

Catalogue of American Amphibians and Reptiles.

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

***Eurycea cirrigera* (Green)**
Southern Two-lined Salamander

Salamandra cirrigera Green 1831:253. Type locality, see Remarks. Holotype, see Remarks (the author has not seen USNM 4743 or 4734, but has collected and examined numerous topotypes).

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

Spelerpes bilineatus: Cope 1869:107. See Remarks.

Eurycea bislineata cirrigera: Dunn 1920:135. Recognition of subspecific status and placement in genus *Eurycea* (Rafinesque 1822).

Eurycea bislineata rivicola Mittleman 1949:93. Type locality, "McCormick's Creek State Park, Owen County, Indiana." Holotype, National Museum of Natural History (USNM) 129397, an adult collected by M.E. and M.B. Mittleman, August 1942. See Remarks.

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

• **DEFINITION.** *Eurycea cirrigera* is a small salamander (adults 60–116 mm TL) characterized by a ground color that varies among shades of yellow, tan, and orange, and with two black dorsolateral stripes that extend from the eye onto the tail (see Remarks). The dorsolateral stripes vary from 46.0% of tail length in a population from Pitt County, North Carolina to 95.9% in a sample from Hocking County, Ohio, and these values overlap those for *E. bislineata* and *E. wilderae* (Sever 1972). Some degree of mottling usually occurs inferior to the dorsolateral stripe, and unpigmented spots indicative of the larval lateral line (Noble 1927) are often present (see Remarks). The venter is unmarked and generally brighter than the dorsum. At metamorphosis, the middorsal area is generally clear, but melanophores accumulate ontogenetically, sometimes forming a distinct middorsal stripe.

The aquatic larvae are usually found in small or medium-sized streams, but I have collected them in many larger rivers in the South as well. In Ohio, larvae hatch at about 9 mm SVL (Duellman and Wood 1954) or 12 mm TL (Brandon 1964), and most metamorphose in their third summer at mean SVL (TL) of 26.0 (52.0) mm for males and 25.7 (50.9) mm for females (Duellman and Wood 1954). Larvae are dull yellow or brown with fine dorsal mottling which becomes heavier laterally, and with two or three rows of unpigmented lateral line spots.

At metamorphosis, 0–2 costal grooves usually occur between toes of the adpressed limbs whereas 2–4 costal grooves between adpressed limbs are generally found in larger adults (Sever

1972)(see Remarks). Cagle (1952) reported 3–7 "intercostal folds" in Louisiana specimens that would be considered topotypic *E. cirrigera*. Bishop (1943) reported 3–4 "intercostal spaces" for the taxon, and Sever (1972) found means as high as 3.15 costal grooves between toes of the adpressed limbs of *E. cirrigera* from North Carolina.

Mean SVL of samples of metamorphosed individuals studied by Sever (1972) ranged from 34.0 mm SVL in Monroe County, Indiana, to 40.2 mm SVL in Hocking County, Ohio. The longest specimen known appears to be a female, 116 mm TL, from Harlan County, Kentucky (Branson et al. 1970). The ratio of tail length to TL varies ontogenetically. In Illinois, Smith (1961) found that in specimens 53–75 mm SVL, the tail length varied from 51.5–57.4% (mean 55.1%), whereas in specimens 85–108 mm TL, the tail length was 53.6–61.0% (mean 57.0%) of TL.

The mean number of vomerine teeth in samples studied by Sever (1972) ranged from 11.6 in Athens and Fairfield Counties, Ohio, to 20.4 in Pickaway County, Ohio; the mean for Pitt County, North Carolina was 12.7. Smith (1961) found a range of 9–30 vomerine teeth in Illinois specimens, with means in three populations of 13.4–15.5. Rubenstein (1969) reported means of 14.4 (male) and 14.9 (female) for specimens from Mount Cheaha, Cleburne County, Alabama. The means reported for these various samples of *E. cirrigera* overlap those reported for *E. bislineata* and *E. wilderae*, so number of vomerine teeth is not a diagnostic character in this complex (Sever 1972). Like other metamorphosing *Eurycea*, the 4–6 premaxillary teeth of males enlarge during the breeding season (Noble 1927), and the teeth are used during courtship to scrape the skin of the female, presumably to enhance application of secretions from the mental gland (Arnold 1977).

Males of some populations of fleshy projections from the upper lip called cirri (see Remarks). Cirri are absent in most populations of *E. cirrigera* in the Ohio River Valley and are not present in some males currently assignable to *E. cirrigera* from parts of eastern Tennessee and northern Alabama, and the Coastal Plain and Piedmont of North Carolina (see Comments). Other male secondary sexual characters include a fan-shaped mental gland with pores ventral to the mandibular symphysis (Sever 1976, 1979), a caudal courtship gland in the skin of the tail base (Sever 1989a), and seven pairs of cloacal glands, six of which are involved in spermatophore formation and one of which produces a mating pheromone (Sever 1980b, 1994). Females possess two cloacal glands, the ventral glands that secrete a protein during the mating season (Sever 1988) and a spermatheca that stores sperm (Sever 1987)(see Remarks).

• **DIAGNOSIS.** The only other salamanders likely to be confused with *Eurycea cirrigera* are other members of the complex (*E. bislineata* and *E. wilderae*) and sympatric species of *Desmognathus*, which occasionally are yellowish and may have



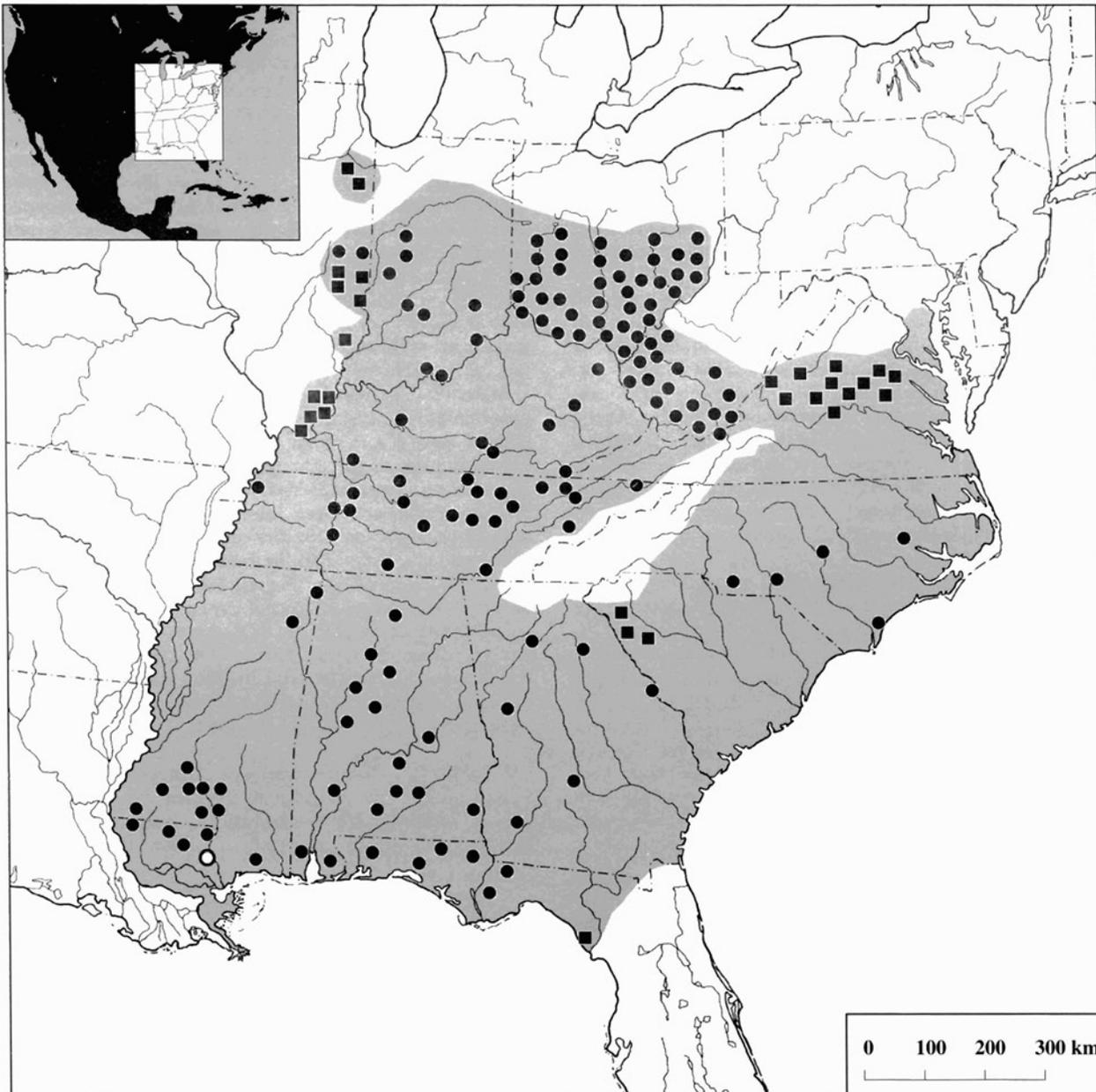
FIGURE. Adult *Eurycea cirrigera* from Shades State Park, Montgomery County, Indiana.

dorsolateral stripes. *Eurycea bislineata* in areas of sympatry has 15 or 16 costal grooves instead of 14 as in *E. cirrigera*. No reliable morphological character separates low altitude *E. wilderae* from *E. cirrigera* (Sever 1989b). *Eurycea cirrigera* and *E. wilderae*, however, are considered parapatric, with the distribution of *Eurycea wilderae* generally restricted to the Southern Blue Ridge Mountains physiographic province (Dunn 1926, Jacobs 1987, but see Comments). Species of *Desmognathus* have a pale line passing from the eye to the posterior border of the jaw.

• **DESCRIPTIONS.** Numerous more or less detailed descriptions occur for this species from various areas throughout its range, e.g.: Alabama (Mount 1975), Florida (Carr and Goin 1955), Illinois (Smith 1961), Indiana (Hay 1892, Minton 1972), Kentucky (Barbour 1971), Louisiana (Dundee and Rossman 1989), North Carolina (Brimley 1944), and Ohio (Guttman

1989). Conant and Collins (1998) described the taxa in the *E. bislineata* complex fairly accurately. Petranka (1998), who did not consider *E. cirrigera* or *E. wilderae* to merit specific status, listed some characters as diagnostic (length of the dorsolateral stripe, retention of larval lateral line spots) that have been demonstrated to be of no value in distinguishing taxa in the complex (see Definition and Remarks).

• **ILLUSTRATIONS.** The first illustrations of the species are in Holbrook (1840, 1842), a black and white drawing that clearly shows the cirri of a male. A colored drawing of an interestingly patterned and shaped specimen occurs in Dundee and Rossman (1989). Black and white photographs are provided by Smith (1961), Minton (1972), and Mount (1975), and color photographs are available in Barbour (1971) and Conant and Collins (1998). Petranka (1998) showed especially good color photographs of the larva and a female with eggs. The plates in Pflingsten and



MAP. Range of *Eurycea cirrigera*. 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 Florida (Carr and Goin 1955), Illinois (Mierzwa 1989), northwestern South Carolina (Kozak 1999), and Virginia (Mitchell and Reay 1999).

Downs (1989) are not attributed, and I cannot ascertain which illustrate *E. bislineata* or *E. cirrigera*.

• **DISTRIBUTION.** *Eurycea cirrigera* is found in the coastal plain and piedmont east of the Mississippi River, and also in the Ohio River and Tennessee River valleys. The species extends into the Gulf Hammock region of Florida (Carr and Goin 1955). Except for some locales in east-central Ohio (Guttman and Karlin 1986), the species apparently is absent from areas in eastern Ohio where *E. bislineata* occurs and is also absent from the Southern Blue Ridge Mountains physiographic province where *E. wilderae* is found. Contact zones between *E. cirrigera* and *E. bislineata* in Ohio (Guttman and Karlin 1986) and Virginia (Mitchell and Reay 1999) have been established based upon electrophoretic analysis of allozyme differences between the species. The contact zone in West Virginia (i.e., the Kanawha River basin) is based upon differences in modal costal groove counts (15 in *E. bislineata*, 14 in *E. cirrigera*). Two genetically distinct, overlapping groups occur in Maryland (Miller and Hallerman 1994), but more work is necessary to delineate their respective distributions within that state. Despite some recent distribution maps (e.g., Conant and Collins 1998, Petranks 1998) that show the species is absent from the extreme northwestern corner of Tennessee, I have seen specimens from Lake County (UKMNH 21645–21656), and Redmond and Scott (1996) believed that a valid record exists for this county. A record that exists for Berrien County, Michigan (Maldonado-Koerdell and Firschein 1947) needs verification. See also Sever (1999a,b).

• **FOSSIL RECORD.** None.

• **PERTINENT LITERATURE.** Much literature exists on the species, and the references listed below by topic are by no means exhaustive and literature cited elsewhere in this account is not repeated here: **courtship** (Noble and Brady 1930); **critical thermal maximum** (Brooks and Sassaman 1965), **diet** (Petranks 1984), **distribution** (Mierzwa 1989, Neill 1957), **ecology, habitat, and habits** (Branson et al. 1970, Eaton 1953, Gentry 1955, Holman 1960, Karns 1988, Klimstra and Hutchison 1965, Scott and Synder 1968), **hematology** (Vernberg, 1955), **hibernation** (Vernberg 1953), **larval interactions** (Gustafson 1994), **oviposition, nesting, eggs** (Bauman and Huels 1982; Duellman 1951; Richmond 1945; Wood 1950, 1953; Wood and Duellman 1951; Wood and McCutcheon 1954), **parasites** (Burchett and Shoemaker 1990), **phototaxis** (Wood 1951), **respiration** (Vernberg 1952).

• **REMARKS.** Green (1831) noted in the original description: "For this remarkable salamander, I am indebted to the kindness and the minute researches of my friend William Stewart, Esquire. He discovered two pair of them near New Orleans, under some large chips of wood." Green's description was "read" 17 August 1830, but the account was not published until March 1831. Thus, the customary use of 1830 as the publication date for the taxon (c.f., Dunn 1926; Jacobs 1987; Mittleman 1949, 1966; Schmidt 1953) is in error. This species is not known from south of Lake Pontchartrain, so the designation of New Orleans as the type locality is probably incorrect. As noted by Dundee and Rossman (1989), "Because New Orleans was then literally the only community of note in southeastern Louisiana, it was used as a geographic designation for many organisms from the general area." The species is fairly common in the Florida parishes of Louisiana, which have been considered the source of topotypes (Mittleman 1949, Sever 1972, Jacobs 1987), and St. Tammany Parish, north of Lake Pontchartrain from New Orleans, is here designated as the type locality. Cope (1889) provided a description "taken from Green's type in the Museum of

the Smithsonian Institution (No. 4743)" and on p. 168 stated, "Form CIRRIGERA.—No. 4734; two specimens; Southern States (La.?)" received from "Dr. F. Bache." Dunn (1926), however, stated that the type was "not known to exist."

Cope (1869) placed "*Salamandra cirrigera*" in his list of synonyms for *S. bilineatus* without explanation. Later Cope (1870, 1889) stated that the only difference between the two taxa was the "singular character" of labial cirri. Cope believed cirri represented retention of a larval character (balancers) and that their presence was an "individual feature" not sufficient for specific recognition.

Eurycea bislineata rivicola (Mittleman 1949) was synonymized with *E. b. bislineata* by Sever (1972). However, Mittleman's type locality for *E. b. rivicola* is within the range of *E. cirrigera*. Some populations Mittleman (1949) allocated to *E. b. rivicola*, however, occur within the range of *E. bislineata* Sever (1999a).

Contrary to a number of accounts (e.g., Conant and Collins 1998; Mittleman 1949, 1966; Petranks 1998; Powell et al. 1998), the extent of the dorsolateral stripe onto the tail is not a diagnostic character (Minton 1972, Sever 1972). Similarly, the presence of unpigmented spots indicative of the larval lateral line are not diagnostic (Sever 1972) despite claims to the contrary (Mittleman 1949, 1966). The range of 0–2, mean 1.5 costal grooves between adpressed limbs used by Mittleman (1949, 1966) to characterize presumably mature *E. b. cirrigera* is also incorrect, although widely used in field-guides and keys (e.g., Dundee and Rossman 1989, Powell et al. 1998).

In the type specimens, Green (1831) stated that the cirri in the living specimens were "about one-fourth of an inch long," which would be quite remarkable in animals described as "three inches" in total length. Cope (1889) stated that in the preserved ("alcoholic") type, the cirri were merely "as long as the outer finger, or 0.05 of an inch in length." Cope (1870) mistakenly believed that cirri were "remnants of an early larval character universal among tailed Batrachia, namely the balancers." Dunn (1917) reported that *Eurycea* larvae lack balancers, and cirri occur only in adults; later, he also was the first to note that cirri occur only in males (Dunn 1920). Noble (1927) correctly reported that cirri represent a hypertrophy of the nasolabial glands below the lip, and that the nasolabial groove continues down the length of the cirrus. Sever (1980a) proposed that the cirri represented an adaptation for perception of olfactory cues important in the breeding season. Studies on a related species, *Eurycea quadridigitata*, demonstrated that cirri hypertrophy only during the breeding season (Sever 1975), but such data are lacking for *E. cirrigera*. Cirri are absent in most populations of *E. cirrigera* in the Ohio River Valley, and are not present in some males currently assignable to *E. cirrigera* from parts of eastern Tennessee and northern Alabama, and the Coastal Plain and Piedmont of North Carolina (see Comments).

Much attention has been given to the phenology of mating, sperm storage, and oviposition in female *Eurycea cirrigera* from Indiana, and the ultrastructure of the spermatheca during these periods. Mating occurs from March to early May, so sperm storage of < 3 months is typical (Sever 1991, Sever and Brizzi 1998). Regionalized spermiophagy by the spermathecal epithelium occurs during sperm storage and results in elimination of sperm remaining after oviposition (Sever 1992, Sever and Brunette 1993).

• **ETYMOLOGY.** The specific epithet refers to the nasolabial cirri found in males in many populations (Green 1830, Sever 1972), and is derived from the Latin *cirrus*, meaning curl, ringlet, or tendril.

• **COMMENTS.** F₁ hybrids between *E. cirrigera* and *E.*

bilineata are known from one area of sympatry in Coshocton County, Ohio (Guttman and Karlin 1986). Otherwise these species are genetically distinct where thorough analyses have been done in Ohio (mean $D = 0.35$; Guttman and Karlin 1986) and Virginia (Mitchell and Reay 1999). Two overlapping but genetically distinct taxa occur in Maryland (Miller and Hallerman 1994), but a more detailed analysis is needed. No genetic data are available from West Virginia populations.

The relationship between *E. cirrigera* and *E. wilderae*, and the relationships among various populations assigned to *E. cirrigera* need much more study. "Integrades" between *E. cirrigera* and *E. wilderae* have been reported from the piedmont of Georgia (Howell and Switzer 1953), and an allozyme analysis by Kozak (1999) revealed the presence of both *E. cirrigera* and *E. wilderae* in the piedmont of Anderson County, South Carolina. Specimens referable morphologically to *E. wilderae* also have been reported from the coastal plain of Alabama (Rossman 1965).

Jacobs (1987) formed *E. cirrigera* from four groups (his A, B, G, and F) that have mean D values among them of 0.24–0.43, far exceeding levels (as low as $D > 0.15$) that commonly are used to denote species level differences (Highton 1998, Thorpe 1982, Wake and Schneider 1998). Jacobs (1987), however, used a conservative D value of 0.38 to determine species groups. *Eurycea cirrigera* very likely is a polyspecific taxon, and more species need to be recognized.

For example, a distinct morphological species apparently occurs in the Sand Hills of central North Carolina (Braswell and Sever, in prep.), and genetic data support species level distinction (Group H of Jacobs 1987). In northern Alabama, Mount (1975) described the "Cole Springs morphotype," a robust form that is sympatric with a more gracile, "wilderae" phenotypic form. I have examined Mount's specimens, and I have seen specimens of this morph from southeastern Tennessee as well. The males lack elongate cirri and have enlarged jaw abductors like the form referred to as "morph A" (Sever 1979), but males of the Cole Springs morphotype possess a mental gland, which morph A lacks.

Elsewhere in Alabama, *Eurycea aquatica* (Rose and Bush 1963) was described as a morphologically distinct species from Jefferson County, Alabama. Although the validity of this taxon has been questioned (Jacobs 1987, Mount 1975), I do not feel that the taxon has been formally synonymized. In an important but unpublished thesis, Jones (1980) found numerous populations assignable to the "aquatica morph" in the Ridge and Valley physiographic province in Alabama and Georgia. He concluded that "aquatica" possessed some distinct traits selected for as a result of isolation in springs during Pleistocene glaciations, but that intermediates with *E. cirrigera* were found at nearly all sites, and *E. aquatica* and *E. cirrigera* therefore should be considered conspecific. I believe judgement should be withheld; I have collected at the type locality and examined type specimens. Even if hybridization through secondary contact (Jones 1980) is genetically demonstrated, at least the types of *E. aquatica* are clearly distinct morphologically from *E. cirrigera* found in non-spring habitats in the area. The allozyme analysis done by Jacobs (1987) indicated that specimens from the type locality (his locality 8) are genetically quite distinct from the other populations from Alabama, Georgia, and non-montane areas of Tennessee.

Finally, a problem exists with morph A, which was described as sympatric with *E. wilderae* in the Southern Blue Ridge Mountains (Sever 1979). In contrast to males of the typical "wilderae" morph, males of morph A lack mental glands, seasonally enlarged premaxillary teeth, and cirri, but possess strongly developed temporal musculature absent in the *wilderae* morph. Females associated with the two male morphs are indistinguish-

able. Morph A within the range of *E. wilderae* has been found in Blount, Monroe, and Sevier Counties, Tennessee, and in Graham, Haywood, Macon, and Watauga Counties, North Carolina (Sever 1989b) and probably occurs throughout the Southern Blue Ridge. Jacobs (1987) could find no genetic differences (D values of 0.03–0.07) between several samples of the typical "wilderae" morph and morph A, indicating some intriguing male polymorphism in male secondary sexual characters was occurring within *E. wilderae*.

A problem concerning the conspecificity of *E. wilderae* and morph A is that animals morphologically similar to morph A from the southern Appalachians are now known from the piedmont and coastal plain of North Carolina, where they are sympatric with *E. cirrigera*. Localities and museum numbers for specimens of morph A from Wake (piedmont) and Carteret (coastal plain) counties, North Carolina are given in Sever (1989b). If morph A is conspecific with *E. wilderae*, then the presence of morph A in the piedmont and coastal plain with *E. cirrigera* is a case of sympatry between the two species. Otherwise, (1) a male polymorphism found in *E. wilderae* occurs identically in *E. cirrigera*, or (2) morph A is a separate species that is sympatric in different parts of its range with *E. cirrigera* and *E. wilderae*.

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