

Catalogue of American Amphibians and Reptiles.

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

***Eurycea wilderae* (Dunn)**
Blue Ridge Two-lined Salamander

Eurycea bislineata wilderae Dunn 1920:134. Type locality, "White Top Mt., Va., 4000 feet (under log in woods)." Holotype, Museum of Comparative Zoology (MCZ) 5848, an adult male, collected July 1919 by E.R. Dunn (examined by author). See Remarks.

Eurycea wilderae: Jacobs 1987:437. Elevation to species status.

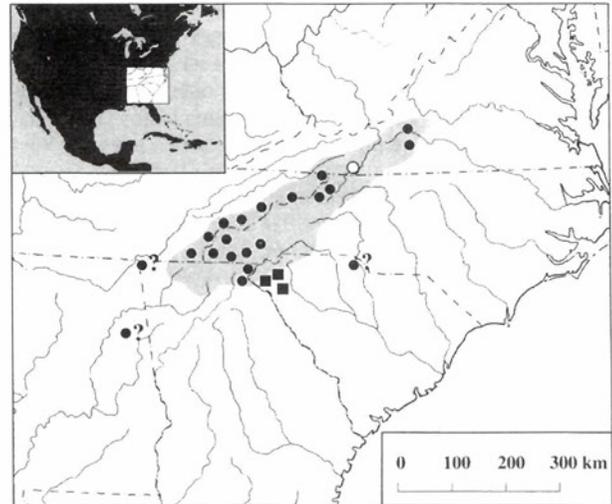
• **CONTENT.** No subspecies are recognized.

• **DEFINITION.** The ground color of *Eurycea wilderae* usually is some shade of orange, yellow, or brown, and the dorsum is darker than the venter. Passing from each eye onto the tail is a black dorsolateral stripe of various thickness that breaks up into a series of dots or is absent altogether on the posterior half of the tail. An extreme amount of variation exists in concentration and distribution of melanophores middorsally and ventral to the dorsolateral stripes.

Mean SVL of adults from various populations ranges from 30.3–49.0 mm (Sever 1979). Total lengths range from 60–90 mm, with the record being a specimen from Indian Gap in the Great Smoky Mountains (120 mm TL, King, 1939). The tail is 55–60% of TL. Vomerine teeth range from 7–22, and means in various samples are 9.8–15.8 (Sever 1972, 1989a).

Eurycea wilderae from altitudes <1600 m have a modal number of 14 costal grooves; >1600 m, the modal number is 15, and counts of 16 occasionally occur (Sever 1979, 1989a). Dunn (1920) stated that the type (from 1200 m) had 15 costal grooves, but Dunn (1926) reported that the same specimen had 14 costal grooves. My examination of the type revealed 15 costal grooves, but the remaining 16 specimens in the type series have 14 costal grooves.

Larvae are pale yellow to yellow-green dorsally with a thin, broken dorsolateral stripe, ventral to which is fine mottling and three rows of unpigmented lateral line spots (Ryan 1997). The tail is flattened and mottled. The venter is clear and a light cream color. Bruce (1982a, 1985) reported metamorphosis usually occurs after one or occasionally 2 years at a mean 18.5–



MAP. Range of *Eurycea wilderae*. The circle marks the type locality. Dots indicate localities from which the author has examined museum specimens and squares indicate literature records for the piedmont of South Carolina (Kozak 1999). The shaded area indicates the Blue Ridge Mountain physiographic region. Questionable records outside of this region are indicated with a question mark and the Wilcox Co., Alabama locality reported by Rossman (1965) is not indicated (see Distribution).



FIGURE 1. Adult male *Eurycea wilderae*: *wilderae* morph from Macon County, North Carolina (top) and "morph A" from Graham County, North Carolina (bottom).

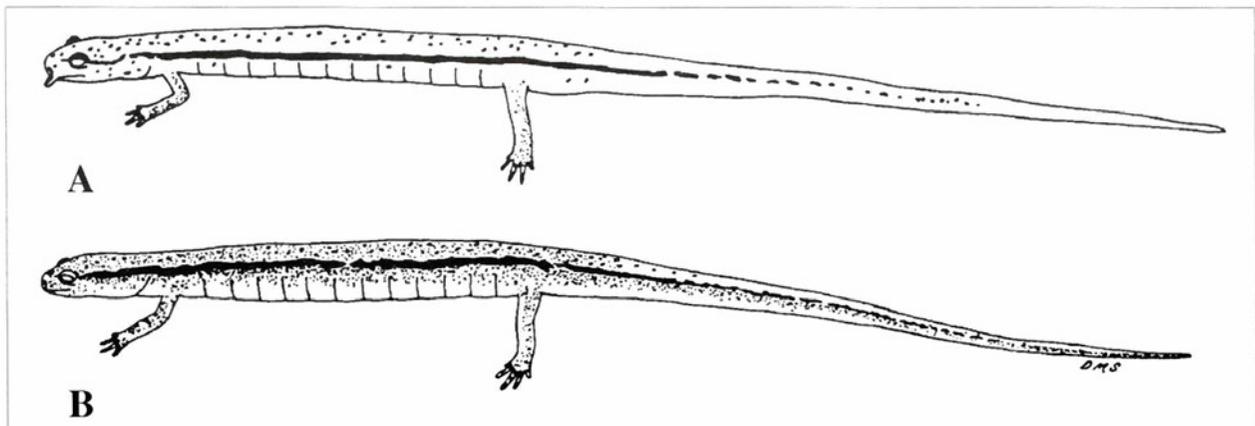


FIGURE 2. Males of *Eurycea wilderae* (from Sever 1989a): (A) *wilderae* morph, 37.1 mm SVL, collected 27 October 1977, Teyahale Bald, Graham County, North Carolina (USNM 209570); (B) "morph A," 44.8 mm SVL, collected 23 October 1977, Indian Gap, Great Smoky Mountains National Park, Sevier County, Tennessee (MVZ 143956).

23.9 mm SVL in stream populations, and at 26.4 mm in a pond. At Santeetlah Creek, Graham County, North Carolina, however, the larval period typically is two years with mean 31.8 mm SVL in the oldest cohort to metamorphose (Bruce 1982b). In addition, Voss (1993) found that larvae metamorphose after one year in first order streams whereas in higher order streams, metamorphosis may be delayed for an additional year. This variation is due to warmer temperatures in first order streams (Voss 1993).

The most remarkable characteristic of this taxon is the presence of two male morphs that differ dramatically in morphology, especially in regard to male secondary sexual characters (Sever 1979, Fig. 1). One of these is considered the typical "wilderae" morph, as it possesses cirri, which also characterize males in the type series (Dunn 1920). Sever (1979) found that the cirri were better developed in samples from October rather than those from March or summer months. Cirri of 67 males (mean 36.8 mm SVL) were 0.70–1.15 mm long (mean = 0.92), and cirrus length was positively correlated with SVL. The *wilderae* morph also possesses a fan-shaped mental gland that hypertrophies during the breeding season. From pores ventral to the mandibular symphysis, distal portions of the glands pass between layers of the *M. intermandibularis posterior* ventrally and the *M. geniohyoideus* dorsally. In specimens from October, 1–8 (mode 4) premaxillary teeth penetrate the upper lip anterior to the apex of the lower jaw. The projecting teeth scrap the female's skin during courtship allowing secretions of the male's mental gland to enter the superficial circulation of the female (Arnold 1977).

Males of the other morph, called "morph A" by Sever (1979) lack cirri, mental glands, and seasonally enlarged premaxillary teeth. During the breeding season, however, the muscles comprising the jaw adductors hypertrophy. In male "morph A" the fibers of the *M. levator mandibulae anterior profundus* extend to the middle sutures of the posterior frontals and anterior parietals, and the muscles are relatively thick. In the *wilderae* morph, this muscle is relatively small and never extends to the medial skull sutures. The *levator mandibulae externus* is also larger in "morph A" than in the *wilderae* morph. Hypertrophy of the jaw adductors is also known in populations of *E. bislineata*, *E. cirrigera*, and *E. junaluska*, but these species all possess mental glands and enlarged premaxillary teeth, and cirri occur in *E. junaluska* and many populations of *E. cirrigera*. "Morph A" is a robust form with short legs so that 2–3 costal grooves occur between toes of the adpressed limbs. The *wilderae* morph is a more gracile form, with long legs and 0–2 costal grooves between toes of the adpressed limbs. Females associated with the two male morphs are indistinguishable but generally have 2–4 costal grooves between adpressed limbs. Whether the morphs represent separate species or a polymorphism in *E. wilderae* still is unresolved (Sever 1999b)(also see Comments). Both male morphs possess a caudal courtship gland cluster in the skin of the dorsal tail base (Sever 1989b) and have seven pairs of cloacal glands (Sever 1980, 1994). Females possess a sperm storage gland (spermatheca) in the cloaca as well as another type of gland (the ventral gland) that may produce a mating pheromone (Sever 1987, 1988).

• **DIAGNOSIS.** *Eurycea wilderae* is sympatric with *E. junaluska* in at least parts of Graham County, North Carolina, and Sevier and Monroe counties, Tennessee. "Morph A" can be distinguished from *E. junaluska* by the lack of mental glands, cirri, and enlarged premaxillary teeth, and shorter legs (0–1 costal grooves between toes of adpressed limbs in *E. junaluska* as opposed to 2–3 in "morph A"). Males of the *wilderae* morph lack the enlarged temporal musculature found in *E. junaluska*. Males of both morphs and females of *E. wilderae* can be distinguished

from *E. junaluska* by having longer tails (only 50% of TL in *E. junaluska* versus 55–60% in *E. wilderae*) and fewer vomerine teeth (mean = 20.6 in *E. junaluska* rather than a maximum mean of 15.8 in *E. wilderae*) and by coloration (*E. junaluska* generally has a brownish, mottled dorsum and lacks distinct dorsolateral stripes; Sever et al. 1976).

Eurycea wilderae probably can best be distinguished from *E. bislineata* and *E. cirrigera* based upon distribution, i.e., *E. wilderae* is the only one of these three taxa presumed to occur in the Southern Blue Ridge Mountains (Dunn 1926, Jacobs 1987, Mittleman 1966). The genetic verification of the presence of *E. wilderae* in the piedmont of South Carolina, however, indicates that the species is not restricted to the Southern Blue Ridge Mountains (Kozak 1999). Low altitude populations of *E. wilderae* typically have 14 costal grooves rather than the 15 that characterize contiguous populations of *E. bislineata*, and males of the *wilderae* morph possess cirri which are lacking in *E. bislineata* (Sever 1999a). No sure way exists to distinguish *E. wilderae* from *E. cirrigera*, especially since "morph A" has been found in the piedmont and coastal plain of North Carolina (Sever 1989a, 1999b). Thus, either the same polymorphism occurs in two separate species, or "morph A" is a separate species that is sympatric in different parts of its range with *E. cirrigera* and *E. wilderae*. The male *wilderae* morph, however, can be distinguished from male *E. cirrigera* by possession of 0–2 costal grooves between the toes of the adpressed limbs rather than the 2–4 characteristic of *E. cirrigera* (Sever 1999b).

The only other salamanders likely to be confused with *E. wilderae* are various species of *Desmognathus*, some of which may mimic *E. wilderae* (Brodie 1981). All species of *Desmognathus*, however, have a light line passing from the eye to the posterior angle of the jaw.

• **DESCRIPTIONS.** Detailed descriptions, based primarily on the *wilderae* morph, occur in Dunn (1917, 1926), Bishop (1943), and Mittleman (1949, 1966). Conant and Collins (1998) and Petranksa (1998) describe both male morphs.

• **ILLUSTRATIONS.** Notable photographs of adult females and/or the male *wilderae* morph appear in Bishop (1943), Huheey and Stupka (1967), Conant and Collins (1998), and other field-guides. Sever (1979, 1989a) illustrated male "morph A" as well as the *wilderae* morph. A fine photograph of "morph A" by K. Mierzwa graces the cover of Vol. 24 (1989) of the Bulletin of the Chicago Herpetological Society. Ryan (1997) provided an excellent drawing of the larva.

• **DISTRIBUTION.** Dunn (1926) stated, "From White Top Mt., Va.; south in mountains to Clayton, Rabun Co., Ga., and Cherry Log, Gilmer Co., Ga. Inhabits the whole Southern Blue Ridge region." The range is sometimes loosely given as "the southern Appalachian Mountains" (Conant and Collins 1998, Jacobs 1987), but essentially the range as defined by Dunn is restricted to the Southern Blue Ridge Mountain physiographic province (see Map). Altitudinally, the species occurs from base-level streams to the tops of the highest peaks (about 1900 m).

Specimens that morphologically resemble the gracile male *wilderae* morph have been reported by Chermock (1952) from Mount Cheaha in Alabama (which Chermock as well as Mount 1975 considered an extension of the Blue Ridge) and by Rossman (1965) from Wilcox County in the coastal plain of Alabama. Allozyme analysis of specimens from these localities, however, align them with *Eurycea cirrigera* (Jacobs 1987). I have seen specimens that resemble the male *wilderae* morph from Cloudland Canyon State Park, Dade County, Georgia (OUVC 4136) and Kings Mountain State Park, York County, South Carolina (OUVC 3434). Howell and Switzer (1953) reported "inter-

grades" between *E. cirrigera* and *E. wilderae* in the Piedmont of Georgia. An allozyme analysis of the contact zone between *E. wilderae* and *E. cirrigera* in northwestern South Carolina revealed the presence of populations of *E. wilderae* in the piedmont of Anderson, Oconee, and Pickens counties (Kozak 1999). The limits of the range of *E. wilderae* and interactions with *E. bislineata* and *E. cirrigera* in areas of contact or sympatry need much more study.

• **FOSSIL RECORD.** None.

• **PERTINENT LITERATURE.** References cited elsewhere in this account are not included in the following list: **agonistic behavior** (Wiltenmuth 1997), **critical thermal maximum** (Brattstrom 1963, Hutchison 1961), **distribution** (Redmond and Scott 1996), **ecology, habitat, and habits** (Bogert 1952, Brimley 1944, Gentry 1955), **keys** (Powell et al. 1998), **larva** (Eaton 1956), **life table** (Bruce 1988), **mimicry** (Brodie 1981), **nests and oviposition** (Wood 1949), and **predation** (Beachy 1997, Huheey and Stupka 1967).

• **REMARKS.** Dunn (1926:311) stated that MCZ 5840 was the type, but this designation was obviously a misprint since on p. 312 he once again identifies the type as MCZ 5848. The type series consists of 17 specimens ("M.C.Z. No. 5841—56 TYPES," Dunn 1926:313). I have examined the type series, and MCZ 5848 is clearly labelled as the type; MCZ 5841—5847 and 5849—5856 are here designated paratypes.

Specimens from low elevations (<762 m) in the Great Smoky Mountains were referred to *Eurycea b. bislineata* x *cirrigera* by King (1939). I examined his specimens and determined that they were *E. junaluska* (Sever 1976).

• **ETYMOLOGY.** The specific epithet honors Inez Whipple Wilder, a pioneer in *Eurycea* biology at Smith College, Northampton, Massachusetts.

• **COMMENTS.** "Morph A" has been reported from Blount, Monroe, and Sevier counties, Tennessee, and Graham, Haywood, Macon, and Watuga counties, North Carolina (Sever 1989a) and probably occurs throughout the Southern Blue Ridge. This morph (or a similar one) has been found also in the piedmont (Wake County) and coastal plain (Carteret County) of North Carolina. In the Southern Blue Ridge, some localities (e.g., Santeetlah Creek) seem to possess only "morph A" whereas others (e.g., Wayah Bald) appear to have only the male *wilderae* morph. Both morphs may be found at many localities (e.g., Hooper Bald). Each morph can be found at all altitudes from base-level streams to the summits of the highest peaks. Interestingly, collections made at Indian Gap, Sevier County (about 1600 m) in the 1930s by King contained exclusively the male *wilderae* morph, but collections I have made at this site for the past two decades have yielded only "morph A." Jacobs (1987) found no genetic differences (*D* values of 0.03–0.07) between several samples of "morph A" and the male *wilderae* morph. Certainly, however, the "morph A" phenomenon merits more study.

Jacob's (1987) "group E" of *Eurycea wilderae* included samples from the type locality (Grayson County, Virginia) and two samples from Watuga County, North Carolina, whereas his "group F" contained all other samples of *E. wilderae* from more southern areas of the Blue Ridge. Mean *D* = 0.30 between the "E" and "F" groups, far exceeding levels (as low as *D* > 0.15) commonly used to denote species level differences (Highton 1998, Thorpe 1982). Thus, *E. wilderae* is likely polyspecific; the northern taxon would still be referable to *E. wilderae*, but the southern taxon would need a new name.

LITERATURE CITED

- Arnold, S.J. 1977. The evolution of courtship behavior in New World salamanders with some comments on Old World salamandrids, p. 141–183. In D.H. Taylor and S.I. Guttman (eds.), *The Reproductive Biology of Amphibians*. Plenum Press, New York.
- Beachy, C.K. 1997. Effect of predatory larval *Desmognathus quadramaculatus* on growth, survival, and metamorphosis of larval *Eurycea wilderae*. *Copeia* 1997:131–137.
- Bishop, S.C. 1943. *A Handbook of Salamanders*. The Salamanders of the United States, of Canada, and of Lower California. Comstock Publ. Co., Inc., Ithaca, New York.
- Bogert, C.M. 1952. Relative abundance, habitats, and normal thermal requirements of some Virginian salamanders. *Ecology* 33:16–30.
- Brattstrom, B.H. 1963. A preliminary review of the thermal requirements of amphibians. *Ecology* 44:238–255.
- Brimley, C.S. 1944. *Amphibians and reptiles of North Carolina*. Reprinted from *Carolina Tips* (1939–1943). Carolina Biol. Supply Co., Elon College, North Carolina.
- Brodie, E.D., Jr. 1981. Phenological relationships of model and mimic salamanders. *Evolution* 35:988–994.
- Bruce, R.C. 1982a. Larval periods and metamorphosis in two species of salamanders of the genus *Eurycea*. *Copeia* 1982:117–127.
- . 1982b. Egg-laying, larval periods and metamorphosis of *Eurycea bislineata* and *E. junaluska* at Santeetlah Creek, North Carolina. *Copeia* 1982:755–762.
- . 1985. Larval period and metamorphosis in the salamander *Eurycea bislineata*. *Herpetologica* 41:19–28.
- . 1988. An ecological life table for the salamander *Eurycea wilderae*. *Copeia* 1988:15–26.
- Chermock, R.L. 1952. A key to the amphibians and reptiles of Alabama. *Geol. Surv. Alabama Mus. Pap.* (33):1–88.
- Conant, R. and J.T. Collins. 1998. *A Field Guide to Reptiles and Amphibians of Eastern and Central North America*. 3rd ed., exp. Houghton Mifflin Co., Boston, Massachusetts.
- Dunn, E.R. 1917. Reptile and amphibian collections from the North Carolina mountains, with especial reference to salamanders. *Bull. Amer. Mus. Nat. Hist.* 37:593–634.
- . 1920. Some reptiles and amphibians from Virginia, North Carolina, Tennessee and Alabama. *Proc. Biol. Soc. Washington* 33:129–137.
- . 1926. *The Salamanders of the Family Plethodontidae*. Smith College 50th Anniv. Publ., Northampton, Massachusetts.
- Eaton, T.H., Jr. 1956. Larvae of some Appalachian plethodontid salamanders. *Herpetologica* 12:303–311.
- Gentry, G. 1955. An annotated check list of the amphibians and reptiles of Tennessee. *J. Tennessee Acad. Sci.* 30:168–176.
- Highton, R. 1998. Is *Ensatina eschscholtzii* a ring-species? *Herpetologica* 54:254–278.
- Howell, T. and V. Switzer. 1953. Integrades of the Two-lined Salamander, *Eurycea bislineata*, in Georgia. *Herpetologica* 9:152.
- Huheey, J.E. and A. Stupka. 1967. *Amphibians and Reptiles of Great Smoky Mountains National Park*. Univ. Tennessee Press, Knoxville.
- Hutchison, V.H. 1961. Critical thermal maxima in salamanders. *Physiol. Zool.* 34:92–125.
- Jacobs, J.F. 1987. A preliminary investigation of geographic variation and systematics of the Two-lined Salamander, *Eurycea bislineata* (Green). *Herpetologica* 43:423–446.
- King, W. 1939. A survey of the herpetology of Great Smoky Mountains National Park. *Amer. Midl. Nat.* 21:531–582.
- Kozak, K.H. 1999. Genetic variation and sexual isolation across a contact zone between montane and lowland taxa of the *Eurycea bislineata* species complex (Amphibia: Caudata: Plethodontidae). M.S. thesis, Clemson Univ., Clemson, South Carolina.
- Mittleman, M.B. 1949. American Caudata VI. The races of *Eurycea bislineata*. *Proc. Biol. Soc. Washington* 62:89–96.
- . 1966. *Eurycea bislineata*. *Cat. Amer. Amphib. Rept.* (45):1–4.
- Mount, R.H. 1975. *The Reptiles and Amphibians of Alabama*. Auburn Univ. Agr. Exp. Sta., Auburn, Alabama.
- Petranka, J.W. 1998. *Salamanders of the United States and Canada*. Smithsonian Inst. Press, Washington, D.C.
- Powell, R., J.T. Collins, and E.D. Hooper, Jr. 1998. *A Key to Amphibians and Reptiles of the Continental United States and Canada*. Univ. Press Kansas, Lawrence.
- Redmond, W.H. and A.F. Scott. 1996. Atlas of amphibians in Tennessee. *Ctr. Fld. Biol., Austin Peay State Univ., Misc. Publ.* (12):1–94.

- Rossman, D.A. 1965. The Blue Ridge Two-lined Salamander, *Eurycea bislineata wilderae*, in southern Alabama. *Herpetologica* 20:287–288.
- Ryan, T.J. 1997. Larva of *Eurycea junaluska* (Amphibia: Caudata: Plethodontidae) with comments on distribution. *Copeia* 1997:210–215.
- Sever, D.M. 1972. Geographic variation and taxonomy of *Eurycea bislineata* (Caudata: Plethodontidae) in the upper Ohio River Valley. *Herpetologica* 28:314–324.
- . 1976. Identity of an enigmatic *Eurycea* (Urodela: Plethodontidae) from the Great Smoky Mountains of Tennessee. *Herpetol. Rev.* 7:98.
- . 1979. Male secondary sexual characteristics of the *Eurycea bislineata* (Amphibia, Urodela, Plethodontidae) complex in the southern Appalachian Mountains. *J. Herpetol.* 13:245–253.
- . 1980b. Cloacal anatomy of male brook salamanders (*Eurycea*). *Herpetologica* 36:51–60.
- . 1987. *Hemidactylum scutatum* and the phylogeny of cloacal anatomy in female salamanders. *Herpetologica* 43:105–116.
- . 1988. The ventral gland in female *Eurycea bislineata* (Amphibia: Plethodontidae). *Copeia* 1988:572–579.
- . 1989a. Comments on the taxonomy and morphology of Two-lined Salamanders of the *Eurycea bislineata* complex. *Bull. Chicago Herpetol. Soc.* 24:70–74.
- . 1989b. Caudal hedonic glands in salamanders of the *Eurycea bislineata* complex (Amphibia: Plethodontidae). *Herpetologica* 45:322–329.
- . 1994. Comparative anatomy and phylogeny of the cloacae of salamanders (Amphibia: Caudata). VII. Plethodontidae. *Herpetol. Monogr.* (8):276–337.
- . 1999a. *Eurycea bislineata*. *Cat. Amer. Amphib. Rept.* (683):1–5.
- . 1999b. *Eurycea cirrigera*. *Cat. Amer. Amphib. Rept.* (684):1–6.
- , H.A. Dundee, and C.D. Sullivan. 1976. A new *Eurycea* (Amphibia: Plethodontidae) from southwestern North Carolina. *Herpetologica* 32:26–29.
- Thorpe, J.P. 1982. The molecular clock hypothesis: biochemical evolution, genetic differentiation and systematics. *Ann. Rev. Ecol. Syst.* 13:139–168.
- Voss, S.R. 1993. Relationship between stream order and length of larval period in the salamander *Eurycea wilderae*. *Copeia* 1993:736–742.
- Wiltenmuth, E.B. 1997. Agonistic behavior and use of cover by stream-dwelling larval salamanders (*Eurycea wilderae*). *Amer. Midl. Nat.* 21:531–582.
- Wood, J.T. 1949. *Eurycea bislineata wilderae* Dunn. *Herpetologica* 5:61–62.

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