

Catalogue of American Amphibians and Reptiles.

Sever, D.M. 1999. *Eurycea bislineata*.

Eurycea bislineata* (Green)*Northern Two-lined Salamander**

Salamandra bislineata Green 1818:352. No type locality or type specimen designated. Cope (1889) reported that the type is from New Jersey, but in the same publication he listed two specimens catalogued as USNM 3738 as types from "western Pennsylvania." Dunn (1926) stated, "Probably there are none [types] in existence and never were any." Fowler (1907) stated that the type locality was the vicinity of Princeton, New Jersey, and this designated type locality has been accepted by most subsequent workers (e.g., Jacobs 1987, Mittleman 1949, Schmidt 1953, Sever 1972). Presumed topotypes from Mercer Co., New Jersey (AMNH 37342-8 and USNM 123945) have been examined by the author.

Salamandra flavissima Harlan 1826:286. Type locality, "Vicinity of Philadelphia, Pennsylvania." "This species will occupy an intermediate station between the *S. bislineata* and *S. rubriventris*. (A specimen in the cabinet of the Acad. of Nat. Sc. of Phil.)." Mittleman (1966) quoted E.V. Malnate (in litt.): "The type is not now extant in the Academy of Natural Sciences of Philadelphia, nor is there any evidence other than Harlan's statement that it ever was."

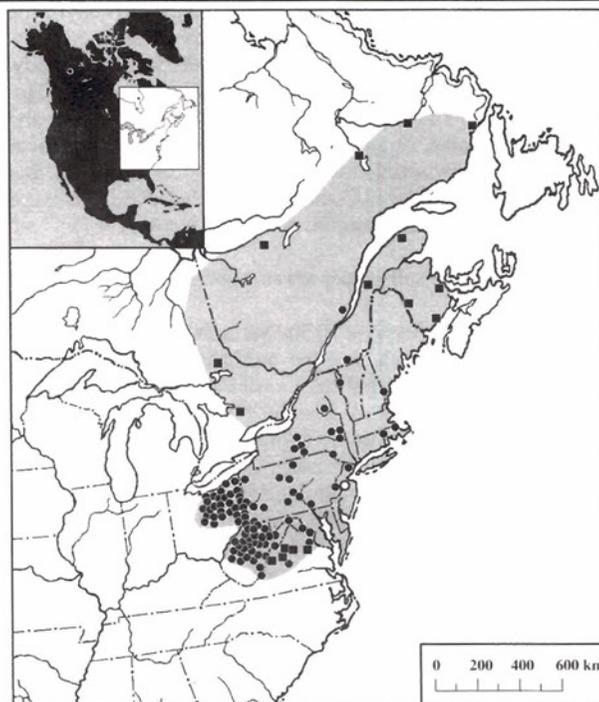
Salamandra bilineata: Holbrook 1839:55. Holbrook noted, "From an error of the press, this stands *Salamandra bislineata*," but the error is perpetuated in Holbrook (1842) and "*Salamandra bilineata* Holbrook" is used by DeKay (1842). Baird (1849) used the new combination "*Spelerpes bilineata* Green" and Cope (1889), Goodale (1911), and others used "*Spelerpes bilineatus* Green."

Salamandra haldemani Holbrook 1840:125. Type locality, "from the borders of the Susquehanna River, [Harrisburg, Pennsylvania]." A holotype was not designated, but may be fixed as Holbrook's (1840) plate 28 (Mittleman 1966). Dunn (1926) stated that this taxon was based upon a transforming specimen of *E. bislineata*.

Spelerpes bilineata: Baird 1850:287. New combination, placing the species in the genus *Spelerpes* (Rafinesque 1832).

Salamandra dorsata Valenciennes, in Dumeril et al. 1854:93. Type locality was not designated, but was restricted to "Harrisburg, Pennsylvania" by Schmidt (1953). A holotype was not designated, but "may be fixed as Figure 1, Vélín 88 du Muséum d'Histoire Naturelle de Paris" (Mittleman 1966).

Salamandra bitaeniata Valenciennes, in Dumeril et al. 1854:93. Neither a type locality or type specimen was designated, but the holotype "may be fixed as Figure 5, Vélín 88 du Muséum



MAP. Range of *Eurycea bislineata*. The circle marks the designated type locality. Dots indicate localities from which the author has examined museum specimens and squares indicate literature records that show the limits of the range in Canada (from Weller and Green 1997) and in Virginia (from Mitchell and Reay 1999).

d'Histoire Naturelle de Paris" (Mittleman 1966).

Spelerpes bilineatus borealis Baird, in Cope 1889:165. Type locality, "Kenebago Lake, near Oquassa, Me." (=Kennebago Lake, near Oquossoc, Franklin County, Maine (Mittleman 1966). The locality has also been referred to as Lake Mooselookmeganic (Schmidt 1953) and Lake Oquassoc (Cochran 1961). Syntypes, National Museum of Natural History (USNM) 4735a, nine adults and two larvae (but see Mittleman 1966), collected by C. Girard, 1852 (not examined by author).

Eurycea bislineata: Stejneger and Barbour 1917:18. New combination, placing the species in the genus *Eurycea* (Rafinesque 1822).

Eurycea bislineata bislineata: Dunn 1920:134. First denotation of subspecies.

Eurycea bislineata major Trapido and Clausen 1938:118. Type locality, "under limestone slabs along Quiatchouan River, Val



FIGURE. Adult *Eurycea bislineata* from Barkcamp State Park, Belmont County, Ohio.

Jalbert, Lake St. John Co[unty], Quebec." Holotype, USNM 104239, an adult, collected by R.T. Clausen and H. Trapido, 17 September 1937 (not examined by author). Synonymized with *E. b. bislineata* by Oliver and Bailey (1939).

Eurycea bislineata rivicola Mittleman 1949:93. Type locality, "McCormick's Creek State Park, Owen County, Indiana." Holotype, USNM 129397, an adult male, collected by M.E. and M.B. Mittleman, August 1942 (examined by author). Sever (1972) synonymized *E. b. rivicola* with *E. b. bislineata*, but the type locality (Owen County, Indiana) lies within the range of what is now considered *E. cirrigera* (Jacobs 1987).

• **CONTENT.** No subspecies are recognized.

• **DEFINITION.** *Eurycea bislineata* is the common "Yellow Salamander" in Canada and the northeastern United States. Actually, the dorsal ground color varies among various shades of yellow, olive, brown, or orange. The venter is whitish at metamorphosis and becomes yellow with maturity. The basal portion of the trunk and the undersurface of the tail may be washed with orange, especially during the breeding season in montane populations. Two black or brown dorsolateral stripes extend from the eye onto the tail. The length of the tail stripe onto the tail is not a diagnostic character, despite some literature that suggests otherwise (Mittleman 1966, Conant and Collins 1998, Petranks 1998, Powell et al. 1998). The length of the tail stripe onto the tail varies from 12.2% of tail length in a population from Pocahontas County, West Virginia to 75.2% of tail length in a population from Ashtabula County, Ohio (Sever 1972). At metamorphosis, melanophores are few or lacking medial to the dorsolateral stripes, but scattered or more concentrated black spots usually are found on the head, trunk, and anterior portion of the tail as maturity is reached. Melanophores sometimes form a middorsal stripe. Various degrees of mottling exist inferior to the dorsolateral stripes, and unpigmented spots, indicative of the larval lateral line (Noble 1927), are sometimes conspicuous in mottled areas (Bishop 1941).

Mean SVL of large samples from various populations range from 32.6 mm in Chittenden County, Vermont to 40.9 mm in Perry County, Pennsylvania (Sever 1972). In the Finger Lakes region of New York, Stewart (1968) found that females were significantly larger than males; in both sexes SVL was 28.9–46.2 mm and TL was 56–111 mm. Sexual maturity can be reached at 61 mm TL in females and 67 mm TL in males (Bishop 1941). The tail is generally 55–60% of TL. Maximum TL is about 120 mm; the record appears to be a female from Mahoning County, Ohio, with 53 mm SVL and 123 mm TL (Sipes 1964).

Eurycea bislineata has 15 and occasionally 16 costal grooves, although lower numbers (13 or 14) occur rarely (Sever 1972). The highest mean costal groove counts noted by Sever (1972) were 15.29 in a sample of 17 salamanders from Ashtabula County, Ohio, and 15.25 in a sample of 72 specimens from Chittenden County, Vermont. The trunk grows faster than the limbs, so the number of costal grooves between toes of the adpressed limbs increases ontogenetically from 0–2 at metamorphosis to 2–4 at maximum adult size.

Maxillary and dentary teeth are larger and less numerous in males than females. Males have means of 24 maxillaries and 30 dentaries whereas females have means of 27 maxillaries and 35 dentaries (Stewart 1958). Males have a mean of five premaxillary teeth that vary from 288–321 mm height in the breeding season to 195–255 mm in the summer; females have a mean of eight premaxillary teeth (mean height 151 mm) that show no cyclic variation (Stewart 1958). Sever (1972) reported that the sum of right and left series of ankylosed vomerine teeth (equals prevomerine or anterior vomerine of some authors) ranges from a mean of 9.22 (Chittenden County, Vermont) to 17.33 (Sum-

mit County, Ohio). Stewart (1958) reported a mean of 10 vomerine teeth in samples from New York, and Muchmore (1955) found a mean of 15 in a population from Ashtabula County, Ohio.

In addition to seasonal variation in the length of male premaxillary teeth, males have other secondary sexual characters highly developed during the breeding season (Noble 1929). A fan-shaped mental gland cluster occurs under the lower jaw. From pores ventral and immediately posterior to the mandibular symphysis, simple tubular glands extend posteriorly in a thin dermal sheath between layers of the *M. intermandibularis posterior* ventrally and the *M. geniohyoideus* dorsally (Weichert 1945; Sever 1976, 1979). The enlarged premaxillary teeth of males penetrate the skin covering the apex of the lower jaw. During courtship the teeth rake the skin of the female while the male applies secretions from the mental gland (Arnold 1977). During the breeding season, heads of males appear swollen posterior to the eyes due to hypertrophy of temporal musculature (*M. levator mandibulae anterior profundus* and *M. l. m. externus*; Sever 1979). Elongate labial cirri are lacking (Sever 1972).

In the dorsal skin of the tail base, a cluster of caudal courtship glands occurs in males (Sever 1989a). These glands may encourage the female to remain astride the male's tail during spermatophore deposition (Sever 1989a). Males possess six pairs of cloacal glands involved in spermatophore production and one pair of cloacal glands (vent glands) presumably involved in pheromone production (Sever 1994). Females possess cloacal sperm storage glands, spermathecae (Kingsbury 1895, Kohring 1925), as well as another type of cloacal gland (the ventral gland; Kingsbury 1895, Sever 1994) that secretes a proteinaceous substance during a preovipository mating period (Sever 1988).

The larvae are aquatic stream-dwellers, although they have been found in ponds and wells (Sever, pers. obs.), and Bahret (1966) reported them from depths of at least 13.5 m in Lake Minnewaska, Albany County, New York. For New York stream populations, the larval period is generally two years with a mean size of 30 mm SVL (45.7–80.0 mm TL) at metamorphosis (Stewart 1968). In Pennsylvania, some individuals take three years to metamorphose, but regardless of whether two or three years are necessary, metamorphosis occurs at 27.1–34.1 mm SVL and 54.6–60.9 TL (Hudson 1955). Trapido and Clausen (1940) reported that in Quebec the larval period in streams may be three years and the smallest metamorphosed individual was 77 mm TL. Larvae from still waters seem to attain a larger size than those from streams. For example, the largest larvae Bahret (1966) collected from Lake Minnewaska were 43–46 mm SVL and 84–92 mm TL. Whether the larger size of these larvae is due to a longer larval period is unknown. A detailed study of the histological changes that accompany larval growth and metamorphosis of *E. bislineata* was done by Wilder (1925). Bishop (1941) provided excellent drawings of the external appearance of larvae at various developmental stages.

• **DIAGNOSIS.** The only other salamanders likely to be confused with *Eurycea bislineata* are other members of the complex (*E. cirrigera* and *E. wilderae*) in areas where their ranges meet or overlap, and *Desmognathus fuscus* and *D. ochrophaeus*, stream salamanders that are sympatric in some portions of their ranges with *E. bislineata* and may have a yellowish ground color. *Eurycea bislineata* can be distinguished from *E. cirrigera* and low altitude (below 1200 m) populations of *E. wilderae* by possessing 15–16 costal grooves rather than 14 (Sever 1989). *Eurycea bislineata* can be distinguished from high altitude populations of *E. wilderae* on the basis of range; no areas of contact or overlap are currently known. Species of *Desmognathus* always have a light stripe passing from the eye to the angle of the jaw (see also Sever 1999a,b).

• **DESCRIPTIONS.** After Green's (1818) original description, Harlan (1826) provided the next account, under the name *Salamandra flavissima*. His specimens were described as "Brownish, yellow above ... a broad black line on each side of the spine extending from the eye to the end of the tail" and are clearly assignable to *Eurycea bislineata*. DeKay (1842) presented a description of the species in New York. He noted, however, "Although this species is said to be very common, both by Green and Harlan, I have never had the good fortune to meet with it, and have consequently been compelled to use their description." Holbrook (1942) believed that *E. bislineata* extended into South Carolina, so his account included *E. cirrigera* (which Holbrook restricted to Louisiana and Mississippi). Later reports by Cope (1889), Dunn (1926), and Bishop (1943) effectively synthesized the descriptive literature available for the species at that time and added new material (e.g., Cope's osteological descriptions). Bishop's (1941) description of New York *E. bislineata* is still the most comprehensive available for the species.

Other accounts occur in various regional and state herpetologies (e.g., DeGraaf and Rudis 1983, Froom 1982, McCoy 1982, Oliver and Bailey 1939) and field guides (Cochran and Goin 1970, Conant and Collins 1998). Petranka (1998) did not recognize *E. cirrigera* and *E. wilderae* as separate species, and combined data on these species with those on *E. bislineata* into one account; however, a careful reading will reveal much material relevant to each taxon.

• **ILLUSTRATIONS.** The first illustrations of *Eurycea bislineata* were in Holbrook's (1839–1840) editions of North American herpetology (see Worthington and Worthington 1976 for the controversy over publication dates), with *Salamandra bilineata* (a typo noted by Holbrook 1839 for "*Salamandra bislineata*") first appearing as Plate 26 in the second version of volume II and *Salamandra haldemani* (a metamorphosing *E. bislineata* according to Dunn 1926) appearing as plate 28 in the edition of volume IV issued in 1840. Both plates occur in the more available second edition (Holbrook 1842). DeKay (1842, part III, plate 23) illustrated a specimen from New York. More recent illustrations include those in Bishop (1941, 1943) and Conant and Collins (1998). The best illustrations of the larvae remain those of Trapido and Clausen (1940) for specimens from Quebec and Bishop (1941) for specimens from New York.

• **DISTRIBUTION.** *Eurycea bislineata* ranges from Labrador and northern Quebec and eastern Ontario to northern Virginia, west through eastern Ohio and the Kanawha River valley of West Virginia. In Canada, *E. bislineata* is found in New Brunswick but still has not been recorded from Nova Scotia or Prince Edward Island (Weller and Green 1997). The distributional limits of the species in Canada are unclear, and the range of the species may actually be expanding. The boundary between *E. bislineata* and *E. cirrigera* has been established by allozyme analysis in Ohio (i.e., between 40°20' and 40°00' N latitude, Guttman and Karlin 1986) and Virginia (Mitchell and Reay 1999). The line drawn by Jacobs (1987) to indicate separation of *E. bislineata* and *E. cirrigera* in Virginia is too far south (Mitchell and Reay 1999). The specific status of Maryland populations has not been determined. Cooper (1953, 1956) and Harris (1975) used *E. b. bislineata* for the taxon found in Maryland, but allozyme analysis (Miller and Hallerman 1994) indicated that two genetically distinct, geographically overlapping forms occur. Some geographic overlap between *E. bislineata* and *E. cirrigera* has been reported in both Ohio and Virginia, and F_1 hybrids have been found in one area of sympatry in Coshocton County, Ohio (Guttman and Karlin 1986). Separation of *E. bislineata* and *E. cirrigera* in West Virginia is

based on modal costal groove count, as the contact zone has not yet been investigated by genetic analysis. *Eurycea wilderae* replaces *E. bislineata* in the Southern Blue Ridge Mountains in southwestern Virginia (Dunn 1926, Jacobs 1987).

• **FOSSIL RECORD.** None.

• **PERTINENT LITERATURE.** A considerable literature exists on *E. bislineata*, and the references listed below by topic are by no means exhaustive and do not include most references cited in other sections of this account: **chromosomes** (Fankhouser and Dluhy 1958), **courtship** (Noble and Brady 1930), **dentition** (Hilton 1951), **development and larvae** (Goodale 1911; Wilder 1924a,b), **diet** (Burton 1976, Smallwood 1928), **distribution** (Bleakney 1958, Cook and Bleakney 1960), **ecology, habitat, and habits** (Brooks and Croonquist 1990, Burton and Likens 1975, Denman and Lapper 1964, Frisbie and Wyman 1991, Hulchison 1956, McCoy 1989, Power 1965, Reed 1955, Wyman and Jancola 1992), **egg capsules** (Salthe 1963), **heat shock proteins** (Near et al. 1990), **induced oviposition** (Noble and Richards 1930), **lateral line sense organs** (Hilton 1947), **life history** (Bishop 1941), **mimicry** (Brodie 1981), **myology** (Hilton 1956b), **neuroanatomy** (Hilton 1956a), **osmoregulation** (Littleford et al. 1947), **osteology** (Hilton 1945, 1948), **predators and antipredator behavior** (Dowdley and Brodie 1989, Whiteman and Wissinger 1991), **reproductive biology** (Bishop 1941), **size** (Bell 1960), **spermatophores** (Noble and Weber 1929, Organ and Lowenthal 1963), **territoriality** (Grant 1955), and **thermoregulation** (Brattstrom 1963, Zweifel 1957).

• **REMARKS.** A number of important studies done prior to the splitting of *Eurycea bislineata* into three species (*E. bislineata*, *E. cirrigera*, and *E. wilderae*; Jacobs 1987) do not specify the localities from which specimens were examined (e.g., Wake 1966), so that the specific identity of the animals used cannot be determined. The only such references cited in this account are the papers by Hilton (1945, 1947, 1948, 1951, 1956a,b) on various anatomical structures that probably do not vary significantly among these three taxa.

• **ETYMOLOGY.** The specific epithet is from the Latin *bis* (= two) and *lineatus* (= line), in reference to the characteristic dorsolateral stripes.

• **COMMENTS.** Petranka (1998) preferred not to recognize the three species of *Eurycea* formerly considered subspecies of *E. bislineata* (*E. bislineata*, *E. cirrigera*, and *E. wilderae*) "until contact zones are examined and the degree of gene exchange occurring between genetic subgroups is quantified." However, Jacobs's (1987) group "C," which occupies the range ascribed here to *E. bislineata*, has Nei's mean genetic distances (D) of 0.24–0.45 when compared with all other geographic groups, and Thorpe (1982) argued that populations with differences of $D > 0.16$ should be regarded as separate species. The contact zones in Ohio (Guttman and Karlin 1986) and in Virginia (Mitchell and Reays 1999) that have been analyzed showed that the species are genetically distinct (mean $D = 0.35$ in Ohio) and are largely parapatric, with little hybridization and/or introgression. Thus, the molecular evidence supports recognition of *E. bislineata* as a distinct taxon from *E. cirrigera* and *E. wilderae*. Genetic interactions, however, still need analysis at additional contact zones between the species.

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