Until raised to full species status by Jacobs (1987), Blue Ridge two-lined salamanders (*Eurycea wilderae*) were considered a subspecies of northern two-lined salamanders (*E. bislineata*) as described by Dunn (1920). Dunn (1920) stated that the range of his new taxon is the “southern division of the Blue Ridge,” and Dunn (1926) reported that the distribution is “from White Top Mountain, Virginia; south in mountains to Clayton, Rabun County, Georgia, and Cherry Log, Gilmer County, Georgia. They inhabit the whole Southern Blue Ridge region.” The range is sometimes loosely given as “the southern Appalachian Mountains” (Jacobs, 1987; Conant and Collins, 1998), but essentially the range as defined by Dunn (1926) is restricted to the Southern Blue Ridge Mountain physiographic province. Blue Ridge two-lined salamanders occur from base-level streams to the tops of the highest peaks (about 1,900 m). The most remarkable characteristic of this species is the presence of two male morphs that differ dramatically in morphology, especially in regard to the male secondary sexual characters (Sever, 1979, 1999c). One of these is considered the typical “*wilderae*” morph because it possesses labial cirri, which also characterize males in the type series (Dunn, 1920). This gracile form also possesses a mental gland, seasonally enlarged premaxillary teeth, and 0–2 costal grooves between toes of the adpressed limbs. Males of the other morph, called “morph A” by Sever (1979), lack cirri, mental glands, and seasonally enlarged premaxillary teeth, and they possess 2–3 costal grooves between toes of the adpressed limbs. During the breeding season, the muscles comprising the jaw adductors hypertrophy, making morph A the “big-headed” form in the Southern Blue Ridge. Hypertrophy of the jaw adductors is also known in populations of northern two-lined salamanders and Junaluska salamanders (*E. junaltsuks*), but these species all possess mental glands and enlarged premaxillary teeth, and cirri also occur in Junaluska salamanders (Sever, 1979). Females associated with the two male morphs of Blue Ridge two-lined salamanders are indistinguishable but generally have 2–4 costal grooves between adpressed limbs. Morph A has been reported from Blount, Monroe, and Sevier counties, Tennessee, and Graham, Haywood, Macon, and Watuca counties, North Carolina (Sever, 1989), and probably occurs throughout the Southern Blue Ridge. Whether the morphs represent separate species or a polymorphism in Blue Ridge two-lined salamanders still is unresolved, but morph A also occurs in populations in the Piedmont and Coastal Plain of North Carolina within the defined range of southern two-lined salamanders (*E. cirrigera*; Sever, 1999b). Note that in some other populations of southern two-lined salamanders, such as in northern Alabama and the Cumberland Plateau of southeastern Tennessee, “big-headed” males occur (Mount, 1975; Sever, 1999b), but these individuals possess mental glands and cirri and therefore are not identifiable as morph A. Specimens resembling the male *wilderae* morph also have been found outside of the Southern Blue Ridge. Individuals morphologically similar to the *wilderae* morph have been reported by Chermock (1952) from Mount Cheaha in Alabama (which Chermock, as well as Mount, 1975, considers an extension of the Blue Ridge) and by Rossman (1965b) from Wilcox County in the Coastal Plain of Alabama. Allozyme analysis of specimens from these localities, however, align them with *E. cirrigera* (Jacobs, 1987). I have seen specimens that resemble the male *wilderae* morph from Cloudland Canyon State Park, Dade County, Georgia, and Kings Mountain State Park, York County, South Carolina. Howell and Switzer (1953) reported “inbetween” 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 sympathy need much more study (Sever, 1999a,b,c). Finally, Jacob’s 1987 group E of *E. wilderae* included samples from the type locality (Grayson County, Virginia) and two samples from Watuca County, North Carolina, whereas his group F contains 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 (group E) is referable to *E. wilderae*, but the southern taxon (group F) requires a new name.

Early reports indicate that Blue Ridge two-lined salamanders were frequently encountered during fieldwork. Dunn (1917a) reported on collections of the species near Brevard, Transylvania County, and Linville, Avery County, North Carolina. He stated, "We found the larvae of this species common in every small stream examined, and even in those as large as the Linville River. Adults were found rarely at Brevard. Only 1 adult and 1 transforming specimen were taken near there. At Linville both adults and larvae were common, but adults were found only on land under logs in situations similar to those chosen by various *Plethodon* and by *Desmognathus o. carolinensis* (*D. carolinensis*), in fact often in company with these species.

In Rutherford County, North Carolina, Welles (1930) found Blue Ridge two-lined salamanders to be “very common, both at camp and in the surrounding mountains.” King (1939) stated, “This is one of the common salamanders in the Great Smokies. It may be found in nearly every spring, seep and permanently damp place at suitable elevations.” In another account on Blue Ridge two-lined salamanders in the Smokies, Huheey and Stopka (1967) reported, “This common salamander ranges throughout the Park, occurring at all altitudes.” I have been collecting the species for over 35 yr. I believe that historically the species probably occurred in

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**Eurycea wilderae** Dunn, 1920

**BLUE RIDGE TWO-LINED SALAMANDER**

David M. Sever

1. Historical versus Current Distribution.

Until raised to full species status by Jacobs (1987), Blue Ridge two-lined salamanders (*Eurycea wilderae*) were considered a subspecies of northern two-lined salamanders (*E. bislineata*) as described by Dunn (1920). Dunn (1920) stated that the range of his new taxon is the “southern division of the Blue Ridge,” and Dunn (1926) reported that the distribution is “from White Top Mountain, Virginia; south in mountains to Clayton, Rabun County, Georgia, and Cherry Log, Gilmer County, Georgia. They inhabit the whole Southern Blue Ridge region.” The range is sometimes loosely given as “the southern Appalachian Mountains” (Jacobs, 1987; Conant and Collins, 1998), but essentially the range as defined by Dunn (1926) is restricted to the Southern Blue Ridge Mountain physiographic province. Blue Ridge two-lined salamanders occur from base-level streams to the tops of the highest peaks (about 1,900 m). The most remarkable characteristic of this species is the presence of two male morphs that differ dramatically in morphology, especially in regards to the male secondary sexual characters (Sever, 1979, 1999c). One of these is considered the typical “*wilderae*” morph because it possesses labial cirri, which also characterize males in the type series (Dunn, 1920). This gracile form also possesses a mental gland, seasonally enlarged premaxillary teeth, and 0–2 costal grooves between toes of the adpressed limbs. Males of the other morph, called “morph A” by Sever (1979), lack cirri, mental glands, and seasonally enlarged premaxillary teeth, and they possess 2–3 costal grooves between toes of the adpressed limbs. During the breeding season, the muscles comprising the jaw adductors hypertrophy, making morph A the “big-headed” form in the Southern Blue Ridge. Hypertrophy of the jaw adductors is also known in populations of northern two-lined salamanders and Junaluska salamanders (*E. junaltsuks*), but these species all possess mental glands and enlarged premaxillary teeth, and cirri also occur in Junaluska salamanders (Sever, 1979). Females associated with the two male morphs of Blue Ridge two-lined salamanders are indistinguishable but generally have 2–4 costal grooves between adpressed limbs. Morph A has been reported from Blount, Monroe, and Sevier counties, Tennessee, and Graham, Haywood, Macon, and Watuca counties, North Carolina (Sever, 1989), and probably occurs throughout the Southern Blue Ridge. Whether the morphs represent separate species or a polymorphism in Blue Ridge two-lined salamanders still is unresolved.

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**BLUE RIDGE TWO-LINED SALAMANDER (Eurycea wilderae)**

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770 PLUTHODONTIDAE
every rocky mountain stream in the South Blue Ridge. Today, Blue Ridge
two-lined salamanders are still commonly found in every stream that has not been
damaged by pollution, siltation, deforestation, channeling, and other factors. The
species, however, appears rather resilient, and one should not be surprised to
find it almost anywhere in the Southern Blue Ridge, even in seemingly inhospita-
tble habitats. For example, Tullulah Creek in Graham County, North Carolina,
is historically a clear-flowing rocky, base-level stream. Large samples of Blue Ridge
two-lined salamanders could be collected in the 1970s where Tullulah Creek runs
through Robbinsville. In the past 15 yr, the stretch through Robbinsville has be-
come increasingly murky and exposed as businesses and homes along the creek
have flourished. Other formerly common salamanders, such as three-lined salam-
ders (E. guttolineata), Junaluska salamanders, and black-bellied salamanders (D. quadramaculatus), are now rare along Tull-
ulah Creek in Robbinsville, but Blue Ridge two-lined salamanders are still com-
mon. Adults aggregate at mating/nesting sites from October–April and may be
abundant in streams where few adults can be found in mid summer. However, mass
metamorphosis of larvae can again make the species seem incredibly abundant
along rocky mountain streams in summer, but these individuals are mostly juveniles.

3. Life History Features. Consult Sever (1999a) for additional references on Blue Ridge two-lined sala-
manders.

A. Breeding. Reproduction is aquatic.

i. Breeding migrations. Many authors have noted that adults can be found consider-
able distances from water (e.g., King, 1939; Huehey and Stupka, 1967). In mid-
summer on Wayah Bald, Macon County, North Carolina, I have found dozens
under single strips of bark on fallen trees hundreds of meters from the nearest
streams. Because the eggs are laid in water and the species is aquatic, the migra-
tion must occur to suitable nesting sites. Also, because both males and females
migrate, nesting sites constitute mating areas as well. Aggregations start in the fall,
and at higher elevations, the mating/nest-
ing areas also serve as hibernation sites.
The peak concentration of adults in mat-
ing/nesting areas is in spring. Courtship
and mating occur on the banks of streams
adjacent to nesting areas. The projecting
premaxillary teeth of males of the wilde-ae
morph scrape the female’s skin during
courship, allowing secretions of the male’s
mental gland to enter the superficial cir-

ii. Breeding habitat. Usually the eggs are
attached to the underside of rocks in
flowing water. I have not noticed any
consistency in the size of the rock (large
or small) or shape (flat or round). Females
remain with the eggs. The gelatinous ma-
trix of the eggs is naturally adhesive; eggs
may be in one rather discreet cluster or
more scattered. A large, favorable rock
may have nests of several females. I occa-
sionally have found eggs (with attendant
females) by digging through gravelly
spring heads; an individual egg in these
situations may adhere to several small
pieces of gravel.

B. Eggs.

i. Egg deposition sites. As reported above,
nests most frequently have been found
under rocks in streams. A considerable
amount of variation, however, occurs in
the timing of oviposition in this species. Dunn (1920) reported: “At Linville a batch
of eggs was found hatching on July 19.
They were attached to the under side of a
stone in a brook just as are the eggs of bis-
lineata.” Wood (1949) stated that late
summer deposition occurs at elevations of
1,252 m, and egg laying occurs earlier at
lower elevations. At 1,220 m on Mount
Mitchell on 4 May, Wood (1949) found a
batch of 87 eggs suspended from the lower
surface of a flat stone in a small seepage
spring. Bruce (1982a) reported numerous
egg clusters in late winter and early spring
in streams in the Tuckasegee River basin
(695–1,050 m) in Jackson County, North
Carolina. At Santeetlah Creek (630 m),
Graham County, North Carolina. Bruce
(1982b) reported finding nests on 13 and 15 May; at the same site, however, I have
found nests in mid-March.

ii. Clutch size. The batch of 87 eggs re-
ported by Mitchell from the lower surface
of a rock in a small spring on Mount
Mitchell probably represents the clutches
of more than one female. Clutch sizes in
various populations have been reported
to range from 8–34 and 28–56 (Ryan and
Bruce, 2000).

C. Larvae/Metamorphosis. Ryan (1997)
provides an excellent drawing of the larva.
The larvae of Blue Ridge two-lined sala-
manders are a pale yellow to yellow-green
dorsally with a thin, broken dorsolateral
stripe, ventral to which is a fine mottling
and three rows of unpigmented lateral
line spots (Eaton, 1956; Ryan, 1997). The
tail is flattened and mottled while the
venter is clear and a light cream color.
Bruce (1986) reported on drift movements
of Blue Ridge two-lined salamanders in a
stream at 1,170 m in Macon County,
North Carolina. He found that down-
stream movements are dominated by first-
year larvae. Upstream movements are not
sufficient to compensate for downstream
drift, so drift may represent a density-de-
pendent means of population regulation.

ii. Length of larval stage. Bruce (1982a,
1985b) reported metamorphosis usually
occurs in late spring and early summer
after 1–2 yr at a mean 18.5–23.9 mm SVL
in stream populations, and at 26.4 mm
SVL in a pond. Although a tendency exists
for growth rates to be lower at higher
elevations, no corresponding tendency oc-
curs for the larval period to be prolonged
(Bruce, 1985b). At Santeetlah Creek, Gra-
ham County, North Carolina, the larval pe-
riod typically is 2 yr with mean 31.8 mm
SVL in the oldest cohort to metamorphose
(Bruce, 1982b). Voss (1993b) found that
larvae metamorphose after 1 yr 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, 1993b). Beachy (1994) found that
survival and growth of Blue Ridge two-
lined salamander larvae raised in the
laboratory together were independent of
density, suggesting a lack of competition.

iii. Clutch size. The batch of 87 eggs re-
ported by Mitchell from the lower surface
of a rock in a small spring on Mount
Mitchell probably represents the clutches
of more than one female. Clutch sizes in
various populations have been reported
to range from 8–34 and 28–56 (Ryan and
Bruce, 2000).

iv. Features of metamorphosis. As reported
in “Length of larval stage” above, meta-
orphosis occurs after 1–2 yr of larval
development. Newly metamorphosed
juveniles are often abundant around
breeding areas in late spring and summer,
indicating some synchrony in metamor-
phosis within a population.

v. Post-metamorphic migrations. Individ-
uals that metamorphose in the late spring
or summer may participate in breeding ac-
tivities the following spring, at the begin-
ning of their third or fourth year (Bruce,
1988b). Thus, the juvenile stage is short,
and juveniles may not move far from
streamside habitats along the natal area.
I have found mature gonads in dissected in-
dividuals that are only 25–28 mm SVL
within the range of body sizes characteriz-
ing newly metamorphosed animals in
some populations (Bruce, 1982a,b, 1985b).

vi. Neoteny. Not known to exist.

D. Juvenile Habitat. As mentioned above,
juveniles often are found in streamside
habitats. They may be found under rocks
and logs, by scraping through leaves
and other detritus. Bruce (1986) did not
find significant differences between up-
stream and downstream movements in
second-year larvae and metamorphosed
individuals.

E. Adult Habitat. Males frequently are
found with females under rocks in streams
during the spring mating period. Females
subsequently stay in the water with their
eggs, whereas the males move into terres-
trial habitats. After eggs hatch, females

PLETHODONTIDAE 771
must follow males into more terrestrial habitats because adults of either sex are usually uncommon along streams in midsummer.

F. Home Range Size. I am unaware of any literature on whether individuals of Blue Ridge two-lined salamanders establish home ranges during any period of the year or stage of life. The study done by Bruce (1986) on upstream and downstream movements suggests that adults and second-year larvae move upstream and downstream in equal frequencies, which no doubt contributes to maintaining a certain density at a locale. First-year larvae, however, move downstream more frequently, resulting in a density dependent mechanism of regulation of excess production (Bruce, 1986).

G. Territories. Wiltenmuth (1997a) reported aggression in larval Blue Ridge two-lined salamanders, but whether this behavior is due to territorial or nonterritorial interference competition requires further investigation.

H. Aestivation/Avoiding Desiccation. Not known to occur. Hutchison (1961) reported on critical thermal maxima in a number of salamanders, including three juvenile Blue Ridge two-lined salamanders. He found a CTMax of 32.1 °C, the lowest of any salamander tested (Hutchison, 1961).

I. Seasonal Migrations. Movements between terrestrial and stream habitats associated with mating/nesting activities are discussed in “Breeding migrations” above.

J. Torpor (Hibernation). Numerous individuals can be found by digging through gravelly spring heads in mid-winter, even at high elevations where harsh winter weather surely precludes much surface activity. At lower elevations, however, activity may occur through mid-winter.

K. Interspecific Associations/Exclusions. The Southern Blue Ridge physiographic province is a center of salamander diversity in North America (Bruce et al., 2000). The Blue Ridge two-lined salamander commonly is found in association with a dozen or more other species. Brodie (1981) reported that yellow-striped Owce salamanders (Desmognathus ochraceus; called D. ochtophaeus by Brodie) from several North Carolina localities are mimics of Blue Ridge two-lined salamanders. However, this model-mimic relationship is not as prevalent as in New York between Allegheny Mountain dusky salamanders (D. ochtophaeus) and northern two-lined salamanders, which are relatively more common in association with Allegheny Mountain dusky salamanders than Blue Ridge two-lined salamanders are with Oocoe salamanders in North Carolina.

L. Age/Size at Reproductive Maturity. The smallest individuals I have dissected that definitely possess mature gonads are 25 mm SVL for a female and 28 mm SVL for a male. However, some individuals as small as 23 mm SVL may be mature, and many are still immature at 30 mm SVL. Bruce (1988b) reported that individuals spend 1–2 yr as juveniles after 1–2 yr as larvae. Age at first reproduction in both sexes is estimated to be 3–4 yr, but usually the latter, since most individuals metamorphose at 2 yr (Bruce, 1988b). Mean SVL of adults from various populations ranges from 30.3–40.0 mm (Seyer, 1999a), with total lengths of 60–90 mm (Bishop, 1943). The record specimen came from Indian Gap in the Great Smoky Mountains and is 120 mm TL (King, 1939).

M. Longevity. Bruce (1988b) constructed a life table for a population of Blue Ridge two-lined salamanders from 1,100 m in Macon County, North Carolina. He found that R0 = 0.821, indicating a declining population and an unstable age distribution. Bruce believed that this R value was a result of procedural errors and used alternative methods (that do not rely upon any assumptions concerning R) to calculate an estimate mean generation time of 4.4 yr; an annual survivorship of 0.408 was calculated for females. Few animals survive beyond 5 yr and none beyond 10 yr.

N. Feeding Behavior. I am not aware of any studies that specifically address feeding behavior of Blue Ridge two-lined salamanders.

O. Predators. Huheey and Stupka (1967) mention that spring salamanders (Gyrinophilus porphyriticus; see also Bruce, 1979; Beachy, 1994) and common garter snakes (Thamnophis sirtalis) are predators. Larval (Beachy, 1994, 1997) and metamorphosed (Davic, 1991) black-bellied salamanders are known predators, and it is likely that several other large plethodontids (including red salamanders, Pseudotriton ruber, and shovel-nosed salamanders, D. marmoratus) eat Blue Ridge two-lined salamander larvae or adults as well (Bruce, 1982a). Beachy (1994) raised larval Blue Ridge two-lined salamanders in the laboratory for 30 d with larvae of spring salamanders and/or black-bellied salamanders. He found that both predators significantly reduced survivorship of Blue Ridge two-lined salamanders, but that spring salamanders were more effective. Larvae of spring salamanders exposed to high prey densities grew more than those exposed to low prey densities, but prey density had no effect on prey survival. When grouped together with Blue Ridge two-lined salamanders, predator effects on prey survival were additive, indicating neither a mutualistic nor a competitive interaction between spring salamanders and black-bellied salamanders. Beachy (1997a) conducted additional experiments in which he exposed larval Blue Ridge two-lined salamanders to larval black-bellied salamanders. Risk of predation caused significant variation in growth rate, with larvae under highest predation risk growing faster than larvae in the absence of predators. However, larvae metamorphosed at the same time regardless of different growth rates and predation risk (Beachy, 1997a).