mi, W, 6 6, 15548- 3.7	2-1.5 mt. W. 2. 16171-1.8 0 2 mi. NF	<ol> <li>Field 0.6 m</li> <li>N. M. 12246.</li> <li>Bu. 17303-2.</li> <li>Bu. 17303-2.</li> <li>(12)23, 14096</li> <li>Vicinity of K</li> <li>Vicinity of K</li> <li>Field 2 mi. 3.</li> </ol>	Bu, T7307 2, 20 Bu, T7307-10, Nucl. 2016. Cond. Nucl. Science of Bu, 17307-10, Nucl. 2016. Cond. Science of Bu, 17307-10, Nucl. 2016. Cond. Science in structure of Cond. Science in structure science in structure science in structure science of Science in Science (Science) and Science) and Science (Science) and Science (Science) and Science (Science) and Science) and Science (Science) and Science (Science) and Science) and Science (Sci
Vermes: Serpula cretacea (Conrad). S.? lineata (Weller). Hannulus onvx Morton.	13581	1309	12921			ULS 20141	
H.? huntensis, n. sp. Echinodermata: Family Cidaridae (1 spine) Hemisser benhurensis, n. sp. Molluscoidea: Lingula aff. L. subspatulata Hall and Meek	×					×	
Pelecypoda: Pelecypoda: Solenvya bilix White? Nuenta percentalis Courad N. chatfieldensis, n. sp. N. microstriata Gardner N. waltouensis, n. sp.					××	x	
N. macatochana, n. sp. Naculang corsicana, n. sp. N. honstoni, n. sp. N. corbetensis, n. sp. N. hongifrons (Conrad). N. sp. a.						×	
Nemodon grandiš navetroanus, n. sat. N. braviel, n. sp. N. adkinsi, n. sp. N. spp. Glycymeris rotundata kaufmanensis, n. vat. G. sp.			×				
Linter acutata Stephenson Breviance plummeri, n. sp. B. nolani, n. sp. Idomenter powerst, n. sp. I, kingsensis, n. sp. I, sp.			× 1		××		
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O, mesculerica Morton Grephaca mutabilis Morton Exogyra costata Say Trigonia stantoni, n. sp. T. enfaulensis gabbi, n. var. Peeten (Peeten?) vennstas Morton P. (Camriometers) kunfinanzeise n. sp.	× × ?		×	x			
P. (Syneyclonema?) simplicius Conrad P. (Syneyclonema?) archeri, n. sp. P. (Badiopecten) mass-sippiensis Conrad? Lina sp. Anomia argentaria Morton Volsella uddetti, n. sp.							
Cornena sp. Lithophaga carolinensis (Conrad) Cansedus tippanus (Conrad) Pholadomya littlei Gabb Lateranta? subctina (Shumard)? La? sublevis, n. sp. L.? Isartoni, n. sp.				×	×		
Anatimya anteradiata texana, n. var. Periploina? edwardsi, n. sp. Liopistha protexta (Conrad) L. formosa, n. sp. Cymella bella texana, n. var. Caspidaria grovensis, n. sp. C. san			×		X		
Var 1994 Venielka contradi (Morton) V. lineata (Shumard) Etea consicana, np. E. pousi, np. E. s Crassatella vadosa chattieldeusis, n. vat.			×	×	×	x 7 x 7 x x x	x     x     x     x     x     x     x       x     x     x     x     x     x       x     x     x     x     x       x     x     x     x       x     x     x       x       x <t< td=""></t<>
C. quinkmensis, n. sp. Uddenia texana, n. sp. Tatanosarcolites? sp. Lacina parvilineata Shumard L. matuformis, n. sp. L. chattifeldana, n. sp. L. chattifeldana, n. sp.					××	x x x x 7	
L. solvadorstanti, n. sp. L. sept. Scintilla" ramoni, n. sp. Cardina (Pachycardium) wadei, n. sp. C. Edinacardium) welleri, n. sp. C. (Edinacardium) bowenae, n. sp.		╋	×	×	?		
C. (Granoendum) (holi, n. sp. C. (Granoendum) spp. C. (Trachycardium) enfaulensis huntanum, n. var. C. (Trachycardium) spp. Brevicardium sp. Isocardia hulbest, n. sp. I. hendersoni, n. sp.				×	xx		
I, shumardi, n, sp. Aphrodina tippana Conrad Cyprimeria depresa Conrad C connecess, n, sp. Legumen ellipticum Conrad Tenea parilis Conrad			?	× .	×××	x x x x x x x x x	X         X         X         Y
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Solvina gardneræ, np. S. / parva, np. Lepto-olen biplicatu Cound, L. ' quadrikateus, np. L. ? levis, np. Cyndophora scabellum, n. sp.							
C, subtilis, np. C, cancellos, n. sp. C, barryi Gardner, C, inflata, np. C, sinipaonesis, np. C, sinipaonesis, np. Corbula censiphen Gobb C, williand Wade					x		
C. rockensis, np. C. subradiata teatum, n. var. C. linterologa, n. sp. C. woadh, n. sp. C. indiata, n. sp. C Sp.					×	x x x	
Canope subpicut sumari Gastrachaen riplevan, u. sp. Pholaidea ngshlensis, u. sp. Xylophagella whitneyi, u. sp. Gomozhasna scaphoides, u. sp. Kansetta whitheldi, u. sp. Scaphopola.					<	9 	
Deutalium navarroi, n. ep Deuts Stephensen Cadulus obmutu (Control) C. conneusis, n. ep. Gastropola: Weeksin hubbeekt, n. ep. Deutsenskin n. ep.					×		
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P. stephensoni Wade Raris sinifornis, n. sp. Gyrades superplicatus (Contad) G. rotandus, n. sp. G. subcartactus, o. sp. G. subcartactus, o. sp. G. splitanan Giobb Tacsically calles Control	×	+ + - ×	×	;	×'x'		
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Diepenschlus, <sup>2</sup> martin, n. sp. D. <sup>2</sup> davis, n. sp. D. tilluuts, n. sp. Prenoenella poinsettitornis, h. sp. Pagnellus densatus noedochants, n. vat. P. johnstis, n. sp.							
Cypraes nucleons, 6, sp Cypraels, n., sp Medhanquis clongitus, 6, sp M.7, sp Napathis tablecellatur, 6, sp Hercothynaus valdostin, 6, sp Hercothynaus valdostin, 6, sp Hercothynaus valdostin, 6, sp		?				· · · · · · · · · · · · · · · · · · ·	
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Drilluta erassicestata, n. sp. D. erassicestata longa, n. var D. paneicestata, n. sp. D. spp. Volutomorpha retifera Dall Volutoherm e (Longoconcha) navarroensis (Shumard Pinefasar's en				×			
Parvivolut (* spp Lupina pyritormis, n. sp. Caveeda producta, n. sp. Matava v dida, n. sp. M. valida multifure, n. var. M. subteres, n. sp.							
Paladmete corbuliformis, n. sp. P. insqualis, n. sp. Anutletum boylet, n. sp. A. curvice-battun, n. sp. A. curvice-battun, n. sp. I. terma simpsonensis, n. sp. I. hubbardi, n. sp.							
L. munda, n. sp. L. geniculata, n. sp. Beretra firma, n. sp. B. contracta, n. sp. B. ornartula, n. sp. Fusimilis robustus, n. sp.							
Troostella sublinearis, n. sp. Troostella sublinearis, n. sp. T.? brevispina, n. sp. Nonacteonina graphoides, n. sp. N. deflexa, n. sp. N.? tritices, n. sp. Tornatellaen scatesi, n. sp.							
T. cretacra appressi, n. var. Ringiculs pulchella Shumard Ellipsocepha striatella (Shumard) Akera constricta, n. sp. Haminea? simpsonensis, n. sp. Cylichna secalina Shumard Aniamuwa kandari Shumard					×		
A norminon naydeni Shumard A, borediis (Morton)? Cephalopode: Entreploceras planoventer, n. sp. Solenceras texanum (Shumard) S, recsidei, n. sp. S, nutlicestatum, n. sp.							
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Parspachydiscus arkansonus, n. sp. P. scotti, n. sp. P. sp. Axonocense sp. Scaphites rugusus, n. sp. S. hrevis Meek S. pumilus n. sp.		XX					
S. sp. Discosciphites erneoidens, n. sp. Spheriodiscus spp. Relamoitella annerienna (Morton)						xx	

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Hamilus on x Morion Hamilus on x Morion H. squamosus Gabb H.? huntensis, n. sp. Febinodermata:	×					?		×					×	×			-				×		×	XX	>	× ×			× ×	××			?	<	×
<ul> <li>Family Conrugeticrinidae aff. Mesocrinus sp. Family Cidaridae</li></ul>	XXXX XXXXX XXXXX XXXXX XXXXX												× × 2								X				>							? 		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
P. (Arthiea) bexarensis, n. sp. P. (Amusiam?) chuck, n. sp. Spandylas munitus, n. sp. S. sp. P. terrica Connul? P. terrica Connul? P. sp. Lima pelagica woolseyi, n. var. I. deatsvillensis, n. sp. I. cockei, n. sp. I. georalineensis, n. sp. I. guodalupensis, n. sp. I. zamitimetta texana, n. var. I. simbreensis, n. sp. I. sp. Anomia argentaria Morton Palvinites" argenteus Connul Cronella serie Connul Cancelus tippanus (Connul) Cancelus tippanus (Connul) Cancelus tippanus (Connul) Cancelus tippanus (Connul) Cancelus tippanus (Connul) Cuesidaria guodis, n. sp. I. sp. C. sp. Veniella connuli (Morton) Eter sp. Astarte? culchersis, n. sp. Veneilla vadea ananowensis, n. var. C. sp. d. Veneilla vadea manowensis, n. var. C. sp. d. C. sp. d. Cuestaria vadea ananowensis, n. var. C. sp. d. Cuestaria sp. Cantana pelapina Connul .	x x x x x x x x x x x x x x x x x x x		×		X			× · · · · · · · · · · · · · · · · · · ·	×	x	X 		× )																			×	×		
Survegeat? 10th, n. sp. Lucha Intervis, n. sp. Cardium (Granoscrolium) tippanum Courad C. (Granoscrolium) sp. C. (Chaelveradhum?) sp. C. (Chaelveradhum?) sp. Brevisatadhum fugile, n. sp. Brevisatadhum fugile, n. sp. Brevisatadhum fugile, n. sp. C. primetia departs a Contad C. primetia departs a Contad Tenes? partici departs a Contad Tenes? partici departs a Contad Tenes? partici contad Tenes? partici contad Tellina? matterscusis, n. sp. Linearia pertici, n. sp. L. spp. L. spp. Leptoolen? linguliformis, n. sp. Corbabile ensiplies Gorbb Gastrochaem ipleyana, n. sp. Pholas? pectorosa Contad Scaphopola: Detailium sp. Castopola: Detailium sp. Castopola: Detailium sp. Castopola: Architectonica sp. C. ? sp. E. pondi, n. sp. C. ? sp. E. pondi, n. sp. C. ? sp. E. pendi, n. sp. C. aphas microscucelli, n. sp. C. ? sp. E. pendi, n. sp. C. aphas interstriatus, n. sp. C. pathosis sp. C. Gradus? Martestinis (Hall and Meek) Hippscampaides sp. C. Sp. E. pendi, n. sp. C. aphas (Control) G. ratundus, n. sp. G. ratundus, n. sp. G. subcurnatus, n. sp. G. subcurnatus, n. sp. G. subcurnatus, n. sp. G. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. C. subcurnatus, n. sp. A. ? cooki, n. sp. A. ? cooki, n. sp. A. ? spp. Nagulas spp. Propeis spp. Nagulas spp. Nagulas spp. Nagulas spp. A. Sp. Anomlofusue? P. Nagulas spp. Anomlofusue? Sp. Anomlofusue? Sp. Anomalofusue? Sp. Anomlofusue? Sp. Anomlofusue? Sp. Anomlofusue? Sp. Anomlofusue? Sp. Anomlofusue? Sp. Anomlofusue? Sp.	2 X X X X X X X X X X X X X							X X X X X X X X X X X X X X X X X X X			X X X																								
redinieus - p. Ornopeis solisiella, n. sp. O. sp. Drilluta sp. Volutomorpha? sp. Caveola sp. Caveola sp. Beretra? elongata, n. sp. Nonactemina sp. Ringicula spp. Chichna sp. Cylichna sp.	x x x		X		9 		? ?							X		?			×																

# TABLE 3. — Distribution and stratigraphic range of fossils of the Consident mark [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

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	lemie ( is	Hunt County	Kantin ni Cu,	Nacator Co. Line-tour Co.	William Ca.	Travis Consty	Grad dups Consty	Taxa County	Medina County	Otha Norma Intratian-	Tyder mad sud u- equividents,	Anstin chalk and its requivalents
Sparies	5500, 5482, 12988, 12984, 10159–24 mi, X. by E. of Malu 15688, 1610–11, mi, S. by E. of Otk Gave 18682 - 2015, S. of Otk Grow	<ul> <li>2223 2. m. S. et Supton Bluff (now)</li> <li>(1982) - Abart a M. E. N. et Greenville</li> <li>(1982) - Abart a M. E. N. et Greenville</li> <li>(1982) - Abart a M. E. N. et Greenville</li> <li>(1911) - A. Mart a M. S. Say, (1916)</li> <li>(1912) - Abart a M. S. Say, (1916)</li> <li>(1914) - A. Mart a M. S. Say, (1916)</li> <li>(1914) - A. Mart a M. S. Say, (1916)</li> <li>(1915) - A Mart a M. S. Greenville</li> <li>(1915) - A Mart a M. S. Say, (1916)</li> <li>(1915) - A Mart a M. S. Say, (1916)</li> <li>(1915) - A Mart a M. S. Say, (1916)</li> <li>(1916) - A Mart a M. A. Greenville</li> <li>(1915) - A Mart a M. A. Greenville</li> <li>(1915) - A Mart a M. A. Greenville</li> <li>(1916) - A Mart a M. A. Greenville</li> <li>(1915) - A Mart a M. A. Greenville</li> <li>(1924) - 12 an, N. F. A Quindan</li> <li>(1924) - 13 an, S. W. a Quindan</li> <li>(1925) - 4 an S. W. a Quindan</li> </ul>	Lastric - San, Sw. Y. Quartan 15441 L 8 no, XX.W. of Tona shiing 15441 Noor Ferred 15441 Noor Kanfum	14118, 14177 - 2 nr. 8, of Costerna 14118, 14177 - 2 nr. 8, of Costerna 16457 - 4 nr. 8W of Costerna 15821, 14157 - 28 nr. 5, of Coolege	[1386] S.5 mi, N. of Cameron 14131, 15538 - 7.7 mi, W. of Cameron	[1412b] Tex. Bu. 2020 - 1 mi, W. of Kimbro Tex, Bu. 2037: Cotton from Kimbro Survey (1927-53) mi, E. by N. of M. nor- 2005, 12029, 14049, 14156, 15539, 15538, 15558, 1565, 161, 625-Onion Cr. 2015, 12029, 14049, 14156, 15539, 15538, 1565, 161, 625-Onion Cr. 2014, 15548, 15649, 15649, 5409, 5409, 1411 Coll. 46, 1 mi, S.E. of Moste's store (1438, Yaza Monen and Env. Store (1438, Yaza Monen and Env. Store (1438, Yaza Monen and Env. Store)	(4) R. (Redacond store) (7) T. (a) R. (a) Redacond store (7) T. (a) R. (b) N. (b) N. (Queury) (1) R. (c) T. (c) M. Queury) (1) R. (c) T. (c) M. Queury) (1) R. (c) T. (c) R. (c) M. Queury) (1) R. (c) T. (c) S. S. (c) M. (c) M. (c) (c) T. (c) R. (c) S. S. (c) M. (c) (c) R. (c) R. (c) S. S. (c) M. (c) (c) R. (c) R. (c) S. S. (c) M. (c) (c) R. (c) R. (c) R. (c) R. (c) R. (c) (c) R. (c) R. (c) R. (c) R. (c) R. (c) (c) R. (c) R. (c) R. (c) R. (c) (c) R. (c) R. (c) R. (c) R. (c) (c) R. (c) R. (c) R. (c) R. (c) R. (c) (c) R. (c) R.	B. Guo, San Theory SU, Dan, W. and Wannin Hollow Crock (1991). Grown and Juni SW, et Highens 90. U. M. 20, M. and Camp Travis heidaid. Hole and the many probability of the A hole and Hole and the rate of the states with the first states with the states of useff. Texa Hard, H. Stur K. S. Jaw, W. at S. Mart, Christengy (1973). Texa Hard R. M. K. Stur S. Jaw, W. at S. Mart, Christengy (1974). Texa Hard R. M. K. Stur S. Jaw, M. at S. Mart, Christengy (1975). Texa Hard R. M. K. Stur S. Jaw, M. at S. Mart, Christengy (1975). Texa Hard R. M. K. Stur S. Jaw, M. at S. Mart, Christengy (1975). Texa Hard R. M. K. Stur S. Jaw, M. at S. Mart, Christengy (1975). Texa Hard R. M. K. Hard R. Mart, S. Mart, Christengy (1975). Texa Hard R. M. Hard R. Stur S. Jaw, M. at S. Mart, Christengy (1975). Texa Hard R. Jam, S. Jaw, M. at S. Mart, Christengy (1974). Texa Hard R. Texa Hard M. at San Matonia (1974). Texa Hard, 1965, Texa Hard, 257, 2975). Stur Athonia (1974). Heider, 1965, Texa Hard, 257, 2784). Stur Matonia (1974). Heider, 1965, Texa Hard, 257, 2782). Stur, Matonia (1974). Heider, 1965, Texa Hard, 257, 2784). Stur, Matonia (1974). Heider, 1965, Texa Hard, 257, 2784). Stur Matonia (1974). Heider, 1966, Texa Hard, 257, 2784). Stur Matonia (1974). Heider, 1966, Texa Hard, 257, 2784). Stur Matonia (1974). Heider, 1974). Heider, 277, 2744). Heider, 2784). Stur Matonia (1974). Heider, 1966, Texa Hard, 257, 2784). Stur Matonia (1974). Heider, 1974). Heider, 1974). Heide	(65.56) 16.719, 17.150 [2000] S. of Chit 10052, The A. In A. The -1 to a 5 mu N. by W. of Chetroville 2055, 7576 - Neu C. A. Hu uper Shows, Media Co, depth 1.045 ft 18511 - Will no G. A. Hu uper Shows, Media Co, depth 1.045 ft 18511 - 9 and W. ar Walford, 1.56 and no.4	Komperla. Use ondelo homorien Verdinskolle na d	Testa and trupter) Decode Gape dark, mender of Testler med Weller City, sool mender of Testler med Testler near divers) Soon Meand Demodran Upen dev Upen dev	Aostro di dk. Gioverno and Aostin dadk (upper Austin) Ricoverno and Ricoven cond Ricoven cond Ricoverno dy
Porifera: Clinoa microtuberum, n. »p. Vermes: Serpula cretacea (Courad)	×	x						2	×	x x x x		
S. howiensis, n. sp. Hamulus ouy: Morton. H. squamosus Gabh H.? huntensis, n. sp. Echnoderonat: Family Bourgueticrinidae aff. Mesocrinus sp Family Ciduridae. Cardinster leonensis, n. sp. Heminater dalli Clark. H. besari Clark H. besari Clark Liuthia variabilis Sleeum? Mienster (Plesinster) americans, n. sp. Mollusca: Peleeypoda: Nucula chatfieldensis, n. sp. Nuculana longifrons (Conrod) N. sp. c		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	<	? X			XX XX X		2 2			
N. sp. Nemodon martindaleusis, n. sp. N. spp. Idouenters expax Conrad I. deatsvilleusis, n. sp. I. spp. Inoceranuus sp. c Ostrea tectico-ta Gabh. O. me-enterica Morton Gryphaca mutabilis Morton G. pella, n. stp.	x x x x x x		X	x			? x           x           ?           xx           ?           xx		× × × × ×		×× ?	?
<ul> <li>Gravin, in Sp. Somer (Morton)</li> <li>Exogyra costata Say</li> <li>E. costata spiniferă, n. name</li> <li>Trigonin custrovillensis, n. sp.</li> <li>T. eufaulensis moorei, n. vat.</li> <li>Peeten (Peeten?) venustus Morton</li> <li>P. (Camptonectes) hubonis, n. sp.</li> <li>P. (Syneyclonema?) simplicins Conrad.</li> <li>P. (Syneyclonema?) moleri, n. sp.</li> <li>P. (Syneyclonema?) moleri, n. sp.</li> <li>P. (Syneyclonema?) kingi, n. sp.</li> <li>P. (Syneyclonema?) kingi, n. sp.</li> <li>P. (Syneyclonema?) moleri, n. sp.</li> <li>P. (Syneyclonema?) moleri, n. sp.</li> <li>P. (Neithea) boxarensis, n. sp.</li> <li>P. (Amusium?) danei, n. sp.</li> <li>Spondylus muitus, n. sp.</li> </ul>								X XXXXXXXX XXX XXX XX X X X X X X X X X				
<ul> <li>S. sp</li> <li>Plicatula multicaensis Weller</li></ul>										2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		
Cremella seriea Control Lithophaga carolineness (Control) Cancolas rippuns (Control) Lateranda? robusta, n. sp. Liopicha protexta (Control) Cuspidaria grandis, n. sp. C. sp. C. sp. Veniella control (Morton) Eter sp. Astante? culchenesis, n. sp. Creasitella valost manorensis, n. var. C. sp.				X X X X X X X X X X X X X X X X X X X	X						x 2	
C (p, b) C (p, b) Stambula perplana Contrad Sanvagesia? hilli, n (p, 1) Lacina lucenia, n, pp, 1) L (p, 1) C (ndium (Granocardiam) tippaouum Contrad C (Granocardiam) (pp, 2) C (Trachycardiam) (pp, 2) C (Trachycardiam) (pp, 2) C (Trachycardiam) (pp, 2) B marcosense, n (p, 2) B marcosense, n (p, 2) Aphrodina tippora Contrad	x			?			x	? 	?	x		
C alta Contad Legunen ellipticum Contad Teues? partis Contad Telline? partis Contad T. Spp. Lancaris pectinis, n. sp. L. eribelli, n. sp. L. spp. Lepto-olen? lingulifornis, n. sp. Centophora sp. Contable crassiplica Gabb Gastrochanen ripleyana, n. sp. Pholas? pectorosa Contad Scamburgda			x x								XX	
Deutalmun sp. Giastropoida: Armael <sup>2</sup> occidentalis (Hall and Meek) Hippo-sampoide sp. Columphalus microcancelli, n. sp. C <sup>2</sup> sp. Epitonium bevarense, n. sp. Epitonium bevarense, n. sp. Epitonium bevarense, n. sp. Copular <sup>2</sup> merostratus, n. sp. Polinices rectilabran (Conrad) Amarropsis sp. Gyrodes suproplicatus (Conrad) G. rotundar, n. sp. G. petrose (Morton)	? ?					x x				X X ? X X X X X X X X X X X X X X X X X X	X	
G. superanatus, n. sp. G. spillnavai Gabb Xeoophera leptosa (Morton) Turrifilla triffar Conrad T. vertebnoides leoni, n. var. T. spp. Anchura? Isnneneis, n. sp. A.?. croki, n. sp. A.?. croki, n. sp. A.?. croki, n. sp. A.?. croki, n. sp. Medionapus? Neulomapus? Napulus spp. Hereohyneus spp. Fueus? sp. Anomalotisus? sp.	X X X X				X							
Aliofosus sp. Beliffusus sp. Ornopsis solistella, u. sp. O. sp. Donitosel? sp. Drilluta spt. Volutonorpha? sp. Caveola sp. Beretra? elongata, u. sp. Nonacteonian sp. Ringicula spp. Ellipsocaphia spp. Cylichna sp. Cephalopoda:	X X		× × ×			2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2						
Entrephocense planoventet, np. E. sop. Hamites? sp. Baculities columna Morton B. sp. Discostruphitte spp. Sphenothecus tirentis, n. sp. S. pleuriscipta (Contad) S. spp.	× · · · · · · · · · · · · · · · · · · ·		× × × · · · ·	×		×		2	× ?	x		

# TABLE 3. — Distribution and stratigraphic range of fossils of the Corsicana marl [Number at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

	Hopkins Co.	Hunt Co.	Navario County	Lime-tone Co.	• Falls County	Williamson Co.		Travi	is County		Caldwell County	Guadalupe County	Bexar Co.	Other Navarro formations,	Taylor marl and its equivalents.	An-tin chalk and its equivalents
Species	12930 – 1.5 mi. SE. of Tira 12865 – 2 mi. SE. of Tira	Tex. Bu. 73910 mi. S. SF. of Greenville 1124712 mi. SF. of Greenville	13757	141365 mi. E. of Oxoledge 17374-4.5 mi. ENE. of Cooledge 13124, 13131, 13132Well 2 mi. W. of Grow-berk	55-i:1-0.5 m. W. of Odds 17372-1 mi, W. by S. of Odds 17372-2 mi, SW. of Stanger 13776-1 http://www.wilenct.htm.	1430- San Gabriel River 0.4 mi, above San Gabriel 15537, 17570, 3 mi, SWV of Theil	14162-5 mi. W. hv. N. of Elgin 13861-31, nui. E. bv. N. of Elgin 14158, 15354-35 mi. E. of Manor	205-2058-14014 16141-3 mi. SE. of Manor 16142-34 mi. SE. of Manor 16142-34 mi. SE. of Manor Tex. Ru. 608-1 mi. E. of Kimbro Tex. Ru. 2388-2 mi. E. of Manor	Let. Bo. 2509	<ul> <li>Aristion and Packwile</li> <li>Alex 7601, 3210, 1111 Coll. 8-Near Webberville</li> <li>7492-Near Webberville</li> <li>7492-Near old Garfield</li> <li>7843-Near old Garfield</li> <li>15533-1.57 mi, NW, of Texas Hill</li> </ul>	15529-145 nu, W. of Lytton Spiruge 15777-65 miles N. of Lockhart 15528. 16151-4.5 mi. N.W. of Lockhart Fex. Bu. 1170-4 mi. N.W. of Lockhart Tex. Bu. 1173 and 1174-3 mi. N.W. of Lockhart 16119. 322 mi. NNW, of Fourtes	108752; ui, WS.W. of Staphe- 108771 uii S.F. of Zorn 7081, 7632, 7635 Nen McQueeney 169582 uii, SS.F. of Schumansville 7638, 1053- 5, of McQueeney 16389- 0.5 uii, N. of Zuehl	7685, 7729, 7721- 1.5 mi, W. of Zuchl 15518-Leon Urwk Valley 0.5 mi, above S. Pac, R. R. 15519- Leon Creek Valley 1 mi, above S. Pac, R. R.	Escondido formation Corsienca mark Nucator sand Nevgandrille mark	Taylor nord (upper) Period of the sourd provide of Taylor mark Wolfs City sund member of Taylor nord Taylor mark hower) Abmeted fine-tone San Mignel formation Upono clark Amona clark	Austin chulk Gober tongue of Austin chalk (upper Austin) Brown-town mart Bloscom sund Bloscom sund Robinan chy Robinan chy
Clioua microtuberum, n. sp Vermes: Serpula cretacen (Connid) S.? lineatu (Weller)		×								×			x		x x 2	
Hemulus squamosus Gabb . Echinodermusta: Heminster sp. Linthia? sp. Molluscoidea:										×		×				
Lingula aff. L. eubeptuhta Hall and Meek Terebrutulina noackensis, n. sp Mollusca: Pelecypoila: Nucula (iboloensis, n. sp									× ,	×x			×			
N. spp. Nuculana colorudoeusis, n. sp. N. traviaana, n. sp. N. longifrons (Contad).		×	×			c		×		x		×		××		
N. ep. a N. sp. e N. sp. f N. spp. Nemodou spp.			x		×					×	×	×				
Breviarea webbervillensis, n. sp. B. sp. Idonearea doatsvillensis, n. sp. Gervilla wellsi, n. sp.			×	×			×××	×	×× v	× ×	×××	×		?		
Ostrea tectico-ta Gabb O, falcata Morton O, mesenterica Morton Gryphnea mutabilis Morton			x						2	×	×	×	x	× × ×× ××	x ? x ? x x ?	2
G, belli, n. Sp. Grypharostrea vomer (Morton) Exogyra eostata Say Trigonia sp. Pecten (Pecten?) venustus Morton		××	× ××	×		×	××	×	× × ×	××	X	× × _ ×	x x x	×××× ××××	xx	x
P. (Comptonectes) bubonis, n. sp. P. (Syncyclonena?) simplicius Conrad. P. (Syncyclonena?) travisuus, n. sp. P. (Syncyclonena?) sp. P. (Syncyclonena?) sp.						×			× *	x x x x					x	
Plicatula spp. Lima sellardsi, n. ep. L. deatsvillensis, n. sp. L. guadalupensis, n. sp.		×								× 0 × 7 ?	×	×		×		
L. 7 accentineata texture, n. cur. Lp. Anomia argentaria Morton. Creuella verica Conrud. Cp.		×	×	×	××				× × ×	x X		x x		×××	××× × ×.	
Lithophuga cerolinen-sis (Conrad) Pholadonya sp. Homonya' thus heri, n. sp. Periplomat' sp. Conjulation grandle n. sp.			×	×						· · · · ·		x		×		
Verifiella contradi (Morton) A-tartenya fentresseneis, n. sp. Veteriondia weblervillensis, n. sp. Crassatella vadosa manorensis, n. var.			×	×	?		×××	× .	×× × × ×	× X × X × ? X	x x		×	* * * *	×?	
C, valora bezarensis, b. var. C, sp. Uddenia sp. Titanosarcollites odd-ensis Stephenson T, 2-p.					× 7					×		×				
Lactina linearia, n. sp. Cardinno (Ti.edrycardium) spp. Brevicardium quadalupense, n. sp. Aphrodina tippana Courad Counteringtia denress Courad			× ×							×	×	×		r x x x x	×	
C. alta Contrad Tenes parilis Contrad Tellina munda, np. Tp			×				×	×	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	× ?	? 			× × × ×		
Cembophora objiectus contat. Cembophora obtilis, n. sp. C. cancellosa, n. sp. C. spp Corpula crassiplica Gabb					2				×××		×	2		xx	x x	
C. spp. Pholadidea sp. Sceptopoda: Dentalium navaroj, u. sp. D. lave Steobieron			× ?	×				- ?		? ?				× ?		
D. spp. Caldulus obuntus (Conrad) Gastropoda: Acmaea? occidentalis (Hail and Meek)				×	××					× ×× ×	×		×	× ?		
Calimphalus intervencelli, n. sp. Creonella deuseni, n. sp. Pseudomelania runnelsi, n. sp. Epitonium sp.					?					x	×	×		×		
Tuba? sp. Architectonica sp. Polinices rectilabrum (Contad) P. rectilabrum texanus, n. var. P. sp.			X X X		×	?				x x x x x x x x x x x x x x x x x x x		×	×	×××× ××	×	
Amanropeis sp. Gyrodes supraplicatus (Connad) G. rotandus, n. sp. Turritella bilins, n. sp. T. userabroides invasi n. v.tr.			?	?	× ?	?	×			× × ×	×	x	? ? X	× × × × ?		
T. vertebroides lougi, a var. T. vertebroides leoni, a var. T. deutsvillensis, n. sp. T. spp.				x			×		× ,	×						
Anchurn nosekeuvis, n. sp. A. bezarensis, n. sp. A.? ciboloensis, n. sp. A.? hoggi. n. sp.						? ×		×		×			× × ×			
A.? spp. Drepniochilus texanus, n. sp. Pugnellus sp. Pyropais lauhani, n. sp. Napulus occibratus (Conrad).			?			×					×		×			
N. sp. Hercorhyncus malleiforme, n. sp. Pinella reticulata, n. sp. Seminola sp. Hydratilulus asper, n. sp.								×	, ,	××		×	× × ?			
Deussenia citoloensis, n. sp. D. mavisana, n. sp. D. multilime, n. sp.									×	2 X			×			
D. conbrs. n. sp. Aliotisus sp. Bellifusz? Jeatsvillennis, n. sp. B. multicostatus, n. sp. B. crassicostatus, n. sp.									× × ×	× × ×		X	2			
B. huffalcensis, n. sp. Ornopsis sp. Graphidule? multicostata, n. sp. G.? gabrielensis, n. sp. Pietschille? Jevis, n. sp.						×				×			× ×			
Drilluta? spp. Paleosphusa? sp. Volutanorphas? sp. Volutaderma (Langeoucha) dolli, n. sp. Fonda and a su.							×		× · · · · · · · · · · · · · · · · · · ·	×			×			
Cancellaria" matsoni, n. sp. Carcellaria, sp. Palaolmete alta, n. sp. P. elegeus, n. sp.				×					×	? ×			x			
Anadetma ? sp. Latema sp. Bereta striata n. sp. Acteon ? uitidus, n. sp. Troostella ? sp.				*					× *	×						
Tornatellass grandis, n. sp. Ringicula culbert-oni, n. sp. R. anfratellaran, n. sp. R. suffizia, n. sp. Oliveraturi, sp.										X						
Ellipsovanjuna sp. Cylicium sp. Cylicium sp. Ibaculites sp.	Ħ		X							×						
Turrilites sandersorum, n. sp. Scaphites yorkensis, n. sp. Discoccaphites roatensis, n. sp. D. spp. Scheucdiscus timensis, n. sn.	××				×			? X		2	2	×		×		
S. pleurisepta (Conrad) S. sp.	×		XXX		×					┼┼┼┼┨			<b>*</b>			

TABLE 4.—Distribution and stratigraphic range of fossils of the Kemp clay [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

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	1	<u>,                                     </u>	1	220	1 11	4	·····						
	Hopkins Co.	Hunt Co.	Navario County	Limestone Co.	• Falls County	<u>Williamson C</u>	Travis County	Caldwell County	Guadalupe County	Bexar Co.	Other Navarro formations,	Taylor marl and its equivalents.	Austin chalk and its equivalents
Species	12030-1.5 mi. SE. of Tia. 12865-2 mi. SE. of Tia.	Tex. In. 739–10 m. S.SF. of Greenville 11247–12 mi. SF. of Greenville	17375-3,5,8, m, XNW, of Bazette 17375-3,5, m, XNW, of Bazette 12921-4,5, mi, NE, of Ruane 12922-3,5, mi, NE, of Ruane 12922-3,5, mi, NE, of Cosienta 17307-3 mi, SE, of Cosienta 17107-3 mi, SE, of Cosienta 14138-741616,5, mi, SW, of Currie 14138-17377-Brouch 0,5, mi, SW, of Currie	11:0:1-0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0	15421 0.5 mi. W. of Odd. 17323-1 mi. W. by S. of Odd. 17323-2 mi. W. by S. of Odds 13752-1 mi. Sw. of Stemper Millan, Cu. Jine 13751- Parson River 2 mi. above Millan, Cu. Jine 15430-5an Galriel River 0.4 mi. above San Galurid	1.005 (12010) 5 m. SW, of thall 1.005 (12010) 10 N, of the 1.005 (12010) 10 N, of Manor 1.015 (1254) - 3.5 mi, E. of Manor	<ul> <li>Dist. Ameri Janis, Ali Manor</li> <li>Dist. Ameri Janis, Si, of Manor</li> <li>Dist. Rai, Sils. J. Manor</li> <li>Tex. Bu. Sils Jani, E. of Manor</li> <li>Tex. Bu. Sils Jani, E. of Manor</li> <li>Tex. Bu. Sils Jani, S. of Manor</li> <li>Tex. Bu. Sils Jani, S. of Manor</li> <li>Tex. Bu. Sils Jani, S. of Manor</li> <li>Tex. Bu. Sils Jani, S. of Manor</li> <li>Tex. Bu. Sils Jani, S. N. of Detaville</li> <li>1128 Jani, S. W. of Detaville</li> <li>1128 Jani, S. W. of Detaville</li> <li>1128 Jani, S. W. of Detaville</li> <li>1128 Jani, S. W. of Detaville</li> <li>1128 Jani, S. W. of Detaville</li> <li>1128 Jani, S. W. of Detaville</li> <li>1128 Sond. Janor</li> <li>1128 New of detaville</li> <li>1128 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of detaville</li> <li>1131 New of</li></ul>	[5520-4.16 mi, W. of Lytton Springs [1577: 16 mills: N of Lockhart [1558: 16161-4.5 mi, NW, of Lockhart [558: 161, 1130-4.1 mi, NW, of Lockhart [78, Bu, 1137-4.1 mi, NW, of Lockhart [78, Bu, 1137-4.1 mi, NW, of Lockhart [79, 19] 101, 10, 22 mi, NNW, of Fentres.	[10875-22] mL WSW, of Staples 10877 - 4 mi SE, of Zorn 10814, 7632, 7633, - North McQueeney 103035-22 mi, S. SE, of Schumansville 7638, 15523-5, an McQueeney 165819-035 mi, N. of Zuebl	7085, 7720, 7721 - 1.5 mi. W. of Zuehl 15548-Leon Creek Valley 0.5 mi. above S. Pac. R. R. 15549-Leon Creek Valley 1 mi. above S. Pac. R. R.	Escondido formation Corterna mart Naeutoda sund Nevelandrile mart	Taylor mul (upper) Real Cap menter of Taylor murf Rolls City sund neurober of Taylor murf Taylor mul tower) Amarzho line-tone Sian Miguel formation Upon chur	Aistin chulk Gober congue of Austin chalk (upper Austin) Browstown mail Browstown stud Bromstown stud Bront corgue of Austin chalk (lower Austin)
Porifera: Cliona microtuberum, n. sp.		×									×		
Serpula cretacea (Conrid) S.? lineata (Weller)	-									×	XXX X X	× × ?	
Echinodermata: Hemiaster sp.	E								x				
Molluscoides: Lingula aff. L. subspatulata Hall and Meek	E		× × ×		╏						×		
Molluwa: Pelecypoda:	Ħ												
Nucula ciboloensis, n. sp. N. spp. Nuculana coloradoensis, n. sp.	E	×			╆╌┾╼┥┥ ┫┥┥┥┥┥┥ ┫╴┧┥┥┥┥┥				X				
N. travisana, n. «p. N. longifrons (Courad). N. sp. d			x		×				×		xx		
N. sp. e N. sp. f N. spp.			x	#	×		× · · · · · · · · · · · · · · · · · · ·	×					
Nemodon spp. Breviarca webbervillensis, n. sp. B. sp.			x	×	×			xx					
Idonearen deatsvillensis, n. sp. Gervillia wellsi, n. sp. Pteria? son				++-	╉ <del>┊┊┊┊╡┥</del>	×××			×		?		
Ostrea tectico-ta Gabb O. falcata Morton O. mesenterica Morton	Ħ		×				×		x	×		x ? x?	2
Gryphaea mutabilis Morton G. belli, n. sp. Gryphaea tree yongy (Morton)			x					X X X		×	X X X X X X	x x ?	? 
Exogyra costata Say Trigonia sp Posten (Pecter 2) venustus Mortos		××	× ×××	×	×	×× :	× × × × ×	x	x x x ?	x x x	××××		
P. (Camptonectes) bubonis, n. sp. P. (Syneyclonema?) simplicius Conrad P. (Syneyclonema?) travisatus, n. sp.	Ħ								×	×	? X' X'X X	x x	
P. (Syncyclonema?) sp. P. (Amusium) sp. Plicatula sop		×					×						
Lima sellardsi, n. sp. L. deatsvillensis, n. sp.	H						X	×	×		×		
L.? aentilineata texană, n. var. L. p. Anomia argentaria Morton	Ħ	×			╆┼┼┿┿╉ ┠┾╍┥╅╂			×	x x		××××	xxx x x	
Crenella serica Conrad Cp. Lithenbarga carolinensis (Conrad)	+			×	××				×		x		
Pholadomya sp. Homonya? thra-heri, n. sp. Perinloma? sp.							×						
Cuspidaria grandis, n. sp. Veniella conradi (Morton) Astartenya fentressensis, n. sp.			? ×		?	×××	×× × ×	x x		×	××××	x ?	×
Vetericardia webbervillensis, n. sp. Crassuella vadosa manoreosis, n. var. C. vadosa besarensis, n. var.				×	?	×××	X X X X X X ? X	x		x x	? X		
Cp. Uddenia -p. Ti nosarcolins addsensis Stephenson	Ħ				× ?		×		×				
T.? sp. Lucina lioearia, n. sp. Cordium (Truchycardium) sup.			× ×					×			?		
Brevicardmin quadalupense, n. sp. Aphrodina tippana Counid Cyprimeria degressa Conrad.								? X	×		xx xxx	×	
C dta Coorad Tenea parilis Conrad Tellina muoda, n. sp.	Ħ					×	× × ?	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			X XXX X		
T. sp. Leptosolen biplicatus Conrad Cymbophora subrilis, n. sp.	Ħ		× .					×	?		x x x x		
C. cancellosa, n. sp. C. spp. Corbula crassiplica Gabb	Ħ		╶╾╴					X			xxx	x x	
C. spp. Pholadidea sp. Scaphopoda:	Ħ			<b>x</b> .									
Dentalium payaroi, np. D. leve Stephenon D. spp.	Ħ		× ?	×	××					×	?		
Cadulus obuntus (Contad) Gastropoda: Acmaen? occidentalis (Hall and Meek)	Ħ		×		×					×	x x		
Pseudomalaxis? «p. Calliomphalus microcancelli, n. sp. Creonella deusseni, n. p.	Ħ				?						<b>x</b>		
Pseudomelania runnelsi, n. sp. Epitonium sp. Tuba? sp.	Ħ							x	×				
Architectonica sp. Polinices rectilabrum (Conrad) P. rectilabrum texanus, n. var.	Ħ		×	+++-	?				×	×	×××× ××	X X	
A mauropsis sp. Gyrodes supraplicatus (Conrad)			?	,			×		X	? ?	×× ××?		
Turritella bilira, n. sp. T. vertebroides jonest, n. var T. vertebroides longi, n. var	Ħ		2		× ?	×		×	×	×			
T. vertebroides leoni, n. var. T. deatsvillensis, n. sp. T. spp.	Ħ			×		× .							
Cerithium sp. Anchura noackensis, n. sp. A. bexarensis, n. sp.	Ħ			<b>†</b>	?,					×			
A.? ciboloensis, n. sp. A.? hoggi, n. sp. A.? spp.	Ħ		╶ <del>╸╸╸╸╸</del> ╺╼╼╼╼╼╼╼╼╼╼ ╼╼╼╼╼╼	×			x x x			Â.			
Drepanochilus texanus, n. sp. Pugnellus ap. Pyropsis lanhumi, n. ap.	Ħ							×		×			
Napulus octobratus (Conrad). N. sp. Hercorhyncus nalleiformø, n. sp.	Ħ					×	×			×			
Seminola sp. Hydrotribulus asper, n. sp.			x						×	?			
Deussenia ciholoensis, n. sp. D. travisana, n. sp.										×			
D. corbis, n. sp. Aliofusus sp. Bolifusus? deutsvillensis, n. 80.				+-+-			× ×		x	7			
B. multicostatus, n. sp. B. crassicostatus, n. sp. B. hyffalcensis, n. sp.	E		×										
Ornopeis sp. Graphidula? multicostata, n. 9p. G.? gabrielensis, n. sp.	Ē				×					×			
Piestochilus? levis, n. sp. Drilluta? spp. Paleosephaet? sp.					×					Â.			
Volutomorpha? sp. Volutoderma (Longoconcha) dalli, n. sp. Eoancilla acutula, n. sp.	F				┟┼┼┼╂╉								
Cancellaria? matsoni, n. sp. Caveola sp. Paladimete alta, n. sp.	Ħ			×	┟┼┼┼╀╀	╂┼┼┼				x			
r, ciegans, n. sp. Anulletum? sp. Lutema sp. Boost	Ħ	╞┼┨		Î	╏╪╪╪╂╁								
Derem strata, n. «p. Acteon? nitidus, n. «p. Troostella? «p. Toostella? «p.	Ħ						× × · · · ·						
Romanenaa grunns, n. sp. Ringienla culbertsoni, n. sp. R. anfraetolineata, n. sp. R. suffaetolineata, n. sp.	Ħ			H		┋┼┼╡							
Oligoptycha americana (Wade)? Ellipsovcapha sp. Cylichna sp.	F		×	X									
('ephalopoda: Boculites *p. Turrilites sandersorum, n. *p.	F	x			×								
Scaphites yorkensis, n. sp. Discoscaphites rosaensis, n. sp. D. spp.	E		×××		×								
Sphenodiscus tirensis, n. «p. 8. pleurisepta (Conrad) 8. sp.	××				×	╏				×	xx		
Belemnitella americana (Morton)		L AL		ن ا ا		I had		أيرا المحسين	أير الطبية والمعادسة	أسلينا	10101	ألبط فعليا المشعلية	أسلسا سانعا عالم

 TABLE 4.—Distribution and stratigraphic range of fossils of the Kemp clay
 [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated.
 Full descriptions of localities are given elsewhere in the text]

## TABLE 5. Part 1.—Geographic and stratigraphic range of fossil species of the Navarro group [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

		т	'exas		Atkansas	Tennesee	Northeru Mississippi	East-central Mississippi	Central and west-contral Alabama	Erst-central Aldania and Chattahoachee region (AlaGa.)	Carolinas	Maryland,	Delaware	New Jersey	Western Interior
Species	Natto group (Liogyra volato zone) volato zone)		Equivalents of Taylor mark	(uppet Austin) Joner Anstin)	llinia zamo) } Éicoggra vostata some voggra ponderosa zone	tiples (np. part of E. cancellata zone) v. (hw. part of E. cancellata zone) v. (Exoner porderosz zone)	$E_{i}$ and $E_{i$	Eregiera castata cone Eregiera castata cone ado con muci mol unte of Eragera moderosa cone)	E. contra nome [Schma chalk and sundy E. contra nome [Schma chalk and sundy unterson rance] contradictic (Ripley) next suit of Eingen punderson zone)	Ripley humiton Eugera rostata zone Ecugra pontersa zone	Prodec formation (Elogyra costata zone) ck Preck fin. (upper part of E. genderosa zone)	Exopper costale rowe) capper roaderose rowe)	ugyra vanællata 2016)   Ekuyyra ponderosa 2010	$m$ elida sme $\left\{ F_{i}$ ogyra cosata zone $\left\{ F_{i}$ egyra ponderosa zone	ndor of Lance formation t and equivalents and equivalents
	Escondido formation <sup>1</sup> Komp clay Corsterna mart Sacatoett sand Neetlandville ml. t <i>E. ca</i>	Tay lor (upper) Peens Gap chalk memb Wolte City sand membe Taylor (lower)	Anaceto fine-tone San Migael formation Upon clay Aurona claik	Att-tin -btalk Goher tongue of Att-tin Brown-down mart Blossom sund Boulour e lay Feren engene of Anstin	Arkadelphta mail Nacatesh sund Suttanya chalk ( $k$ $ono$ Mathjorok mail Aunona chalk Ozan formation	Rewnstown mart 1 Com Creck tongue at 1 Schur ch, and sdy, equi Schur ch, and sdy squi	Owl Creek formation Replay formation Selma chalk ( <i>Coupper</i> Selma chalk (tripter par Coffee soul (hower part Tombelier soul (hower	Pranto Eliafi chalk Upper part (at Solma) <i>E-segger concelleta zone</i> Lawer part ( <i>E-organ p</i> Tambigler sond (bowen	Pranto Bluff chaik Upper part (of Schna) E. concellate zone Lower part (Ecopargu p Tranhigher and theory	Providence sund Upper peri E-opper envillede zom E-opper sond Consets sond Consets sond Consets sond Consets sond Consets sond	l pper part Erogen errertlede zon Erogen Hill men, et Bis	Monnouth burnation v Matawar forgetion (E	Mount Laurel sond ( <i>E</i> ) Marshalltown formation Crosswicks clay	Red Ruck stud Navesiak nurd Monut Laurel stud (Z. Wennia stud Maschilftown fatmation Woodbury Gr.	Comontall marine me Fox Hills sund-tone Pierre shale, upper par Pierre shale, lower part
Porifera: Cliona microtuberum, pp			2			× × + + + + + + + + + + + + + + + + + +						x ???			
Cardiaster lements, 0, sp							x		2		X				
Mullus-oiden: Langula aff L. sub-patulato Hall and Meek Terbuntulina noaekeesis, o. sp. Mollissa: Peleeypola: Soleniya bilix White?. • Nucuti perceptifs Control N. elutifeldensis, u. sp. N. elutifeldensis, u. sp. N. elutifeldensis, u. sp. N. elutifeldensis, u. sp.								X							× × ×
N. waltomensis, n. sp. N. noratochana, n. sp. N. sp. Nuchtana cosia ana, n. sp. N. colaraboneris, n. sp. N. travisana, n. sp. N. travisana, n. sp. N. honstoni, n. sp. N. honstonis, n. sp. N. subjettensis, n. sp. N. subjettensis, n. sp.							xx			× ×					
Nemodou grandis navartoanuts, h. vat. N. bowiet, n. sp. N. mattinddensis, p. sp. N. mattinddensis, p. sp. N. enfailensis huratus, n. vat. N. spp. Glycymeris totundata kaufmanensis, n. vat. G. spp. Linter aentata Stephenson Breviana plummeti, n. sp.															
B. nolani, n. sp. B. webbervillensis, n. sp. B. webbervillensis, n. sp. Idomanca powersi, B. sp. I. kingscrois, n. sp. L. capex Control I. deatscullensis, n. sp. I. marrayt, n. sp. L. marrayt, n. sp. Limogsis meeki Wade							X	x	x						
Gervilla piss en ilotitis extensi, to sur- Gervilla la tayani, np. G. wellsi, np. Lancerannis vanistenii Meek and Hayden? Jpp. Pietra? Tinguaeformis (Evans and Shutmard) Ppp. Ostro- owenana Shutmard O. ponda Morton - O. ponda Morton				×××××××							XX?	x			
<ul> <li>O. tecticesta Gabb.</li> <li>O. plumosa Morton</li> <li>O. faleata Morton</li> <li>O. faleata Morton</li> <li>Graphasa mutolifis Morton</li> <li>G. belli, u. sp.</li> <li>Graphasa mutolifis Norton</li> <li>E. costata Stephenson</li> <li>E. costata spinifera u name</li> <li>E. costata spinifera u name</li> </ul>			× × ? × ? ?				XXXXXX XXXXXX XXXXXX XXXXX XXXXX XXXXX XXXX					x x x			
Trigomia castrovillensis, n. sp. T. stantoni, n. sj. T. enfanlensis gabbi, n. var. T. enfanlensis mootei, n. var. T. spp. Petero (Peters) vennetos Morton P. (Camptonectes) bubonis, n. sp. P. (Camptonectes) bubonis, n. sp. P. (Syney-homena?) simplicins Contrad. P. (Syney-chomena?) archeria (n. sp. P. (Syney-chomena?) archeria (n. sp.	× × × × × × × × × × × × × × × × × × ×				x		x	x x ?	×	x x x x	? × ×	x	×××	× ?	
<ul> <li>P. (Symychonema?) twitte, 0, sp.</li> <li>P. (Symychonema?) twittsinuts, n. sp.</li> <li>P. (Symychonema?) sp.</li> <li>P. (Neitheal bearrenists, n. sp.</li> <li>P. (Anursium) sp.</li> <li>P. (Anursium) sp.</li> <li>P. (Radiopecten) mississippiensis Conrud?</li> <li>Spondylus munitus, n. sp.</li> <li>Spindylus munitus, n. sp.</li> <li>P. Ristingerten) mississippiensis Conrud?</li> <li>Spindylus munitus, n. sp.</li> <li>P. Batopic Conrud?</li> <li>Spindylus munitus, n. sp.</li> <li>B. sp.</li> <li>Plicatula nullicensis Weller?</li> <li>Potensi Conrud?</li> </ul>			?		×	X	X	x	x.		X			×	
<ul> <li>P. Jerna Contait.</li> <li>P. spin.</li> <li>Lima sellardsi, n. sp.</li> <li>L. pelagia woolsey, n. var.</li> <li>L. deatsvillensis, n. sp.</li> <li>L. geronimoensis, n. sp.</li> </ul>	XX           X           XX           XX														
L. spp. Anomia tellimodes Motion •A. argentata Motion Pulvinites? argentous Contad Voledla uddeni, u. sp. Crenella serica Contad C. spp. Lithoptaga carolinersis (Contad) Cunedus tippomus (Contad) Charles and Carolinersis (Contad) Charles and Carolinersis (Contad) Charles and Carolinersis (Contad) Charles and Carolinersis (Contad) Charles and Carolinersis (Contad) Charles and Carolinersis (Contad) Charles and Carolinersis (Contad)									× × ×			x:x x ?			
<ul> <li>1. * point a third berg, n. sp.</li> <li>Laternola 2 substituta ("binnard)"</li> <li>L.? subletis, n. sp.</li> <li>L.? battooit, n. sp.</li> <li>L.? battooit, n. sp.</li> <li>L.? battooit, a sp.</li> <li>L.? battooit, a sp.</li> <li>Partineya anternaliata texano, n. vat.</li> <li>Periploma? edward-i, n. sp.</li> <li>P.? sp.</li> <li>Liopistha protexta ("onnad")</li> <li>L. formes, n. sp.</li> </ul>			x		× x	X	××.	X	×	xx	X	x	X	XX X	
Cymedla hella texma, n. yer. Co-pidaria grandis, n. sp. C. grovenis, n. sp. C. spp. •Veniella controll (Morten) V. limeta (Shamard) Etea constema, n. sp. E. persei, n. sp. E. persei, n. sp. Astartenya fentressensis, n. sp.			?			XX		× ××	x			××	×××	x · v · x	
A drafter conferences, in sp. Veterierarlia weldow villensis, n. sp. Crassitella vadosi manorensis, n. var. C. vadosi bevarensis, n. var. C. vadosi bevarensis, n. var. C. vadosi cellenensis, n. var. C. quinkanensis, n. sp. C. spp. Uddenia tevana, n. sp. U. spp. U. spp.						×	X			×					
Titamosarcadices oddecosis Stephenson, T <sup>2</sup> spp. Sauvagesia? hilli, n. sp. Durania? -p. Lacina purvilineata Shumard L. mattiformig, np. L. chatticidana, np. L. chatticidana, np. L. seminolis, np. L. okodorsum, np.															
<ul> <li>L. Spp.</li> <li>Unicardium?, spp.</li> <li>Scintilla? rangoni, n. sp.</li> <li>Carluma (Paelycardium) walei, n. sp.</li> <li>C. (Paedycardium) velleri, n. sp.</li> <li>C. (Erhmeeratium) welleri, n. sp.</li> <li>C. (Granecardium) delamum), n. sp.</li> <li>C. (Granecardium) delamum), n. sp.</li> <li>C. (Granecardium) tosset n. sp.</li> <li>C. (Granecardium) tosset n. sp.</li> <li>C. (Granecardium) theli, n. sp.</li> <li>C. (Granecardium) theli, n. sp.</li> <li>C. (Granecardium) theli, n. sp.</li> <li>C. (Granecardium) theli, n. sp.</li> <li>C. (Granecardium) theli, n. sp.</li> </ul>								×		2					
C. Granoczadium) -pp. C. (Trachyczadium) edianlen-e huntanum, n. v. C. (Trachyczadium) -pp. Brevieroflum fragile, np. B. tenne, np. B. gualduperse, np. B. marcesterie, np. B. sp. Iscentia hubbes, np. I. hendersoni, np. I. hendersoni, np.							X								
L shumardi, n. sp. Aphratina tippina Courad . A. neverrana, n. sp. Cyprimeria depressi Courad . C. noncend. C. concensis, n. sp. Lagunon ellipticum Courad . *Tenea parilis Courad . Cyclorisma 2 pumila, n. sp. Tellina munda, n. sp.	2 × × 2 × × × × × × × × × × × × × × 2 × × 2 × × 7 × ×				x	× × × ×		X			× · · · ·	x x x x x x x x			
T.? matrosensis, n. sp. T.? patha, n. sp. T. spp. Limearia wisserae, n. sp. L. pertinis, n. sp. L. ribelli, n. sp. L. natarroaua, n. sp. L. spp. Solyma gardnerae, n. sp. S.? patya, n. sp. ************************************						×	XX			xxxxxx	x x				
L. <sup>4</sup> quadrilaterus, n. sp. L.2 linguliformis, n. sp. L.2 longuliformis, n. sp. Cymbophora scaleffun, n. sp. C. suballs, n. sp. C. cancellost, n. sp. C. berryi Gardner, C. birryi Gardner, C. inflata, n. sp. C.2 - impesimensis, n. sp. C. sp.															
Corbula crassiplier Gabb     C. willardt Wade     C. totta, n. sp.     C. rockensis, n. sp.     C. rockensis, n. sp.     C. indivadiata texana, n. vat.     C. linterioldea, n. sp.     C. wordl, n. sp.     C. willata, n. sp.     C. indiata, n. sp.						X									
<ul> <li>Costrocations representations of specific sectors and sectors and specific secto</li></ul>							X					X			
D, pauperculum Meek and Hayden D, spp. Calubis objuitus (Courad)						×				x x	?	4		×	

Only the species that are common to the other formations of the Navarro group are recorded here. The E-condido carries a large fanna that is not treated in this work.
 Present also in the Niobrara linestone below the Pietre shale.
 Reported also from the upper part of the Tokio formation below the Brownstown mark.
 Reported also from the Magothy formation below the Merchantville clay.

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### TABLE 5. Part 1.—Geographic and stratigraphic range of fossil species of the Navarro group [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

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				T	T		<b>1</b>				T			L L
		Texas		Arkaasas	e	rthern si-sippi	t central sissippi	otral and stscotral abuna	4-central abama and attabochee jion (AlsGa.	tolina+	ryland	Linure	New Jersey	etern Interio
	-	011¢)			T <sub>et</sub>	<u>22</u>	ŔĊ	dy (; ) MF	zone Ea Al Ch reg	one) ("	ĨW	Ť		W.
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	lo formation loy a mart 1 sand Aille nd <i>(1</i>	upper) ap chalk m ity saud m lower) or finu-tone wel formati	Lov chaik hidk ongue of Ar own mart sand celay	philo mark be-and rehalk ( <i>E.</i> ok mark chalk thattor	nek tongne h, and silv. h, and silv.	A. formation bernation halk ( <i>Ersey</i> halk rupper and Jower her sand do	Butt dadk set tot Sch er transfiela set t <i>Lisgue</i> bee send the	Blaff (Laff ant 1of Sch <i>floto 2</i> and ant ( <i>Ecopy</i> base and (b	ios - stud act i <i>stran llata</i> - stud vis formation samation	ort comerliata fill mem of	uth tormati u formation Lannel sand	lltown form	A mert A mert Lannel sand 1 sand 1 sand Brown form ury clay	Aall marine Its sendston Inde, upper Itale, lower
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<ul> <li>Hamilus on y Mottou</li> <li>H. spinnoen Gido</li> <li>H. spinnoen Gido</li> <li>E hinodemata:</li> </ul>	× x × x	x x x 1- x x	2 X X X							×	? ?			
Conflicter Fernensis, 0, 56 Henniseter dolli Clark H. bezari Clark H. benhurensis, n. 56 H. sn.														
Linthia varabilis Slovum? Lp. Micraster (Plesiaster) americana, np. Family Cidaridae						×		?		×				
Mollaciolaet Liogula aff L. sub-patilata Hall and Meek Terchatalina nonckensis, n. sp. Molluscy	<b>X X</b>													xxx
<ul> <li>Solenya bilix White?</li> <li>Solenya bilix White?</li> <li>Niceth peregadic Courad</li> <li>N. chadoensis, n. sp.</li> <li>N. chadioblensis, n. sp.</li> </ul>						× · · · ·	X ++++++++++++++++++++++++++++++++++++		x x x					x.x ?
N, mierostriata Gardner N, waltonensis, n. sp. N, noratoethana, n. sp. N, spp. N, spp. Nneukana consistana, n. sp.														
N. coloradocceis, np. N. travisana, np. N. honstoni, np. N. conhetensis, np. N. conhetensis, np.					x									
N. spp. Nemodon grandis navativanuts, n. vor. N. bowiet, n. sp. N. adkinsi, n. sp.														
N. mathalaenes, op N. enfauleeis limatu, o. vat. Npp. Glyckneris rotundata kaufinanensis, n. vat. Gpp.														
Linter aentata Stephorson Breviana plummeri, np. B. nolori, np. B. weblervilletisis, np. B. sp														
Idmirara powersi, n. sp. 1. kmgasreis, n. sp. 1. capax Comrad 1. deutsvillensis, n. sp. 1. marrari n. sp.	X X X X X					x		× 1 · · · ·						
L, spp. Linopois mecki Wade Gervillingis confininis yctoroa, n. vur. Gervillingis pryani, n. sp. Gervillingi pryani, n. sp.					×									
G, wenst, n. sp. Inocertations variation Meek and Hayden? I spp. Pteria? linguacformis (Evans and Shumard) P.? - pp.														
Ortea ownana Shumard O. ponda Morton O. congesta Conrad O. terficesta Gabh O. phuness Morton		x x x x x ? x	×× ×× ×××		×××	××××××	x x x x x x x x x x	×× ×××××	x x x x x x x x	××? ×××	x			×x²
<ul> <li>O. fakata Marton</li> <li>G. nesenterica Marton?</li> <li>Gryphase mutabilis Morton</li> <li>G. belli, n. sp.</li> <li>G. belli, n. sp.</li> <li>G. bellis are summer (Marton)</li> </ul>	X XX XXX XXX XX XX XX	X X ?				x x x x x x x x x x x x x	x x x x x x x x x x x x x x x	x x x x x x x x x x x x		x x x x x	x x x x	× × × ×		
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T. stantoni, np	x x 2 2 2 2 2					×	×	×	····	?			< <u>x</u> ?	
<ul> <li>P. (Comptonectes) banhonis, n. 95.</li> <li>P. (Comptonectes) kantinamensis, n. 85.</li> <li>P. (Syncyclonena?) simplicity Control</li> <li>P. (Syncyclonena?) atcheri, n. 9.</li> <li>P. (Syncyclonena?) atcheri, n. 9.</li> </ul>	7 X X X X X 7 X	×	×	X X			2			××	×××	×××		
P. (Syncychonena?) travismus, n. sp. P. (Syncychonena?) sp. P. (Neithen) bexarrous, n. sp. P. (Amusium?) danei, n. sp.														
<ul> <li>P. (Antiopeten) mississippiersis Control?</li> <li>P. Radiopeten) mississippiersis Control?</li> <li>Spondylas munitus, n. sp.</li> <li>S. sp.</li> <li>Plicatula multicaensis Weller?</li> </ul>		× ?		×	×	×	×	×		×			×	
P. terica Control <sup>9</sup> . P. spp. Lima sellardsi, n. sp. L. pelagica woolseyi, n. str. L. deatsvillensis, n. sp.														
L. cokei, b. sp. L. geronimeensis, b. sp. L. guadalupensis, b. sp. L. 7 acutilineata texatta, b. ya. L. 8. kubureensis, b. sp.	× ? X X X X X													• • • • • • • •
L.2 Styrei, u. sp. L. spp. Anomata Ellinoides Morton • A. argentaria Morton Bolacito 2 scenatura Control		× × × ×	×				×	× ××× ×	× ××××××	××××	×××	×××	× × ××	
Vulsella addaria, n. sp. Vulsella addaria, n. sp. Crenella scrica Connel C. spp. Lithophaga carolinencis (Conned)				××		x x	x	×	××	x x	x			
Cuncolus (appants (Contad) Pholodomya littlei Gabb P. sp. Homonya thrasheri, n. sp. Lateroula? suleatina (Shumard)?									×××	×				
L. 2 sublevis, n. sp. L. 2 robusta, n. sp. L. 2 bartoni, n. sp. Anatinya anteradiata texana, n. vat. Periolama 2 edwarbi, n. sp.														
P.2 sp. • Liopischa protexta (Conced) L. formesa, n. sp. Cynnella hella textana, n. var. Consideria regulis, n. su.	× ×× ×× ××	× ×	x	××	×	×× ×	x	×	××	× ?	××		××××	
C. grovenisk, co. sp. C. spp. •Veniella contadi (Monton) V. limenta (Shumaud)		× ?	X		(x	xx x	x xx	x x	×× ××		×××	××	× × •× ×	
E. parasi, n. sp. E. parasi, n. sp. E. spp. Astatemya feutresensis, n. sp. Astate: culchrensis, n. sp.	X X X X													
Vetericardia weblewyllensis, n. sp. Crussifeli, vados i maiorensis, n. var. C, vadosi chattieldensis, n. var. C, vadosi dexarensis, n. var. C, vadosi celatensis, n. var.														
C. quintanensis, n. sp. C. spp. Uddenait texana, n. sp. C. spp. Scondula perplana Control					×	x			×				x x	
Titanosarodito addsensis Stephenson T.? spp. Sanvagska? billi, n. q. Durania? ep. Lacina navidineata Shumard														
L. mattiformis, np. J. linearia, np. L. chattieldana, np. L. seminolis, np. L. seminolis, np.	X ? X ? X													
L. orconstant, n. 19 L. esp. Unicardinus?, epp. Scinilla? mound, np. Cardium (Pachycordium) wadei, np.														
C. (Echnocardian) velleri, n. sp. C. (Echnocardian) velleri, n. sp. C. (Granocardian) deltanum, n. sp. C. (Granocardian) rosse, n. sp. C. (Granocardian) boyetae, n. sp.				?										
C. (Granocardium) tholi, n. sp. C. (Granocardium) tippoutin Coural C. (Granocardium) sp. C. (Trachycardium) enfinitence humanoum, n. sar, C. (Trachycardium) sp.						X	<b>X</b>		?					
Brévierwlinn fragilé, n. sp. B. tenne, n. sp. B. gnad/dopense, n. sp. B. marcosense, n. sp. B. n. sp.	x x x													
Foreirtha bulbosa, n. sp. 1. headersoni, n. sp. 4. irclandi, n. sp. 1. shumardi, n. sp. 3. shumardi, n. sp.					×	×x			××	x	×			
A) pursua a triptona s p. A.2: navarroana, n. sp. C primeria depressi Contai C, alta Contai C, conums, n. sp.		×		× >>	x x	x x x x x x x x x x x x x x x x x x x	x		×× ×××	? X	× × ×		×	
• Taegimen ellipticum (minu • Taeta partilis Conrad Cyclotrisma? pamila, n. sp. Tellina munda, n. sp. T. narrosensis, n. sp.	? x x x 7 x 				×	××			× × ?		××			
T.? potula, n. sp. T pp. Jinearia wieseme, n. sp. L. pertinis, n. sp. L. cribelli, n. sp.														
L. navarroana, n. sp. L. spp. Solyma gatdnetae, n. sp. S. <sup>9</sup> parva, n. sp. *Leptosalen binlicatus Control					x	××			×× ×××	x x	×			
L. <sup>2</sup> quadrilaterus, n. sp. L. <sup>2</sup> Inguliformis, n. sp. L. <sup>2</sup> Lovis, n. sp. Cymbophora scabeflum, n. sp. Cymbophora scabeflum, n. sp.														
C. cancedlosi, n. sp. C. herryi Gardner C. indixta, n. sp. C. indixta, n. sp. C. indixta, n. sp.														
<ul> <li>- pp.</li> <li>• Corbuta consciplica Gabb</li> <li>C willardi Wade</li> <li>C totta u. sp.</li> <li>C torka u. sp.</li> </ul>		× ×			×	×			XXXX			××		
C. subpaliata texana, n. var. C. linteroidest, n. sp. C. woodi, n. sp. C. inflata, n. sp. C. spp.	X X X X X		┥╾╊┽┿┿┿ ┿╋╋┿╋┿┿┿											
Panoje-subplicata Shumard Gastrochaena iiplevaua, u. sp. Pholalible mgeddensis, u. sp. Pp. Y. oplevanlie whitneyi u. sp.	× 7 × 7 × ×				?	××		?						
Goniochasma scaphoides, n. p. Rameetia whittieldi, n. sp. Pholas? pectorest Conrad Scaphopeda:						x								
D, navatroit, n. sp. D, navatroit, n. sp. D, leve Stephenson D, panperculum Meek and Hayden D, pp.	? X X ? X X X X X ?								x x	×	2			××

Only the species that are common to the other formations of the Navarro group are recorded here. The Excondido carries a large fauna that is not treated in this work.
Present also in the Niobran limestone below the Pietre shale.
Reported also from the upper part of the Tokio formation below the Brownstown mark.
Reported also from the Magothy formation below the Merchantville elay.

 TABLE 5, Part 2. — Geographic and stratigraphic range of jossil species of the Navarro group
 [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given elsewhere in the text]

	Texas	Arkansas 25-000-2	Northeau Mississippi	Essentral Mississippi	Central and west-central Malema	East-central Alabarna and Chattabroochee region (AlaGa	Cuolinas	Maryland	Delaware	Now Jersey	Western Interior
	(אוסי גיסע קאונים) ויין שיולסיבן (אוס	fa zone) data zone) z zone)	nistata 2011e       284 ZOTIE	Selina chalk wa zane)	halk and sundy lents (Ripley) 'osa zone)	onor nafala zono	iyra vaslada zone) E. muderasa zone)			u castata zosue e	
Species	Navarto gi aner ) v <i>olsta z</i> u yler nart i <i>Kangur</i> lente of Taylor mar (ustan)	$\left\{ E_{inggrave cost} \\ E_{inggrave cost} \\ indervoer zone \\ indervoer zone \\ indervoer and line \\ interval$	zone) Erggyen yn ponderwar zone) of Erggyer ponder	ara astata zane zane) of Ezugra panda	ata zone   Sohna e zone)   cquiva of E-cone ponder	ev formation $\left  E_{i} \right $	les formation ( <i>Ezo</i> g fin (numerant of	endata zone) adazoen zone)	wellata zawe) 1914: ponternsa zam	la soure)   Erogyn 14 soure)   Erogyn	ance formation itvalents ivalegts
	$\begin{array}{c} \begin{array}{c} & \text{unition} \\ 1 \\ & \text{in } (E, construction) \\ 0 \\ \text{in } (E, construction) \\ 0 \\ \text{in } (E, construction) \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ $	of Att-tin (lower A mart) & G. smochata zu at Excipto p mart) Excipto p mart) Excipto (u towart) Excipto (u	rmation fion <i>Eogramment of Eog</i> upper part of <i>Eog</i> od chowerment part	$e_{11,1}$ (A. $e_{11,1}$ (A. $e_{12,1}$ (A. $e_{1$	Alalk d Selmoi   E vod zane Evergan pooderesa	$\left. \frac{1}{dtate} \left  \frac{1}{t_{total}} \right _{E_{total}} \left  \frac{1}{t_{total}} \right _{$	<i>illate so</i> ac   Peee on of Black Creek	an don't <i>broppe</i>	4 sund ( <i>Ecoperatio</i> (formation () <i>Eac</i> av	$ \begin{array}{c} \operatorname{id} \\ \operatorname{id} \\ \operatorname{d} \\ \operatorname{-and} (E \ converte) \\ \operatorname{formation} \\ \operatorname{formation} \\ \operatorname{form} \\ \operatorname{formation} \\ $	matine member of 1 nd-tone upper part and equ
Gastropoda: Acouse? avoidentalis (Hall and Meek)	<ul> <li>Essentiale for Kernig elay</li> <li>Corstenar ana Corstenar ana Navienda de Trajola trajora</li> <li>Navienda de Trajola trajora</li> <li>Poson Gap ela corst Prison Gap ela corst</li> <li>Poson Gap ela corst</li> <li>Poson Cap ela cors</li> <li>Poson Cap ela corst</li> <li>Poson Cap ela c</li></ul>	Actor togene Arter togene Xactory chail Sartoge chail Mattheok an Annon chail Ovar formatio Ovar formatio Ovar formatio Ovar formatio	Owl Creek to Ripley former Solma chalk a Solma chalk a Solma chalk a Coffice sand al	Traine Bluff Upper part to <i>Errighter aun</i> Lower pert au	Praine Blatt Upper jort to <i>E-sume-flatta</i> Lower part to Tombieleer to	Providence ~ C ppor part Lenggra error Crisselt sand Builltown for	Coper part	1. Monuouth fe		L - Red Bark - a Navesink ma Nount Laura Wennan suu Marbury d Wendbury d	For this sector is the sector
Wineksia (ubboekki, n. sp. Pseudomalaxie? patens, n. sp. P? -p. Hippositupoides sp. Calliomphalus seliulus; n. sp. C. spp. C. spp. Pseudohana tabaradatan erasum n. yn.											
Garranites nitidus, n. sp. Monodonta? cancellest, n. sp. Failing elata Wade Croonella white, n. sp. C. triplicata Wade C. deusseni, n. sp. Pseudonelania runnelsi, n. sp. Futuatium Leavrence, n. sp.											
E. pondi, u. sp. E. sp. Prosala americana Wade Bellievala for-hevi (Shumard) B. crideri, u. sp. B. rockenss, n. sp. Tular, manzaneti, n. sp. T. 2, an											
Mathilda codarcusis, n. sp. Architectonica conziltannis, n. sp. A. spp. Marguitella pamila, n. sp. Spinocena pervi, n. sp. Capitas spacifier Henderson C. enthandensis, n. sp. C. crettus, n. sp.			2								
C <sup>**</sup> microstriatus, n. sp. C <sup>*</sup> spp. • Dolmics: rectalabrum (Conrad) P. rectilabrum texamis, n. var. P. stephenson: Wade P. sp. Amatropist' spp. Amatropist' spp.			XX X			×					
Gyrodes supraphicatus (Conrad) G. rotundus, n. sp. G. sub-armatus, n. sp. G. sub-armatus, n. sp. G. spillmani Gabb *Xecophora Icabb Turritella triffra Conrad. T. bilina, n. sp.	2 × × × × ? × × × × × × × × × × ×			x	x	x x x x	x x	2 × ×	×	2  x   x   x   x	
T, winchelli Shumand . T. vertebnoides tennispira, u. var											
T, spp. Cerithian simplonensis, n. sp. C, -p Nultrague? cooperensis, n. sp. N.? -p. Auchara now kensis, n. sp. A. Jonari, n. sp. A. Jonari, n. sp.											
A 2 biotra Wade A.2 biotra media, n. vat. A.2 biotra media, n. vat. A.2 degans, n. sp. A.2 degans, n. sp. A.2 elipadomis, n. sp. A.2 (vaniousis, n. sp. A.2) A.2 (vaniousis, n. sp. A.2) A.2 (vaniousis, n. sp. A.3)											
$\Lambda^{(2)}$ completilli, n. sp											
D. spp. Prenocredla poinsettiformis, n. sp. Prignellus densatus nacatachanus, n. sut P. robustus, n. sp. P. spp. Tundora tuberculata, n. sp. Cyprace amelformis, n. sp. C. gravitis, n. sp.											
Pyropsis konhatnik, n. sp. P. spp. Medionapu: clongatus, n. sp. M. <sup>2</sup> spp. Napulus tuberculatus, n. sp. N. octolizans (Conzud)? N. spp. Hereorhytocus malleiforme, n. sp.											
H. vanhestin, n. sp. H. modostin, n. sp. H. mundifin, n. sp. I. coronale, n. sp. Busycon? sp. Pinella reticulata, n. sp. Sargana stantoni (Weller)							x				
Morea enneellaria conseniorais, n. var. M. enneellaria consist, n. var. M. marylandica bella, n. var. M. anarylandica baguida, n. var. Seninola erassa Wade S. spp. H.y.drottibulus asper, n. sp. Tryonia vulida, n. sp.		×									
Deussenia cibolaensis, n. sp. D. travisuna, n. sp. D. multilirae, n. sp. D. corbis, n. sp. Pu-us? robertsi, n. sp. F.? - pp. Anomalofusus bellulus, n. sp. A. son											
Aliofusus reagani, n. sp. A. reagani subitiis, n. var. A. regani iunidus, n. var. A. spp. Bellifusus coronatus, n. sp. B. renustriatus, n. sp. B. tenuistriatus, n. sp. B. denasiliensis, n. sp.											
B. multicostatus, n. sp. B. crusijcostatus, n. sp. B. buffalensis, n. sp. B. spp. Ornopsis pulchm, n. sp. O. solistella, n. sp. O. maxeyi, n. sp. O. sp.											
Remera microstriata, np. R. decora, n. sp. Graphidula terebriformis, n. sp. G. ? multico-tata, nsp. G. ? gabrielensis, nsp. G. sp. Lomirosa cretacea (Wade) L. spp.		×									
Piestochilus? levis, n. sp. Liopeplum leioderma longuta, n. var. L. leioderma tabulatum, n. var. L. leioderma breve, n. var. Drilluta crassicostata n. sp. D. enusicostata longa, n. var. D. paucieostata, n. sp. D. brevispira, n. sp.		?									
D. spp. Palessephaen? sp. Volutomorpha retifera Dull V. spp. Volutoderina (Longoconcha) navarroensis (Shumard V. (Longoconcha) dulli, n. sp. Parafusa? sp. Parafusa? sp.											
Lupira pyriformis, n. sp. Eoxneilla acutala, n. sp. Cancellaria? matsoni, n. sp. C2? sp. Carcela acuta (Wade) C. producta, n. sp. C. app. Matxa valida, n. sp.											
M. valida multiline, n. var. M. subters, n. sp. Paladmete corbuliformis, n. sp. P. alta, n. sp. P. inequalis, n. sp. P. elegans, n. sp. A muletym boylei, n. sp. A. eurocostatum, n. sp.											
A. vernistum, n. sp. A.? sp. Fulgerea venusta, n. sp. Lattema simpsonensis, n. sp. L. hubbardi, n. sp. L. munda, n. sp. L. geniculata, n. sp. L. Sp.											
Bereira inna, n. sp. B. contracts, n. sp. B. striatu, n. sp. B. ornatula, n. sp. R. ? elongata, n. sp. Remnite biacuminata (Wade) Acteon? throckmortoni, n. sp. A ? oliidas n. sn.		x.									
Troostella sublinearis, n. sp. T.? brevispira, n. sp. T.? sp. Nonacteonina graphoides, n. sp. N. deflexa, n. sp. N. terist, n. sp. N.? trificea, n. sp. N.? trificea, n. sp.							┥┺╹┖┿┿┙╹ ┙┇┶┇╉╞┾╋╼				
Tornatellaca scatesi, n. sp T. cretacca heles, n. var. T. cretacca propress, n. var. T. grandis, n. sp. Ringienta palchella Shumard R. culbertsoni, n. sp. R. anfretolinetta, n. sp. R. suffacto, sp.			X			×					
R. spp. Ofigoptycha americana (Wade) Elliposteapha striatella (Shumard) E. spp. Aken constricta, n. sp. Haminea? simpsoneosis, n. sp. Cylichna seatina Shumard C. ineisa, n. sp.											
Cpp. Anisomyon havdeni Shumard A. boredis (Morton)? Cephalopoda: Entrephocens planoventer, n. sp. Epp. Solenocense texanum (Shumard) S. reedidi, n. sp.			7 7								× .
S. multirectatum, n. sp. Hamites? sp. Pacolite claviformis, n. sp. B. ondatus, n. sp. B. colanna Morton B. spp. Nostoernes stantoni Hyatt N. statotni prematurum Hyatt		× · · · · · · · · · · · · · · · · · · ·		×	×						+
N. stantion aberrans Hyatt N. hyatti, n. sp. N. helicinum (Shumard) N. helicinum enssum, n. var. N. helicinum humile, n. var. N. colubritormis, n. sp. N.? duconis, n. sp. N.? sp.											
Turnities splandidus Shumard Turnities splandidus Shumard T, sandersorum, n. sp. T. spp. Helicoceta: maaroense Shumard H.? sp. Parapachydisets arkanstons, n. sp. P. sout, n. sp. P. sout											
A concerns compression, n. sp. A, pingme, n. sp. A, multicestatum rotandum, n. var. A, multicestatum rotandum, n. var. A, sp. Scaphites rugosus, n. sp. S, brevis Meck S, multus a, sp.											
S. porkensis, n. sp. S. sp. Discoscaphites roanensis, n. sp. D. erucoideus, n. sp. D. spp. Placenticeras mecki Bohm P. intervalare Meck (variety) Sohondison											
S. pleurisepta (Conrad). S. spp. Belennitella americana (Mastan)			×	xxx	++++	×	<x i<="" td=""><td>×</td><td></td><td>××</td><td>2</td></x>	×		××	2

 TABLE 5, Part 2. - Geographic and stratigraphic range of fossil species of the Navarro group

 [Numbers at heads of columns are the collection numbers of the United States Geological Survey, except as otherwise indicated. Full descriptions of localities are given cleawhere in the text]

	Texas	Arkansas	Truncer	Northern Mis-Estippi	Easterated Mississippi	Created and weeks eathl Alabana	East-central Alabana and Chataloochee region (AlaCia)	Catolinas	Maryland	Delawate	New Jersey	Western Interior
	all i Krajpra e) prakrosa roset	11 ZODE	da zone) zone)	oslala Tone 	Selma chalk sar zone)	adk and sundy∙ ents (Ripley) 687 2000	дуги совени гонс.	yra costato zone) E. punderosa zone)			rustata zome	
Species	(NANDA 2019 20- act) (NANDA 201 (action) (Eropper, the mark (Eropper, action) action (Eropper, action)	. ). 1. ). 1. Singgin costat aderasa zaw	, part of E. cancell art of E. concellato ra ponderose zone)	El Partico Contra de Contr	ret costeta zone	ta zone   Selma ch onei   equivali ot Econyra pondere	y formations Err	er formation ( <i>Eroy</i> ) for troner nart of	ustate zone) udo rase zone) orthata zone)	and road zone	a ranet   Eroyara 4-4 ponterosa zane	ance lormation ivalents valents
	$\frac{1}{2} \cdot \frac{1}{12} \cdot \frac{1}{2} \cdot 1$	$ \stackrel{\text{(E) current later rough}}{=} E_{2,qq_{1} \rightarrow q_{2}} $	argue of Ripley (up eds. equiv. clow. p eds. equiv. ( <i>Econo</i>	mation on <i>Compton constituta</i> Uper part of <i>Ecopy</i> wer part of <i>Ecopy</i>	halk (Sedma) (Sedma) (Sedma) (Seq hato zone ) (oggari pouch risa z	$\left  \frac{1}{2} \left( \frac{1}{2} \right) + \frac$	$\frac{1}{10^{10}} \frac{1}{10^{10}} $	Rate zone   Pend m. of Black Clerk	anation Allengger - adim ( <i>Elegent</i> po said ( <i>Elegine</i> -	formation 1 Eco	t 1 sand (E. 1 on Alut formation { 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	artine member of L al-tune upper part and equi ower purt and equi
Gastropoda:	Econdidation Komp day Komp day Komp day Negraph and Negraph and Press Gap da Press Gap day Annois day Annois day Annois dak Annois dak Annois dak Annois dak Annois dak Annois dak	Arkadelphia n Nacatoch sand Svatoga chalk Marlbrook ma Annona chalk Ozan formatio	Coon Creck to Selma ch. and Selma ch. and	Owl Creek for Ripley formati Schurt chalk ( Schurt chalk ( Schurt chalk ( Coffee sund ch	Prairie Blaff o Upper part of <i>Lower</i> part ( <i>I</i> Lower part ( <i>I</i>	$\begin{array}{c} P_{\text{Lattrace}} = B(a) \\ U(p) e^{-p} p = p = 0 \\ E^{-conce}(p) e^{-p} \\ Lower p = 0 \\ 1 \\ \text{Combissions} = 0 \end{array}$	Providence su Cipper port <i>Ecogytes conce</i> Crissets and Blufftown fort	[ pper part Everyger rap.	Monuouth fo Matawan Jorn	Marshalltown Chrewicks of Red Bank so	Xovesink man Mount Laure Wenoma sand Marshalltown Merchanty el-	X Canoodall a Fox Hills su Figure shale. Pigure shale.
Armaer's occidentatis (1501-000 Meek) Weeksia hubbooki, n. sp. Pseudomataxis? patens, n. sp. P.? sp. Hippocampoides sp. Calbomphalus bellulus, n. sp. C. microconcelli, n. sp. C. sp. C. sp.												
Garranitis utidas n. sp. Garranitis utidas n. sp. Monodonts? exneelloss, n. sp. Enlime etara Wade Croundla white, n. sp. C. tripheata Wade C. denseni, n. sp. P. andonekania ruond si, n. sp.			x									
E. pondi, n. sp			×									
Marthida redurensis, n. sp. Architectomer voragiformis, n. sp. A spp. Margaritella pumila, n. sp. Spironena perryi, n. sp. Capalus spangleri Højderson C. embandensis, n. sp.				2								
C. 2 microstructure, u. sp. C. 2 microstructure, u. sp. Polames, rectal.brum (Courad) P. roytilabrum texanus, n. yar, P. stephensoni Wade P. sp. Amamoprist spp.			×	XX X			×					
Groudes and applicatine (Contrad) Groundlus, n. sp. (G. petroeus (Morton) G. subcarmatine, n. sp. G. splatimani Gabb • Neurophota Leprosa (Morteo) • Tarritella milita Contrad T. Infine Group		××	× × ×		x ? x	x x x x	××× ×	× >	? (X X	x	2	
T. winchell Shumard T. vertebroides femaispira, u. var. T. vertebroides jones, u. var. T. vertebroides longi, n. var. T. vertebroides longi, n. var. T. austini, n. sp. T. honstoni, n. sp. T. honstoni, n. sp.												
T. massiver improvements, n. sp. C. sp. Nadizagne? conjectensis, n. sp. N. sp. Auchura nowekensis, n. sp. A. lanari, n. sp. A. lanari, n. sp.												
$X_{+}^{(2)}$ lobata Wade, $X_{+}^{(2)}$ lobata media, n. 897, $X_{+}^{(2)}$ phenotosta, n. 89, $X_{+}^{(2)}$ elegans, n. 89, $X_{+}^{(2)}$ eledoensis, n. 89, $X_{+}^{(2)}$ eledoensis, n. 89, $X_{+}^{(2)}$ volucies, n. 89, $X_{+}^{(2)}$ evolucies for 89, $X_{+}^{(2)}$ evolucies $X_{+}^{(2)}$ eledoensis, n. 89, $X_{+}^{(2)}$ evolucies $X_{+}^{(2)}$ eledoensis, $X_{+}^{($												
X.2 completii, n. sp X.2 long(n. sp												
11 spp. Protocredia poinsettiformis, n. sp. Protocredia densitus mactachanus, n. var P. robustus, n. sp. P. spp. Tandora underenkaa, n. sp. Cyprawa undeformis, n. sp. C. gravitis, n. sp.												
Peropsis kanhaini, n. sp. P. spp. Medianapus clongstus, 0. sp. M. <sup>2</sup> spp. N. spp. N. setolitzens (Control)?, N. setolitzens (Control)?, N. spp. Her ordyneus malleiforme, 0. sp.				x								
H. unologia, n. sp. H. mundam, n. sp. H. mundam, n. sp. H. coronale, n. sp. H. spp. Basycon? -p. Pholar reticulata, n. sp. Sarguna stantoni (Weller) M. sp.			×				x	×				
M. cameellaria ersissa, n. var. M. marylandhea hella, n. var. M. anarylandhea hoginia, n. var. Seminuda erassa Wade Spp. H.ydrottidulus aaper, n. sp. Tryonia valida, n. sp.			X									
Densonia ciholornais, n. 40 D. travistana, n. sp. D. multilinae, n. sp. D. cotiis, n. sp. Fusus? robotts, n. sp. F.? sp. Anomalofusus bellulus, n. sp. A. sp.												
A horitasis reagani, h. sp. A. reagani subilis, n. var. A. reagani tumidus, n. var. A. spp. Bellifusus coronatus, n. sp. B. rohustus, n. sp. B. tenuistmitus, n. sp. B. dentavillensis, n. sp. B. dentavillensis, n. sp.												
B. crawieostatus, n. sp. B. huffaloensis, n. sp. B. spp. Ornopsis pulchra, n. sp. O. solistella, n. sp. O. maxeyi, n. sp. O. maxeyi, n. sp. O. sp. Bomen microstriata, n. sp.												
R, dievra, n. sp. Graphidula terebrilornnis, n. sp. G.? multicosta, n. sp. G.? gabrielensis, n. sp. G. sp. Lomirosa cretacea (Wade) L. spp. Piestochilus? levis, n. sp.			x									
Liopepium leioderma longuo, n. var. L. leioderma tabulatum, n. var. J. leiuderma breve, n. var. Drilluta crussico-tata, n. sp. D. enresico-tata longa, n. var. D. paueies-tata (n. sp. D. brevispira, n. sp. D. spp.		?										
Volutomorphina: "pr. Volutomorphina retifera Dull V. spp: Volutoderma (Longoconcha) navarroeusis (Shuman V. (Longoconcha) dalli, n. sp. Parafusus? sp. Parafusus? sp. Lupira pyriformis, n. sp. Eoreilla southa n. sp.												
Cancellaria: mateoni, n. sp. C.? sp. C.? sp. C. producta, n. sp. C. spp. Matzas valida, n. sp. M. valida multilizae, n. var. M. valida sp. sp.			X									
Paladmete corbuiliornis, n. sp. P. alta, n. sp. P. inequalis, n. sp. P. elegans, n. sp. Anuletym boylei, n. sp. A. eurovocstatum, n. sp. A. veruvocstatum, n. sp. A. veruvtum, n. sp. A. <sup>3</sup> sp.												
<ul> <li>Fujgera venusta, n. sp. Luterna simpsonencis, n. sp.</li> <li>L. hubbardi, n. sp.</li> <li>J. munda, n. sp.</li> <li>L. geniculata, n. sp.</li> <li>L. sp.</li> <li>Beretra firma, n. sp.</li> <li>B. contracta, n. sp.</li> <li>B. etriata, n. sp.</li> </ul>												
B. sornatula, n. sp. B. ornatula, n. sp. Fusimilis robustus, n. sp. Fusimilis robustus, n. sp. Remnita biaccuminata (Wade) Aeteon? throckmortoni, n. sp. A.? nitidus, n. sp. Troostella sublinearis, n. sp. T. 9 brevisping, n. sp.			×									
T.? sp. Nonacteonina graphoides, n. sp. N. deflexa, n. sp. N. tensa, n. sp. N.? triticea, n. sp. N. spp. Tornatellara scatesi, n. sp. T. createca heles, n. var.												
T. cretacca appressa, n. var. T. graudis, n. sp. "Ringicula pulchella Shumard R. cubertsoni, n. sp. R. aufractolineata, n. sp. R. sulllata, n. sp. R. sullata, n. sp. Oligoptycha americana (Wade) Oligoptycha americana (Wade)			×	X			×					
K. spp. Akera constricta, n. sp. Haminea? simpsonensis, n. sp. Cylichna scealina Shumard C. incisa, n. sp. C. spp. Anisomyon baydeni Shumard A. borealis (Morton)?		×										
Cephalopoda: Eutrephoceras planoventer, n. sp. E. spp. Solenceeras texanum (Shumard) S. reesidei, n. sp. S. multicostatum, n. sp. Hamites? sp. Baculites claviformis, n. sp.		×	x	?								
B. uudatus, n. sp. B. columna Morton B. spp. Nostocerns stantoni Hyatt N. stantoni preonuturum Hyatt N. stantoni aberanus Hyatt N. stantoni aberanus Hyatt N. stantoni aberanus Hyatt N. hyatti, n. sp. N. helicinum (Shumard)					×	×						
N. netronum crussum, n. var. N. heliorinum humile, n. var. N. colubriformis, n. sp. N. sp. N. sp. Anaklinoveras reflexum, n. sp. Turrilites splendidus Shumard T. sandersorum, n. sp. T. syn												
Helicoceras navarroense Shumard H.? sp. Parquedydiscus arkansonus, n. sp. P. seotti, n. sp. P. spp. Axunceras compressum, n. sp. A. ningue, n. sp.		×										

A multing total materialism in the							
A. muthcostation rotungino, a. var							
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Scaphites rugosus, n. sp.			<b>╶╶┼╶┽╶┽╌╋╶╪╍┾╌┽╶┼╶╋╶┼╶┼</b>	╶╞╌╋╌╞╼╞╼╞╶╞╴╢╴┊	<b>──┼╸╉╍┼╍╉╸┾╸┼</b> ╸┦	┫╌╞╌╞╼╞╌┠╺┥	
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0. 016415 -900A							
S. pumilus, n. sp.		<del>╶╺┥╺┨╺┥╸┫┍╉</del> ┉╅╼ <del>╞┉┥</del> ╾┤╾┽╶┨╶┽╴┦╴╋╺	┽╌ <del>┥╶┥╶┥╺┫╶┥╶┥╺╋╺┥╸╡╺</del>				
S. vorkensis, n. sp.		┍╍╅╾┟╾┥╾┽╼╋╼╉╾┽╶┾═┼╸┿╍┥╼╉╌┞╴┼╶╉╴	<del>┆╶╎╶╽╍╪╍╞╌╋╶╎╸╿╶╿╶╿╶┫╶╽╍┥╾┾</del>	<b>→</b> ╋·┾·┼·┼ ┼ ╉ ┼			
S en						▋╌┞╴┠╶┼╸╄╶┥╴┫┈┥	-
1	X						
Discosciptities roanensis, n. sp		┝━┫╍╊╾╂╌╋╴╋╌╂╌╂╌╡╌┽╶┽╵╉╾╏╶╎╴┣╾					
D. erucoideus, n. sp.		<del>┈┥╶╡╸╪╺╋╍╞╍╎╶╎╶╡╼┥╶╿╶┫╸┝╴┝╸╋╸</del>	<del>╎╶╎╶╎╶╎╶╎╶┨╶╎═╄╸┼╍╄┉╋╸╏╶╎╶╎</del>	<del>····································</del>			
D spn			↓ ··↓ · ↓ ↓ · ↓ · ↓ · ↓ · ↓ · ↓ · ↓ · ↓			ã → ↓ ↓ ↓ ↓ ↓ <del>↓</del> ↓ <b>↓</b> ↓	-
Di sul su li D lui							XX
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P. intercalare Meck (variety)		<del>╶┼╪╪╉╡┉╋┇╏╎╞╍╪╍╞┥╋╹╡╹╋╹</del>	<del>╎┊╞╏╎╸╋╺╡┊╞╺╋╺╡┊</del>	<b>─┼─╂</b> ─┼─┼─┼─┼─┨─┼			111
Spherodisens tirensis, n. sp.	XX		<del>┆┊┊╎╸╎╸┝╋╺┝╶╎╴┥╺╋╺┥╺┝</del>	═┼╾╂╌┼╌┼┈┼┈┼╶╉╶┥	<u> → ↓ ↓ ↓ ↓ ↓ ↓</u>	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	+++
S plannicenter (Commet)	XXX						
e. picurisepta (connut)	XXX						
Suspension and a sub-							2
Belemnitella americana (Morton)							الهذيبة بشده

#### TABLE 6.—Range of Navarro genera in Upper Cretaccous sediments above the Eagle Ford shale, in the Atlantic and Gulf Coastal Plain [The plus ( +) sign indicates the range of a genus into sediments older or younger than those embraced by the table.]

	Π	1	g	Т	T			-,																																Mollu	est																						-										
Geologic units	Poritera	Vernes	Echinodermat	Mollu-condea															P	elecyp	oda															Suphopoda																Gast	opoda																	Ceph;	аюрума	)	
Kemp clay								2+ 11 11						+ +																												?						?																									
Corsicenta mart Corsicenta mart Nacatoch sand		?																						?																		?								?									?														
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Austin chalk and equivalents																									22							2				2	?											2																			?	2					
Genera	Cliona	Serpula Hamulus Cardiaster	Hemiaster Linthia - Micester (Pheiaster)	Family Cidaridae Aff. Mesocinus Lingula	Tereforatulina. + Solemva.	Nuculat.	Glycymeris	Istevialitation	Gervilliopsis	Preția? + + + + + + + + + + + + + + + + + + +	Gryphaeatrea	Exogyra Trigonia Pecten (Pecten?)	P. (Camptometres) P. (Synevelonema?)	P. (Actinet) P. (Amasium?) P. (Radiopecten)	Spondylus Plicatula Lima	Anomia	Crenella Lithophaga	Cuncetts Pholademya Hemenya	Lateraula? +	Ferphona: Liopistha Cymella	('uspidaria + Ventella	Astartenya Astarte?	Veterieardia Crassatella 17.3.1.65	Scambula Titanosarcolites	Sauvagesta?	Unicardiam?	C. (Granocardiun) C. (Granocardiun)	C. (Trachycardium)	Aphrodina Cvurimeria	Legumen Tenea	Cyclorisma Tellina	Laucarua Solyma Laptosolen	Cymhophora Corbula P++	f anope Gastrochaena Pholadidea	Nylophagella Gomiochasma	Eamsetna Pholas? Dentalium	Cadulus Aemaea? Weeksia	Pseudomelaxis? Hippocampoides	Vautompuates	Monodonta? Eulima Cremella	P-endomelania E-pitoniunt	Processor Relliscula Tubu?	MathildaArchitectonica	Spironema	Polinices ++++++++++++++++++++++++++++++++++++	Gyrodes Xenophora 	Turmitella Cerithium Nudivaens?	Anchura Drepanochilus	Pterocerella Pugnellus Timdosi	Cyptura Pyrojsis Vi u	Napulus	Pinella Surgana	Seminola Bydrotribulus	Tryonia Deussenia Fusus?	Anomalofusus Aliofusus Bellifusus	Ornopsis Remera Graphidula	Lomirost Piestochilus? Lomendum	Driffuta Paleo-ephatea: Voltromortha	Volutoderma (Longoconcha) Parafusus	Farvivoluta? Lupira Eomeilla	Carrellaria? Cavrola Mataxa	Paladmete Anuletum Follooven	Lutena Lutena Beretra	Fusimilis Remnita Actron?	Troostella. Nomactrontina Tornatellaca	Ringicula	Akera Akera Hamiwa?	Anisomyon Entrephoceras	Solenoceras Ramites? Baculites	Nostoretas Anaklinoeetas Turrilitos	Helicocens Pampachydiseus	Axonoregas Scaphites Discoscaphites	Phrenticeras Sphenodiscus Rolemnitella

#### TABLE 6.-Range of Navarro genera in Upper Cretaccous sediments above the Eagle Ford shale, in the Atlantic and Gulf Coastal Plain [The plus (+) sign indicates the range of a genus into sediments older or younger than those embraced by the table.]

	Π		j.		T																							÷											Me	ollusca																																	
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Genera	(liuna	Nerpula Hamulus Cardiaster	Hemiaster Linthia Microster (Plesiaster)	Family Cidaridae Aff. Mesocrimus Linearla	Terebastulina + Solemva	Nuculana Nemodon	Linter Breviatea	Linupsis Linupsis Gervilliopsis	Gervillia ++ Inovemans ++ Ptenia? ++	Ostreat Activities	Gryphaco-trea	Perten (Preten?)	P. (Neithea)	Spondylas	Anomia Pulvinites?	Creatla Creatla Lithushure	Cuncolus Pholadomya	Lateruda? +	Periploma? ++++++++++++++++++++++++++++++++++++	Cuspiduria Veniella	Etea . Astartenya .	Astarte: Veteriendia C'rassuella	Uddenia Scambula Tr	Lucauosarcontes Sauvage-ia? Durania?	Lucina Unicardium?	Sentulia'', Cardium (Pachycardium) (' (Pithmeendium)	C. (Granocardium)	Brevitandium Isocardia A.Aradiaa	Cyprimeria Levnnen	Tenea Cyclorisma	Tellina Linearia Solaaria	Loptosolen	Contonta Panope Controdorom	Pholadidea Xylophagella	Giomiochasma Ramsetia Pholas?	Dentalium	Weeksia P-eudomelaxis?	ffippocampoides Calliomphalus Creedabaran	Garramites Monodonta?	Creanella Pseudomelania	Epitonium	Tuba? Mathilda	Architetonica	Capulus Polinices	Amauropsis?	Neuophora Turriella	Cerithium	Drepanochilus Pterocrefa	Pugnellus Tundora Cyprisea	Pyrupsis Medionapus	lercorhyneus Busycon?	Pinella Surgana Morea	Seminola Il vdrotribulus Tryonia	Deussenia Fusus? Anomalofusus	Miofusus Bellifusus Ornopsis	Remera Graphidula Lomirosa	Piestochilus? Liopephum Driftuta	Paleo-sphaer? Volutonorpha Voluto-leena (Loneo-acha)	Parvivoluta" Parvivoluta"	Eonocilla Cancellaria?	Mataxa Mataxa Paladmete	Amuletum Fulgerea Lationa	Beretra Fusimilis	Remnita Acteon? Troostella	Nonacteonina Tornatellacu Dimenda	Oligoptycha Filipsoscupha	Akera Haminea? Cylichna	Ani-oniyon Fattepnecetas	Hamites? + Burnlites	Nostorents . Anaklinoceras Tumilitos	Turrintes Helicoceras Parapachydiscus	Axonocerus Scaphites +	Placenticerus Sphenodiscus Dominations

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