

DEAN HENDRICKSON

ICHTHYOLOGICAL SURVEY OF THE RIO SALADO, MEXICO
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ICHTHYOLOGICAL SURVEY OF THE RIO SALADO, MEXICO

by

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THESIS

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PREFACE

A survey of the fish fauna of the Rio Salado, which runs through the Mexican states of Tamaulipas, Nuevo Leon, and Coahuila, was selected as a suitable project for a Master's thesis after a thorough search of the scientific literature yielded very little information on the fish fauna of most of the Mexican rivers and none on the Rio Salado system. As an international dam is under construction across the Rio Grande at Falcon, Texas, I decided to make a study of the Rio Salado before introduction of exotic fishes disturbed the native fauna of this little-known stream system.

I believe that a study of this nature would be of considerable value to fresh water fisheries work because all of the Mexican fish fauna native to Falcon Lake will come from the Rio Salado and its tributaries. After Falcon Dam is finished, the waters of the Rio Grande and its western tributaries, including the Rio Salado and its tributaries, will be impounded. With this impoundage of the waters, there will be some ecological changes in many of the stream systems concerned. These will be brought about mainly by the introduction of alien fish species into the lake and their subsequent migration into tributary waters, and by the effect of "backed-up" water in the lower Rio Salado and some of its tributaries. It has been the purpose of this work to study the ecological niches before they are changed so that fisheries planning concerning the waters of the lake may be based on sound scientific information and so that the present fauna may be compared with that which occurs after impoundage.

I wish to thank Mr. Marion Toole, Chief Aquatic Biologist for the Texas Game and Fish Commission, for being instrumental in securing official permits and providing some of the equipment for this work.

I am grateful to General Hermenegildo Cuenca Diaz, Secretary of National Defense Fifth District, for granting permission to enter the country and collect fishes.

I am indebted to Dr. Clark Hubbs of the University of Texas for help in preparation for this work, for his diligent and constant help in verifying identification of some of the specimens, and for aid in the determining the ecological distribution of some of the more widespread species.

To Mr. Kenneth C. Jurgens and Mr. William H. Brown, Aquatic Biologists for the Texas Game and Fish Commission, who aided me in searching the scientific literature and verified some of my identification, I also wish to extend my sincere thanks.

To Dr. James L. Wilson, of the Department of Geology of the University of Texas, I wish to extend thanks for checking the section on the geology of the Rio Salado.

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INTRODUCTION

This study was begun in order to determine what fishes occur in the Rio Salado and to learn something of their distribution, as well as to gain some knowledge of the ecology of some of the more common species. To my knowledge there has never been a published report of any ichthyological work on this river. This survey, it is hoped, will be of some benefit to fisheries improvement at the international dam where the waters of this river will eventually be impounded.

ECOLOGY OF THE RIO SALADO

The water in the Rio Salado proper comes from two branches (the Rio Sabinas de Coahuila and the Rio Salado de los Nadadores) and two tributaries (the sporadic Rio de Candela and the Rio Sabinas de Nuevo Leon).

The Salado is a clear stream, having its rise in the sierras of igneous and metamorphic rock to the west, and forms a true oasis in the wilderness of rotten limestone which is found on either side of the lower Rio Bravo (Rio Grande), and which causes the waters of most of the tributaries to be brackish and unwholesome. (Emory, 1857)

Source of the Rio Salado

A freshwater spring pouring out of a limestone hill in the Sierra Del Carmen is the source of water for the northern branch of the Rio Salado, the Rio Sabinas de Coahuila. This spring is located one-half mile north of the small town of Nacimiento, Coahuila.

The southern branch, the Rio Salado de los Nadadores, has its origin at another hillside spring that comes from below the hill line near the town of Sacramento, Coahuila. This spring over a period of many years has worn out a pool fifty-six feet wide and

sixteen feet deep in the limestone bedrock above it. The water in this area is sweet to taste, and only after it goes over a salt basin near the towns of Abasolo and Hermanas does it get the brackish and unsavory taste which gives the Rio Salado its name.

The Rio de Candela, an intermittent stream, forms a minor tributary; this river enters the Rio Salado near the town of Ciudad Anahuac.

The final tributary is the Rio Sabinas de Nuevo Leon, which empties its waters near the mouth of the Rio Salado.

Course of the Rio Salado

The Rio Salado proper is formed by the junction of the Rio Sabinas de Coahuila (=Rio Babia, =Rio Sabinas) and the Rio Salado de los Nadadores at the northern end of Don Martin Lake. The lake is located near the town of Don Martin, Coahuila, which is eighteen miles from the state border of Nuevo Leon.

The Rio Salado flows in a south-southeasterly direction from Don Martin Lake. It continues to flow in this general direction until it reaches Ciudad Anahuac, Nuevo Leon, near the place where the Rio de Candela joins it from the south. The river flows in a southeastern direction from Ciudad Anahuac until it passes by the town of La Gloria, Nuevo Leon, that is located on the Laredo-to-Monterrey highway near collection station no. 1. After the Rio Salado leaves La Gloria, it follows an easterly direction until it is joined by the Rio Sabinas de Nuevo Leon twenty miles east of La Gloria and where together they disgorge into the Rio Grande at a site twelve miles northeast of Guerrero, Tamaulipas.

Geology of the Rio Salado

The two spring sources of the Rio Salado branches have their origin in the Sierra del Carmen. This region is of Lower Cretaceous age and is marked by massive limestone strata.

Some igneous rocks are present along the course of the Rio Sabinas de Coahuila. These outcrops are principally basaltic, and they occur in the Nueva Rosita-Musquiz area (Bose, 1927).

In the central region of the Rio Salado and its tributaries from Sabinas, Coahuila, to Anahuac, Nuevo Leon, there are Upper Cretaceous outcrops of soft limestone.

The region of Rio de Candela and Anahuac is situated in a valley between the Sierra del Burro on the north and Lower Cretaceous outcrops of Kiamichi marl on the south.

The region from Anahuac to a site eight miles south of La Gloria, Nuevo Leon, lies in a valley (the Salado Arch) formed on Upper Cretaceous between a southern extension of the Sierra del Burro and Lower Cretaceous outcrops of the Sierra Lampazos. Massive limestone blocks mark the Lower Cretaceous in this region, while less resistant limestone and shale occur in Upper Cretaceous beds along the river.

Southeast of Anahuac the Rio Salado flows in a syncline between the southward extended axes of the Sierranias del Burro and Sierra del Carmen.

Formations of Eocene age including the Midway, Wilcox, and Claiborne continue from the end of the valley southwest to the Salado Arch. These formations extend all of the way to the mouth of the Rio Salado near the town of Guerrero, Tamaulipas. The Eocene formations are characterized by their sands, clays, and sandstones.

The southern tributary of the Rio Salado, the Rio Sabinas de Nuevo Leon, has its birth in the hills of Ojo de Aqua, which is eight miles south of Sabinas Hidalgo, Nuevo Leon. Massive limestone outcrops of Lower Cretaceous age occur in this area.

On a straight line the distance from Don Martin Dam to the mouth of the Rio Salado on the Rio Grande is 105 miles; however, were its meandering course measured, it is very probable that it would cover more than 300 miles. The spring sources of the two northern tributaries, the Rio Sabinas de Coahuila, and the Rio Salado de los Nadadores, are eighty miles from Don Martin Dam; but if the meandering course of either branch were measured, it would probably have a length of more than 220 miles. The Rio Sabinas de Nuevo Leon, flowing into the Rio Salado twenty miles east of La Gloria, has a wandering course that has a straight map distance of sixty-five miles; however, if the winding course were straight, it would probably be more than 150 miles long. This river has its origin in two hills at Ojo de Aqua, eight miles south of Sabinas Hidalgo, Nuevo Leon.

The intermittent stream, the Rio de Candela, empties into the Rio Salado seven miles south of Anahuac. This sixteen-mile-long river has water in it only at sporadic times during the year. If all twists and turns were measured, this river would probably have a length of more than twenty-five miles.

The total distance over which water flows from the spring source of either branch to the mouth of the Rio Salado on the Rio Grande would therefore exceed 520 miles.

The total area covered by the Rio Salado and its four tributaries (the Rio Sabinas de Coahuila, the Rio Salado de los Nadadores, the Rio de Candela and the Rio Sabinas de Nuevo Leon) which form the Rio Salado

watershed, is 17,383 square miles. These rivers flow through the states of Tamaulipas, Nuevo Leon, and part of Coahuila.

Major Segments of the Rio Salado

From an ecologic viewpoint, the Rio Salado is divided into four segments, each of which is subdivided into many small, highly localized ecological niches.

The Rio Sabinas de Coahuila, the northern fork of the Rio Salado, forms the first major segment of the Rio Salado system. This segment extends from its origin at Nacimiento, Coahuila, to Don Martin Lake at Don Martin, Coahuila. It is at this locality that the Rio Sabinas de Coahuila unites with the Rio Salado de los Nadadores.

Vegetation was present in the two headwater collection stations. Among the list of aquatic or semi-aquatic plants found growing in this tributary of the Rio Salado are such genera as: Eleocharis, Myriophyllum, and Isnardia. In the upstream locality vegetation occurred in sand beds over bed rock in the shallow water areas. In the downstream locality the vegetation was found anchored in the accumulated silt beside large boulders, where some protection was afforded to it against the direct effect of the current.

The bottom of the Rio Sabinas de Coahuila varied from a bedrock area with fine gravel near its birth at Nacimiento, Coahuila, to rocks and boulders over bedrock at Crucero Villa Juarez, Coahuila. In one area (station 17) there was some sandy silt suitable for good plant growth, but coal mine waste polluted the stream to an extent that no vegetation existed. The fish collection obtained from this station, consisting of few specimens and species, further confirms the extent of

pollution of the stream.

The current in this tributary is either swift or very swift. In all places where the current is very rapid, the bottom is bedrock, which is not at all suitable for the attachment or growth of vegetation, except on the protruding sand bars.

The second major segment of the Rio Salado is the southern fork, the Rio Salado de los Nadadores. This tributary has its origin near Sacramento, Coahuila, at an elevation of 1750 feet. This segment terminates at Don Martin Lake, Coahuila, where the elevation is 900 feet.

Vegetation was generally absent from the river channel. Collection station twenty-two had some vegetation of the genus Typha growing on the edges of the pool.

The bottom for the most part was of mud and silt. In one case a bedrock and pebble bottom prevailed. The current at the collecting stations varied from none to slow. The water was turbid and murky.

Although stream and bottom conditions were suitable for luxuriant growth of aquatic vegetation, it was generally absent. This perhaps may be explained by the salinity of the water of the Rio Salado de los Nadadores.

The third and principal segment of the Rio Salado is the Rio Salado proper. This segment begins at the union of the two forks, the Rio Sabinas de Coahuila and Rio Salado de los Nadadores respectively, and ends at its outlet on the Rio Grande, twelve miles northeast of Guerrero, Tamaulipas.

The area generally could be characterized as one of gradually inclined, cypress-lined banks with relatively semi-clear or murky waters, with a current varying from slow to moderately rapid, depending on the local

irregularities in the bottom foundation. The elevation ranges from 900 feet at Don Martin to 450 feet southeast of La Gloria, Nuevo Leon.

Aquatic vegetation in this portion of the river was generally absent, occurring in only three localities where the water was rather shallow over sand or silt beds and where there was some protection from the direct effect of the current.

Two hours' seining at station four yielded only thirty-five specimens of seven species. Since conditions were suitable for fish propagation, an explanation for the general absence of fish from this locality was sought. Further investigations revealed this area abounded in soft-shelled turtles, Amyda sp. The cut-off pools with bedrock bottom provided the fish little cover from the turtles. It is also salient that the smaller pools did not have any degree of water circulation or aeration; consequently, the water temperature at these pools was higher than in the flowing stream, and it may have exceeded the maximum tolerance for some fishes.

The last major segment of the Rio Salado is formed by its southern tributary, the Rio Sabinas de Nuevo Leon. In this intermittent river, only one collection was made, near the headwaters of Ojo de Aqua, Nuevo Leon. Survey results of this river showed one positive station to eight dry stations.

The aquatic plants collected at station two (two miles southwest of Sabinas Hidalgo, Coahuila) were of the genera: Najas, Potamogeton, and Nymphaea. The water was fresh, relatively free of turbidity, and the current was swift over a bedrock bottom covered by sandy silt. The bank was gradually inclined dirt and was lined with trees of the genera: Fraxinus, Ulmus, Celtis, Parkinsonia and Salix.

This locality is very suitable for fish growth and propagation, but perhaps its proximity to the origin of the river somewhat reduces the number of species that could possibly occur at this site. Species known to occupy clear, swift-running and vegetation-filled water were collected at this site which had an elevation of 1025 feet.

ANNOTATED LIST OF SPECIES

Thirty species of fishes were found in the Rio Salado and its tributaries. In each case an attempt has been made to generalize on the distribution of the species; and, in the case of the more common species, notes on their ecology have been given. The results of twenty-two collections of specimens have been broken down by species in Table 1. All statements concerning the distribution of the various species have been based on this table. The nomenclature is based principally on Hubbs and Bonham (1940) except for some subsequent changes.

Family Lepisosteidae

Lepisosteus productus Cope

Spotted Gar

Fourteen specimens of the spotted gar were collected from five stations which range from near the mouth of the lower Rio Salado, to the headwaters of the south fork. The stream current varied from a very slow to a moderate speed. The depth of capture was around five feet. The water in all cases was either semi-clear or slightly murky. The bottom in all cases was composed of mud and silt over rocks.

From the evidence that has been obtained in collecting this species, it may be concluded that the spotted gar prefers areas of relatively deep water that is semi-clear or murky, and that have a bottom of mud and silt over rock,

Even though this species is found scattered through the Rio Salado and its tributaries, it is restricted to the deeper, nonvegetated, mud and silted bottom areas. This corresponds with collection data on Texas gars.

Lepisosteus osseus leptorhynchus Girard

Southern Long-nose Gar

Only one specimen of Lepisosteus osseus leptorhynchus was collected. This specimen was taken from a depth of five feet in semi-clear water. This specimen was taken at night in the area of Gonzalez Hacienda in La Trinidad. The current in this area was rather slow, and the bottom was composed of mud over small rocks. All of the large gar that were collected in this survey were collected at night, which serves as an indication that the adults do most of their feeding in the early part of the night.

Family Clupeidae

Dorosoma cepedianum(Le Suer)

Gizzard Shad

The gizzard shad was taken in a total of five collections. The farthest downstream collection of this species was in the area of Rio de Candela, where the Rio Salado is backed up into its dry channel. The rest of the collections were made in waters that had a depth of three to four

feet and had a current speed ranging from moderate to rapid. The water at the latter four collection stations ranged from clear to murky.

It appears that this species is restricted to the central portion of the Rio Salado in or about extensive quiet water. Vegetation for the most part was absent from the collection areas. In most cases the bank shores of the localities seined were void of any natural cover which could afford some protection from predators. In Don Martin Lake, where this species has been stocked, it was one of the more common forage species and was collected in areas near obstructions such as sunken logs, barges and piers.

It is of interest to note that the gizzard shad replaces Astyanax fasciatus mexicanus, the Rio Grande tetra, in the vicinity of Lake Don Martin. This would indicate that there is intraspecific competition between the two species, but without further work this remains theoretical.

The ecological habits displayed by this species agree in all respects with those observed in the San Marcos River, Texas (Jurgens, 1951).

Family Characidae

Astyanax fasciatus mexicanus (de Fillippi)

Rio Grande Tetra

The Rio Grande tetra is one of the most common species in the Rio Salado and its tributaries. Astyanax fasciatus mexicanus was collected in all but five stations.

The water in which this species occurred varied from clear to murky, and the speed of the current varied from very slow to very swift. The bottom for the most part was composed of sandy silt over rocks.

TxU

This species is found all over the Rio Salado and its tributaries, with the exception of the region of Don Martin Lake. In this general area Dorosoma cepedianum, the gizzard shad, is common and may occupy its habitat.

This neo-tropical species was collected in six areas that had some form of vegetation growing in them as well as in ten localities that had no vegetation. Therefore, it may be assumed that Astyanax fasciatus mexicanus is indifferent to vegetation. In all cases where this species was collected, the Rio Grande tetra was observed in groups or schools; this is congruent with the previous statements that this is a pelagic species.

Family Catostomidae

Carpiodes carpio elongatus Meek

Slender Carpsucker

Sixteen specimens of this species were collected from five stations on this survey. The water varied from clear to murky, and the current flow ranged from slow to moderate. Vegetation was absent in all cases from the mud and silt bottoms where these specimens were collected.

The distribution of the slender carpsucker is restricted to the Rio Salado proper, from Don Martin Dam in Coahuila to a station twenty-five miles southeast of La Gloria, Nuevo Leon.

This species was collected in mud and silt bottom areas that were rich in aquatic invertebrates and devoid of vegetation. It is, therefore, possible to assume that this type of river bottom represents the preferred ecological habitat for this species as is the case in central Texas.

Moxostoma congestum albidum Girard

Mexican Gray Redhorse

The only specimen of this species was collected near the headwaters of the Río Salado de los Nadadores. The water at this place was murky and the current very slow. Vegetation was absent from this area which had a bottom composed of mud and silt over rocks.

The salinity of the water at this locality was very high as some decayed plant stems from the area were calcified. The high salt concentrations may also account for the small number of species and specimens obtained from this area, but no chemical analysis of the water was made. In central Texas this species is often collected in clear headwater streams.

Family Cyprinidae

Extrarius aestivalis aestivalis (Girard)

Mexican Speckled Dace

The Mexican speckled dace was collected in twelve localities along the Río Salado and Río Sabinas de Coahuila. This species was present from San Felipe, Coahuila, to La Gloria, Nuevo Leon.

The water where this species was collected was either semi-clear or murky, while the current was generally slow. Vegetation was found in only two localities. The bottom for the most part was of mud and silt over rocks.

The known distribution of this species in this river system is from La Gloria, Nuevo Leon, to the outlet of the Río de Candela on the Río Salado. This species was not collected in the western section of the

Rio Salado proper, but was taken from the lower portion of the Rio Sabinas de Coahuila. The Mexican speckled dace is totally absent from the collections from the Rio Salado de los Nadadores. It is also absent from the one collection made at the southern tributary of the Rio Salado, the Rio Sabinas de Nuevo Leon.

Specimens obtained in two collections, station ten (Rio Salado, ten miles west of Anahuac) and station eleven (Rio de Candela outlet on the Rio Salado), tend to approach another subspecies, Extrarius aestivalis sterlitus (Cope), the Rio Grande speckled dace.

Notropis jemezianus Cope

Rio Grande Shiner

The Rio Grande shiner was collected only at station seven in the Rio Salado. Little can be said of the ecology or distribution of this species except that it can inhabit the downstream segment of this river system.

Notropis amabilis Girard

Texas Shiner

The Texas shiner was present in four of the twenty-two collections made on this survey. In all cases this species was collected in water that was slightly to moderately turbid. The current for the most part was moderately swift.

Vegetation occurred in three of the four places where the specimens were taken. The bottom was generally composed of mud and silt over rock.

The four collections of Notropis amabilis were rather widely scattered in the river system. It is of interest to note that the Texas shiner was

not found in the Rio Salado de los Nadadores, whose waters have a higher degree of salinity than those of the Rio Sabinas de Coahuila, the Rio Salado, and the Rio Sabinas de Nuevo Leon.

Notropis simus orca Woolman

Texas Blunt-nose Shiner

The Texas blunt-nose shiner was collected from fourteen localities along the course of the Rio Salado and its tributaries, with the exception of the southern tributary, the Rio Sabinas de Nuevo Leon. This species also occurred at the outlet of the Rio de Candela on the Rio Salado.

The turbidity of the water was slight to moderate, over a water depth averaging four feet. The river current over these collection stations was generally moderate, and in one case the water was stagnant.

Vegetation occurred twice in fourteen collections; so it could probably be said that vegetation is of no significance in the ecological distribution of Notropis simus orca. The bottom was for the greater part composed of mud and silt over rock.

Reference to Table 1 shows that Notropis simus orca is absent from the collections made at the extreme headwaters of all tributaries.

Notropis lutrensis lutrensis Baird and Girard

Plains Red Shiner

The Plains red shiner was collected from twelve locations along the Rio Salado and its upper northern tributary, the Rio Sabinas de Coahuila. This species was not collected in the Rio Sabinas de Nuevo Leon or the Rio Salado de los Nadadores.

The water over these locations was for the most part semi-clear to clear and had an average depth of four and a half feet. The river current varied from slow to moderate according to the river bottom conditions.

The distribution of this shiner is restricted to the upper fork of the Rio Salado, the Rio Sabinas de Coahuila, and the Rio Salado. It is of interest to note that this species does not occur in the more saline waters of the Rio Salado de los Nadadores, or the swift, clear waters of the southern tributary of the Rio Salado, the Rio Sabinas de Nuevo Leon. The distribution of the Plains red shiner is very similar to that of the Texas blunt-nose shiner. These two species prefer the same ecological habitats and were collected simultaneously with only six exceptions.

Notropis proserpinus Girard

Proserpine Shiner

The Proserpine shiner was the most common species found in the Rio Salado and its upper-fork tributaries. This species occurred in twenty of the survey's twenty-two collections, the exceptions being in the southern tributary of the Rio Salado, the Rio Sabinas de Nuevo Leon, and in one locality along the Rio Salado de los Nadadores.

The water ranged from clear to semi-clear, over a river channel that had an average water depth of four feet and a current speed ranging from slow to rapid. Vegetation was observed in only five of the twenty collection stations. The bottom conditions showed a wide variation, mud, silt and rocks over bedrock being most common.

It is readily apparent that this species is widely distributed in this river system. In only one locality (the Rio Sabinas de Nuevo Leon) is its absence noteworthy. Perhaps its absence is due to the presence of large populations of Dionda episcopa couchi and Astyanax fasciatus mexicanus

which may occupy the Proserpine shiner's preferred habitat.

The ecological distribution of this species is very similar to that of Notropis lutrensis lutrensis, the Plains red shiner. The ecological habitat relations exhibited by these in this area is very similar to those displayed by Notropis lutrensis lutrensis and Notropis venusta venusta, in the San Marcos River (Jurgens, 1951).

Notropis braytoni Jordan and Evermann

Tamaulipas Shiner

The Tamaulipas shiner was one of the most common species found in the Rio Salado and the Rio Sabinas de Coahuila. This species was taken from sixteen stations out of twenty-two.

The waters where Notropis braytoni was collected had a turbidity range of slight to moderate and an average depth of four feet. Vegetation for the most part was absent, occurring in only three of the sixteen localities, while the river channel bottoms were made up mostly of mud and silt over rock.

The collections of this species indicate that the Tamaulipas shiner occurs in the lower reaches of the Rio Sabinas de Coahuila and the Rio Salado proper. The collections also indicate that Notropis braytoni does not occur in the more saline waters of the Rio Salado de los Nadadores. Its distribution is similar to that of Notropis simus and Notropis lutrensis.

Notropis chihuahua Woolman

Chihuahua Shiner

The Chihuahua shiner occurred in one-half of the survey's twenty-two collections. Its general distribution is from La Gloria, Nuevo Leon, near

the outlets of the Rio Salado into the Rio Grande, to an area north of Don Martin Lake on the Rio Sabinas de Coahuila. This species was not found in the upper headwaters of the Rio Sabinas de Coahuila, the Rio Salado de los Nadadores, or the southern tributary of the Rio Salado, the Rio Sabinas de Nuevo Leon.

The water was for the most part semi-clear and in a few cases completely clear. The current was generally slow to moderate over water depths that averaged four feet, varying slightly with the river bottom profile. Vegetation was characteristically absent, occurring in only two cases out of eleven. The bottom for the most part was of mud and sandy silt over rock.

Notropis chihuahua is one of the rarer species collected on this survey (only sixty-eight specimens). It is a salient fact that this species is not an inhabitant of the river headwater areas, the clear, swift-running waters of the Rio Sabinas de Nuevo Leon, or the more saline waters of the Rio Salado de los Nadadores, as is true of a large number of the species previously discussed.

Notropis robustus Meek

Robust Shiner

The robust shiner was collected in ten localities along the Rio Salado and its northern fork, the Rio Sabinas de Coahuila.

The waters in which Notropis robustus was collected were for the most part vegetation-void, semi-clear to clear waters with a current speed variation from slow to moderate. The river bottom could be characterized as one of mud and sandy silt over bedrock. The average depth of capture for this species was four feet.

This is another species which avoids the headwater habitat. Like

Astyanax fasciatus mexicanus, it is absent in the collections from the vicinity of Lake Don Martin.

Notropis deliciosus deliciosus (Cope)

Sand Shiner

Only one specimen of this species was collected in the area of Presita, Coahuila, which is five miles northwest of Villa Juarez, Coahuila.

On the basis of only one specimen, it is almost impossible to give any facts as to its distribution or ecological preferences. However, it may be assumed that Notropis deliciosus occurs in other similar areas of clear, very swift, vegetation-laden waters over a rock bottom, as it does in central Texas.

Notropis sp.

Six specimens of an apparently undescribed species were collected in two stations in the Rio Sabinas de Coahuila.

The ecological conditions in the two collection localities of this species were different. The water was always clear, but in one instance the current was moderate and in the other very swift. Vegetation was absent in one site while it was heavy at the other. In both places the bottoms were composed of sandy silt and rocks and gravel over bedrock. Other consistent factors about the stations were the water temperature (eighty-six degrees Fahrenheit) and being located in the upper reaches of the stream system.

Dionda episcopa couchi Girard

Rio Grande Round-nose Minnow

Two hundred and twenty-three specimens of the Rio Grande round-nose minnow were collected from four locations. It is apparent from this survey that the preferred ecological habitat of this species is centered around the headwaters region of the Rio Sabinas de Nuevo Leon, the Rio Sabinas de Coahuila, and the Rio Salado de los Nadadores.

The water was in most cases clear with a rapid to very swift current. The average depth of capture for this species was approximately four feet. In all cases vegetation was present either in the stream or on the deep-cut bank-line area. The bottom was for the most part composed of mud and sandy silt over rocks and bedrock.

This species is a definite river, head-water inhabitant, living where the water temperature is relatively constant at eighty-eight or eighty-nine degrees Fahrenheit. It is of interest to note that this species was always observed in schools.

It was observed that Dionda episcopa couchi when excited tend to seek the protection offered by the bank-line vegetation. Several times this species was observed to swim rapidly out of its protective micro-habitat and attack invertebrates thrown near the bank-line area.

Pimephales vigilax vigilax Girard

Parrot Minnow

The parrot minnow, which was collected in nine localities on the Rio Salado, is restricted to the lower segment of the river. Its known

geographical range in the Rio Salado is from La Gloria, Nuevo Leon, to Salinillas, Nuevo Leon.

In all cases, this species was taken from waters that were slightly turbid. The current over the average depth of capture of four and a half feet, was for the most part slow to moderate. Aquatic vegetation was found in only three localities. The bottom may be generally described as one of mud and sandy silt over rock.

The data obtained from this survey indicate that the area of most abundance of this species in the Rio Salado occurs near Ejida de Nuevo Camaron, twelve miles southwest of Anahuac. This assumption is based on the decrease in number of specimens obtained both down and upstream from this locality.

Family Ameiuridae

Ictalurus punctatus punctatus X lupus

Channel Catfish

The specimens of channel catfish of this species collected on the survey represent intergrades between Ictalurus punctatus punctatus and Ictalurus punctatus lupus. This species was collected from seven localities, that range from La Gloria, Nuevo Leon, to Musquiz and San Buenaventura, Coahuila. This species was found in collections scattered through all the Rio Salado and its headwaters, except the Rio Sabinas de Nuevo Leon.

This species was collected from waters of slight turbidity with a slow to moderate current and from an average capture depth of five feet. Vegetation was present in two of the seven localities where this species was taken. Specimen numbers from the two localities indicate that this species

is not abundant in vegetated habitats. The bottom for the most part was composed of mud and silt over rock.

Ictalurus furcatus affinis (Baird and Girard)

Rio Grande Blue Catfish

Only one specimen of the Rio Grande blue catfish was taken at Ejida de Nuevo Camaron, twelve miles southeast of Anahuac, Nuevo Leon. On the basis of one specimen, nothing definite may be said pertaining to its ecological preferences or habitats. This species was collected in vegetation-void, semi-clear, slow-moving water, over a bottom of mud and silt on rock. The general depth of capture for this species was approximately five feet. Even though this species did not appear in other collections, it might be expected to be found rarely in other, similar habitats.

Pilodictis olivaris (Rafinesque)

Flat-head Catfish

The one specimen of Pilodictis olivaris collected from the waters of the Rio Salado at a site ten miles west of Anahuac serves only to indicate its possible habitat preference. This species was taken from vegetation-void, slightly turbid, moderately moving water, at a depth of five feet. The bottom was of mud and silt over rock.

Family Poeciliidae

Gambusia affinis (Baird and Girard)

Common Mosquito Fish

The common mosquito fish occurred in eight locations along the Rio Salado

and the Rio Sabinas de Coahuila. The geographical range for this species is from Musquiz, Coahuila, to near La Gloria, Nuevo Leon.

Gambusia affinis was found to occur at the surface of the river in localities that for the most part were clear or semi-clear and slow or moderate of movement. Vegetation was found in three of the eight localities, while the bottom was composed mostly of mud and sandy silt over rock.

It is of interest that this species does not occur in the clear-running waters of the Rio Sabinas de Nuevo Leon, or the more saline waters of the Rio Salado de los Nadadores.

Gambusia sp.

This apparently undescribed species was found in twelve locations along the Rio Salado and its lower fork tributary, the Rio Salado de los Nadadores. The range of this species in this general area is from Sacramento, Coahuila, to La Gloria, Nuevo Leon.

This apparently top-water inhabitant was for the most part found in waters of slight or no turbidity and slow to moderate movement. Vegetation along the river channel or bank-line area occurred at only two of the collection areas; so for all practical purposes, vegetation is of no consequence in the distribution of Gambusia sp. The conditions of the bottom of the waters where this species was collected show a variation from bare bedrock strata to a soft, vegetation-laden, sandy, deep subsurface.

Gambusia sp. is very similar to Gambusia nobilis (Baird and Girard) and Gambusia senilis Girard, as described by Alvarez (1950); however, Miller (1951) corrects Alvarez's misidentification on the basis of Hubbs' (1926) work, which shows that Gambusia nobilis is restricted to the Pecos River drainage of New Mexico and western Texas.

The two species of the family Poeciliidae, Gambusia affinis (Baird and Girard) and Gambusia sp. on this survey occupy different headwater areas. Even though both species occur on the Rio Salado, Gambusia affinis (Baird and Girard) is found only in the headwaters of the Rio Sabinas de Coahuila, while Gambusia sp. occurs in the more saline headwaters of the Rio Salado de los Nadadores.

Family Percidae

Poecilichthys lepidus grahami (Girard)

Rio Grande Darter

This is the only species of darter that was collected in the area of the survey. Twenty-seven specimens were collected at one locality (Musquiz, Coahuila).

The water was clear, fresh and flowing very swiftly over vegetation beds from which this species was collected. The bottom was composed of fine gravel and sandy silt over rock. Poecilichthys lepidus grahami apparently is restricted to a definite section of the Rio Sabinas de Coahuila where fresh, clear waters and heavy vegetation beds form a habitat similar to that in which this species is found in Texas. It may be assumed that this species does not occur in survey stations due to the absence of the dense vegetation.

Family Centrarchidae

Micropterus salmoides (Lacepede)

Largemouth Bass

Micropterus salmoides in the region of this survey has wide ecologic preferences. The largemouth bass was found in waters ranging from very clear to very muddy. The depth of capture for this species was from two to six feet, with a collection average of four feet. The speed of the current was always in proportion to the bottom profile, the general composition of the subsurface strata, and the degree of declivity in the river bed. The speed range was from slow to very swift. Vegetation occurred in four of the eleven collection sites. The bottom presented a series of conditions, from solid bedrock to fine sandy silt and mud over rocks.

This species has a range in this survey area which in part helps to account for the excellent fishing in some of the better known lakes in Mexico. One reason for the large numbers of Micropterus salmoides may be the exceedingly large numbers and species of food fish that are available for this more desirable game fish. Another reason for the abundance of largemouth bass may be the low numbers of bass predator species that exist in the area.

The specimens of Micropterus salmoides collected on this survey have slight morphological differences from specimens of Micropterus salmoides taken in Texas. The area surveyed undoubtedly contains one of the populations least contaminated by hatchery stocking. This largemouth bass race easily might be superior to hatchery stocks, and thus might account for the excellent fishing in the area. This is logical, as natural selection has

had an opportunity to modify the bass according to the natural habitat, not to hatchery conditions.

The tendency for this species to become common in the upper reaches of the stream correlates with data from central Texas.

Lepomis megalotis occidentalis Meek

Rio Grande Longear Sunfish

Eighteen specimens of the Rio Grande longear sunfish were collected from eight locations. The geographical range of this species in the area of this survey is from the upper portion of the Rio Salado to and including the two forks, the Rio Sabinas de Coahuila and the Rio Salado de los Nadadores.

The waters from which Lepomis megalotis occidentalis were collected were for the most part clear or semi-clear. The average collection depth for this species was four feet. The current ranged from slow to very swift, with a swift speed being the general condition, which is in accordance with the general topography of the headwaters area. Vegetation is of some consequence in the ecological distribution of the species, as it was found in four out of the eight collections. The bottom was composed for the most part of mud and silt over rocks.

The Rio Grande longear sunfish was found to occur in the quiet pools which were protected from the current by vegetation or sand bars. These findings are similar to those in central Texas.

Lepomis macrochirus speciosus (Baird and Girard)

Bluegill

Bluegills were for the most part restricted to the lower Rio Salado proper; in only two of the eight collections of bluegills were from the Rio Sabinas de Coahuila. The geographical range for this species in the survey area is from La Gloria, Nuevo Leon, to five miles north of Villa Juarez, Coahuila.

In most localities the water was semi-clear. The average depth of capture was three and a half feet. The speed of the current ranged from very slow to very swift. The bottom was composed for the most part of mud and silt over rock, while vegetation occurred in only one of the eight localities where this species was collected.

This species differs from the other sunfish (Lepomis megalotis occidentalis) that were collected in this survey in its ecological habitats. Lepomis macrochirus speciosus was found to occur in all parts of the river channel with no preferences for vegetation or water obstructions.

Reference to Table 1 shows that this species never occurred in the same collections as Lepomis megalotis occidentalis. With the exception of collection twelve, the ranges of the two sunfish species do not overlap, i.e., Lepomis macrochirus speciosus occupies the lower parts of the Rio Salado and Lepomis megalotis occidentalis is generally restricted to the headwaters regions.

Family Sciaenidae

Aplodinotus grunniens Rafinesque

Fresh Water Drum

The fresh water drum was collected from five locations along the Rio Salado and the Rio Sabinas de Coahuila.

Aplodinotus grunniens usually was collected from clear waters; the current was generally moderate, and the average depth of capture was four feet. Vegetation was present only once in the generally muddy and silt-over-rock bottoms.

The fresh water drum was found only in the Rio Salado, and on a lower collection site on the Rio Sabinas de Coahuila. It did not occur in the fresh, clear-running waters of the Rio Sabinas de Nuevo Leon, or the more saline waters of the Rio Salado de los Nadadores.

Family Cichlidae

Herichthys cyanoguttatus cyanoguttatus (Baird and Girard)

Rio Grande Perch

The Rio Grande perch is the only member of this tropical family that was encountered in the survey.

This species was found in seventeen collections of the survey's twenty-two. It was found in the Rio Salado, the Rio Sabinas de Coahuila, the Rio Salado de los Nadadores and the Rio Sabinas de Nuevo Leon. It also occurred at the mouth of the intermittent river, the Rio de Candela.

The Rio Grande perch was collected from waters that ranged from very clear to very muddy. The depth of capture for this species varied from three to six feet. Vegetation, either sparse or luxuriant, was found to occur in eight of the seventeen localities where this species was collected. The current varied from stagnant to very rapid. The stream bottom picture presented a multitude of conditions ranging from boulders over bedrock to one of fine sandy silt over rocks.

Collection notes indicate that this species prefers the shaded, somewhat quieter waters of the streams. In this survey it was found that the stream gradient had no effect upon the distribution of this species.

SUMMARY

An ichthyological and ecological survey of the Rio Salado system in the states of Tamaulipas, Nuevo Leon, and Coahuila, Mexico, has been made in order to obtain more knowledge of the Mexican ichthyo-fauna. The Rio Salado system is comprised of the upper fork tributaries, the Rio Sabinas (de Coahuila), the Rio Salado de los Nadadores, the Rio Salado proper, in the middle region the intermittent river of the Rio de Candela, and its southern tributary the Rio Sabinas (de Nuevo Leon).

The total linear distance over which water flows in this river system is about 670 miles. It covers an area of approximately 17,383 square miles, and exists mostly in the Tamaulipan and partly in the Chihuahuan biotic provinces of Blair (Blair-1950).

The Rio Salado may be broken into four ecologic segments, each exhibiting a wide range of highly specialized ecological niches and habitats. These segments are set upon the basis of the two main tributaries, the Rio

Salado proper and its southern tributary. The exact geographic and physical limits of the ecologic subdivisions remain unknown. Much additional field work would be needed for this information. It is believed that this precise ecologic work is not of great import at the present due to the isolated geographic locality. It is very probable that the physical factors separating the ecologic subdivision are similar to those subdividing Texas streams, i. e., a combination of many different factors working together to modify the habitat in such a way that the fish fauna changes.

Vegetation was relatively absent from the river channel because of its bedrock bottoms and the high saline content of some areas.

The collections obtained on this survey contained thirty species of fish, which may be broken down into eleven families and twenty genera. The distribution of these species may be seen by reference to Table 1 and the map.

In conclusion it may be said without reservations that the ichthyological fauna of this survey area is very similar ecologically to that of central Texas. The only differences between the faunae noted could be caused by geographic isolation.

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MAP I.

LIST OF THE COLLECTION STATIONS

Number	Locality
1	Rio Salado, 2 miles S. La Gloria, Nuevo Leon.
2	Rio Sabinas de Nuevo Leon, 2 miles S. W. of Sabinas Hidalgo, Nuevo Leon.
3	Rio Salado, 2 miles N. E. Rio Salado Bridge on Laredo-Monterrey Highway.
4	Rio Salado, Gonzalez Hacienda, 25 miles N. N. E. La Gloria, Nuevo Leon.
5	Rio Salado, Gonzalez Hacienda, 1.5 miles S. E. of Water Pump, Nuevo Leon.
6	Rio Salado, Gonzalez Hacienda, 3 miles S. E. of Pump, Nuevo Leon. (Night Collection)
7	Rio Salado, Pase Santeno, 1 mile N. E. Ejida Rodriquez, Nuevo Leon.
8	Rio Salado, 4 miles E. Anahuac Road at Ejida Nuevo Camaron, Nuevo Leon.
9	Rio Salado, Bridge Crossing at Rodriquez, Nuevo Leon.
10	Rio Salado, 1 mile W. of Manuel Martinez Parcela, 10 miles W. Anahuac, Nuevo Leon.
11	Rio Salado, at Outlet of Rio de Candela, 10 miles S. of Anahuac, Nuevo Leon.
12	Rio Salado, 8 miles S. W. Anahuac, Nuevo Leon.
13	Rio Salado, 6 miles W. Salinillas, Coahuila.
14	Don Martin Lake, Union of Rio Sabinas de Coahuila, and Rio Salado de los Nadadores, Don Martin, Coahuila.
15	Rio Sabinas de Coahuila, 2 miles S. W. Crucero de Villa Juarez, Coahuila.
16	Rio Sabinas de Coahuila, at Presita, Coahuila.
17	Rio Sabinas de Coahuila, 2 miles S. W. of San Felipe, Coahuila.
18	Rio Sabinas de Coahuila, 2 miles S. W. of Nueva Rosita, Coahuila.
19	Rio Sabinas de Coahuila, 2 miles N. of Musquiz, Coahuila.
20	Rio Salado de los Nadadores, 3 miles S. of Hermanas, Coahuila.
21	Rio Salado de los Nadadores, 8 miles N. of San Buenaventura, Coahuila.
22	Rio Salado de los Nadadores, 2 miles N. W. of Sacramento, Coahuila.

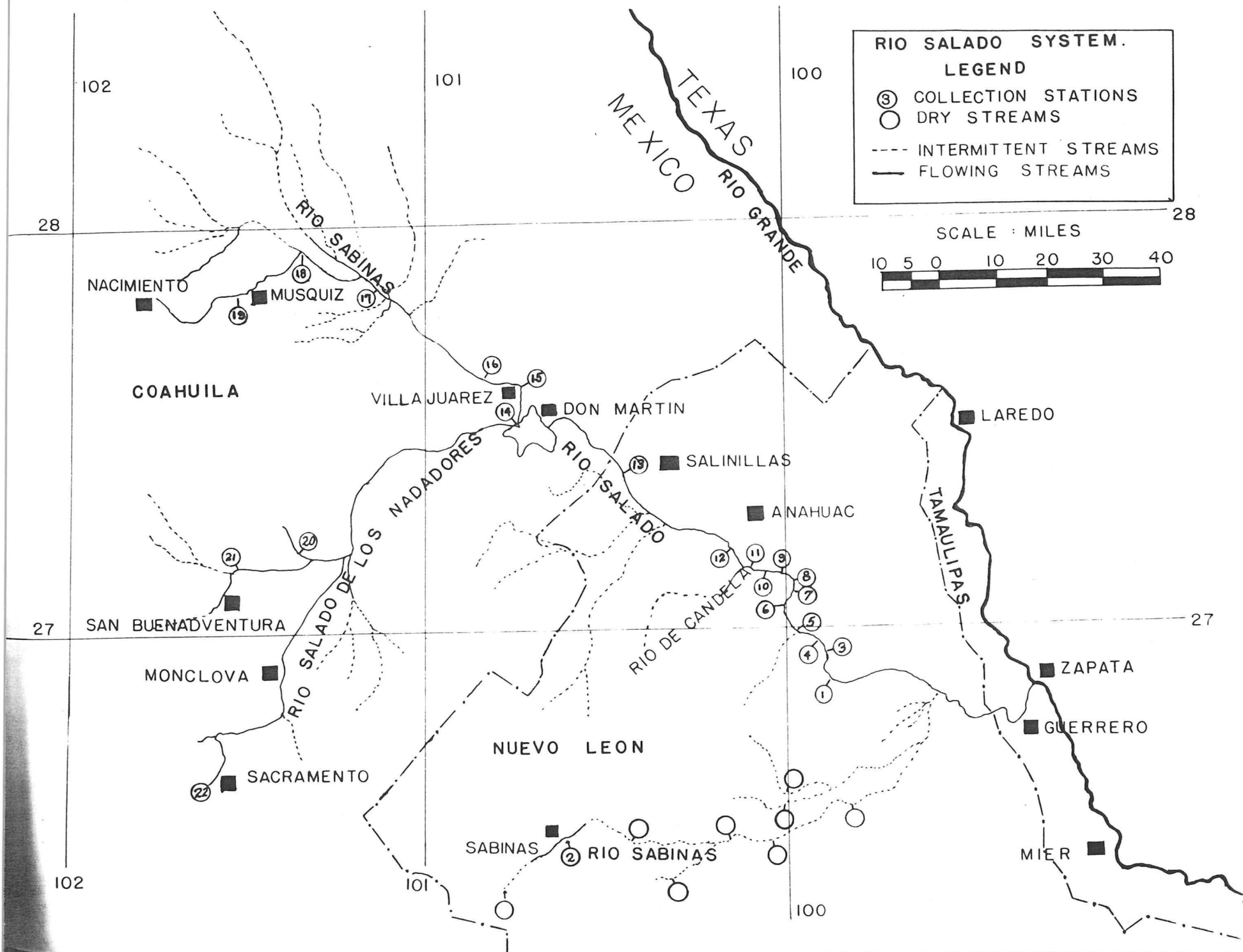


Table 1. Seining Collections of Specimens
from the Rio Salado

COLLECTION STATIONS

GENUS AND SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	TOTAL
LEPISOSTEUS PRODUCTUS			6			2		1		4											1		14
LEPISOSTEUS OSSEUS LEPTOHYNCHUS						1																	1
DOROSOMA CEPEDIANUM											4		42		20	3							69
ASTYANAX FASCIATUS MEXICANUS	8	40	30	30		2	5	4	33	33	16	1	10					18	4	14	12	8	268
CARPIODES CARPIO ELONGATUS				1				1		4	1			9									16
MOXOSTOMA CONGESTUM ALBIDUM																					5		5
EXTRARIUS A. AESTIVALIS	2		10	17	2	65	55	9	100	61	5					2	4						332
NOTROPIS JEMEZANUS							8																8
NOTROPIS AMABILIS		40					9						8						36				93
NOTROPIS SIMUS-ORCA	32		50	17	8	23	5	30	9	16	1			5	215	135	62	1		12			621
NOTROPIS L. LUTRENSIS	17		1	1				6	8	13	7	37		41	96	8	1						236
NOTROPIS PROSERPINUS	12		23	12	6	14	37	56	39	43	23	65	3	41	6	49	19	1	56		15	193	713
NOTROPIS BRAYTONI	29		59	55	1		61	76	61	90	27	13	4	15	24	14	49						578
NOTROPIS CHIHUAHUA	17			2				1	1	5	13		1	22	1	1							64
NOTROPIS ROBUSTUS	7		13	33	12	17	1	5		9						2	1						100
NOTROPIS D. DELICIOSUS																		1					1
NOTROPIS SPECIES																1			5				6
DIONDA EPISCOPA COUCHI		79																1	127			16	223
PIMEPHALES V. VIGILAX			4	3			4	6	3	3	2	3											28
ICTALURUS P. PUNCTATUS X LUPUS			1			7	3	1		1									1		1		15
ICTALURUS FURCATUS AFFINIS								1															1
PILODICTIS OLIVARIS										1													1
GAMBUSIA AFFINIS			8	4	4		1	35			8				1				7				68
GAMBUSIA SPECIES			21		2			5	6	2	15	38	3	1	1				1	22	3	156	276
POECILICHTHYS LEPIDUS GRAHAMI																			27				27
MICROPTERUS SALMOIDES		2								1	10	1	5	12	18	1		1		5	7	1	64
LEPOMIS MEGALOTIS OCCIDENTALIS												1					1	1	5	1	8	1	18
LEPOMIS MACROCHIRUS SPECIOSUS			1							13			26		1	1							42
APLODINOTUS GRUNNIENS	2		1									3		12		3							21
HERICHTHYS C. CYANOGUTTATUS		16	2	5		2	2	1	10	10		1	21				4	4	5	4	3	52	142
TOTAL	126	177	230	180	35	133	191	238	271	318	123	167	130	164	366	219	141	28	274	58	55	427	4051

VITA

Luciano Val Guerra was born in Mission, Texas, on May 21, 1922, the son of Andrea Olivarez de Guerra and Dario Guerra, Sr. He graduated from Mission High School in Mission, Texas, in 1941. In the fall of 1941 he entered the University of Texas, remaining until the spring term of 1943. In 1943 he entered military service, volunteering in the navy, where he served until February, 1946. Upon discharge he re-entered the University of Texas until 1947. In the fall of 1947 he entered Edinburg Junior College in Edinburg, Texas. In 1948 he returned to the University of Texas where he received his Bachelor of Arts degree in 1950. In September of 1951 he entered the Graduate School of the University.

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This thesis was typed by Evalyn K. Jurgens.