HANDBOOKS OF AMERICAN NATURAL HISTORY

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VOLUME III

Handbook of Salamanders

BY SHERMAN C. BISHOP

Part 3

mesad to it and extends to the side of the snout. Another group on the side of the head behind the eye extends forward to the margin of the lip below the naris, and from this point sometimes turns backward in a

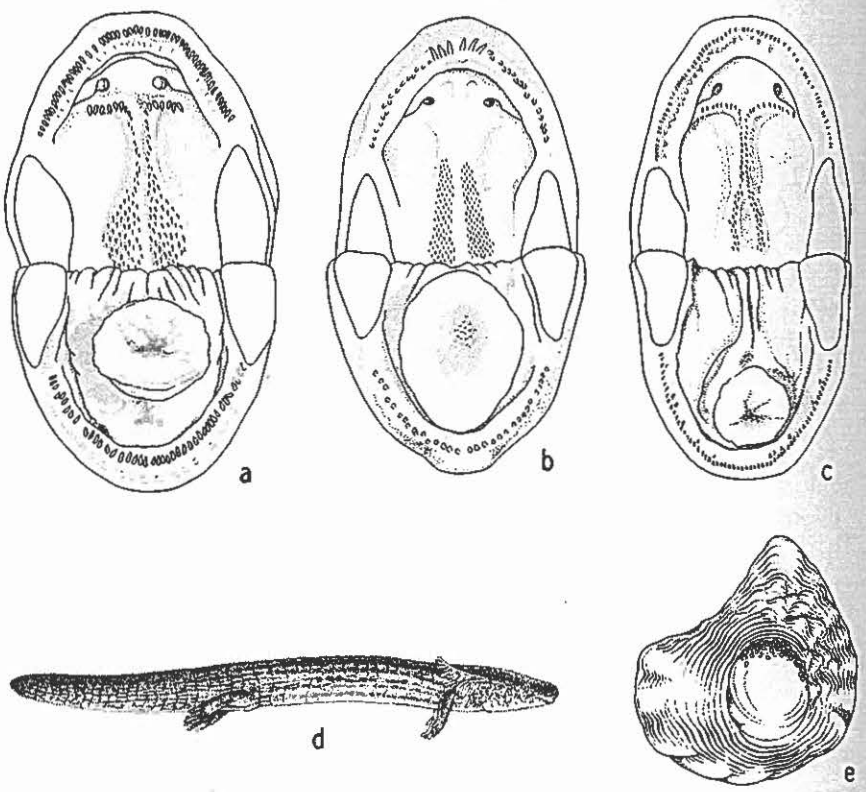


FIG. 101 (a) Open mouth of *Pseudotriton ruber ruber* to show the character of the tongue and teeth. (b) Open mouth of adult male *Desmognathus fuscus fuscus*. (c) Open mouth of *Stereochilus marginatus*. (d) Larva of *Stereochilus marginatus*. [H.R.B. *del.*] (e) Spermatophore of *Eurycea longicauda melanopleura*. [a–c, M.L.S. *del.*; e, H.M.Z. *del.*]

single line to the anterior angle of the eye. A deep, darkly pigmented groove extends from the posterior angle of the eye to the lateral extension of the gular fold, and from this a short vertical groove passes behind the angle of the jaw. The eyes are of moderate size and may be retracted to the contour of the head. Trunk cylindrical, somewhat flattened below, and with an impressed median dorsal line. Costal grooves 18, and

about 8 or 9 intercostal spaces between the toes of the appressed limbs. Legs short, slender; toes long and slender without webs, in order of length 1–5–2–4–3 from the shortest. Toes of the fore feet 1–4–2–3. Tail oval in section at base, beyond rounded below, sharp-edged above, the tip compressed. Tongue small, broadly oval in outline, slightly de-

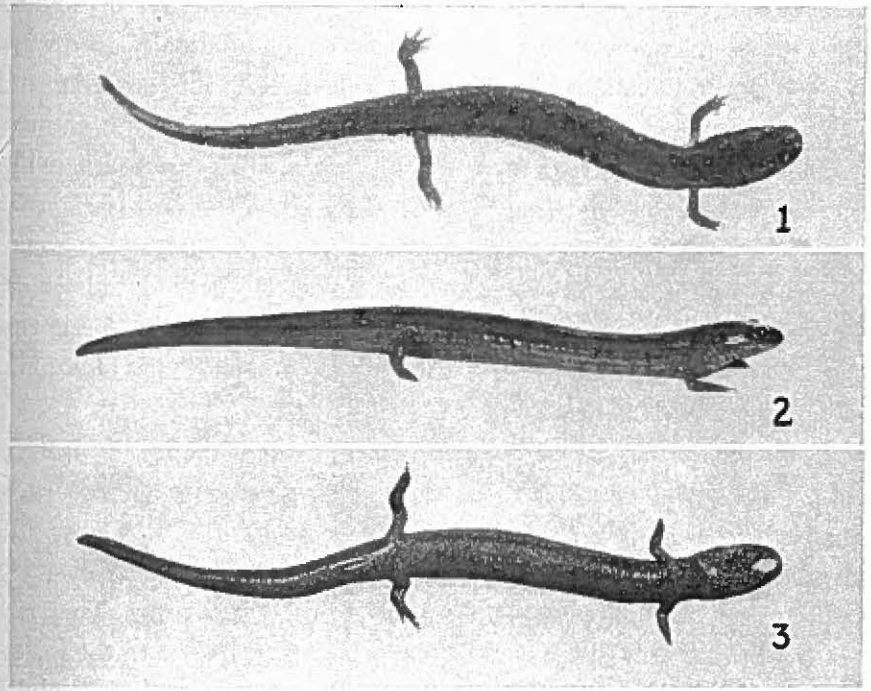


FIG. 102. *Stereochilus marginatus* (Hallowell). (1) Adult male, actual length about 3″ (77 mm.). (2) Same, lateral view. (3) Same, ventral view. Near Emporia, Virginia.

pressed into the floor of the mouth, and surrounded by a low fleshy ridge. It is rather broadly attached in front at the mid-line and this membrane continues to the pedicel near the center. Vomerine teeth continuous with parasphenoid. The vomerine series arise behind and just outside the outer margin of the inner naris, curve inward and gently forward toward the mid-line, where they are narrowly separated from the series of the opposite side, then sharply backward. Parasphenoid teeth in 2 slender patches which diverge slightly posteriorly.

COLOR. The general ground color above is a dull yellow, slightly lighter on the upper sides. The middorsal impressed line is darkly pigmented and in young individuals the entire dorsal surface is lightly reticulated with seal-brown. In old adults the dark brown pigment largely obscures the lighter ground color, which strikes through in small circular spots. The ground color of the lower sides is considerably lighter than that of the upper. The sides are narrowly, longitudinally lined with alternating brown and yellow, best developed in the younger specimens. The dark lines of the upper sides originate on the snout, continue through the eye and along the trunk to the tail, where they unite with the lower series to form a coarsely reticulate pattern. In many specimens, the narrow dark lines of the sides are arranged in threes, the upper group separated from the lower by a yellow interspace. The belly is dull yellow with a few dark specks scattered irregularly over the surface. Specimens from dark swamp waters are very dark-colored and with little indication of light lines on the sides.

BREEDING. The egg-laying habits of captive, stimulated specimens have been studied by Noble and Richards (1932, p. 5). As many as 121 eggs may be deposited by a single female, but the average of 19 was 57. Individual eggs with their external envelopes attain a diameter of 3–3.5 mm., the inner envelope 2.5–3 mm., the egg itself 2–2.5 mm. They are attached singly to a support in water, probably in nature to the lower surface of a stone, piece of bark, or log. The outer capsule is slightly elongated to form a stalk.

LARVAE. Larvae attain an extreme length of 3 7/16″ (87 mm.), the older individuals resembling the adults in general form and color. The gills are long and extremely compressed, the filaments slender, flattened, and well pigmented. The younger larvae tend to be more mottled above than the adults, but the irregular streaking of the sides is noticeable.

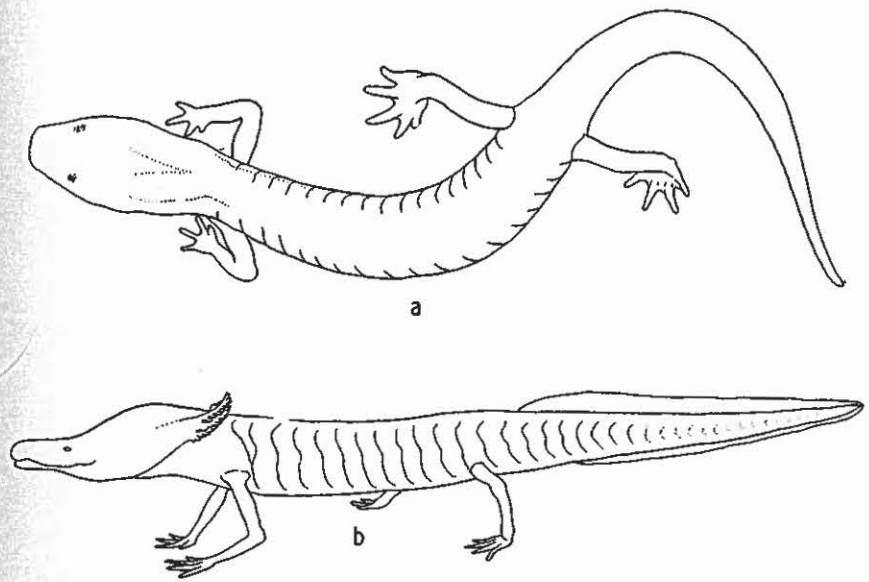


FIG. 103. (a) Outline of *Typhlotriton spelæus* to show the form of the body, reduced eyes, and character of legs and feet. (b) Outline of *Typhlomolge rathbuni* to show the form of the body, the slender and elongate legs, and the toes, gills, and vestigial eyes. [H.P.C. *del.*]

GENUS TYPHLOTRITON

OZARK BLIND SALAMANDER. *Typhlotriton spelæus* Stejneger. Figs. 103a, 104. Map 43.

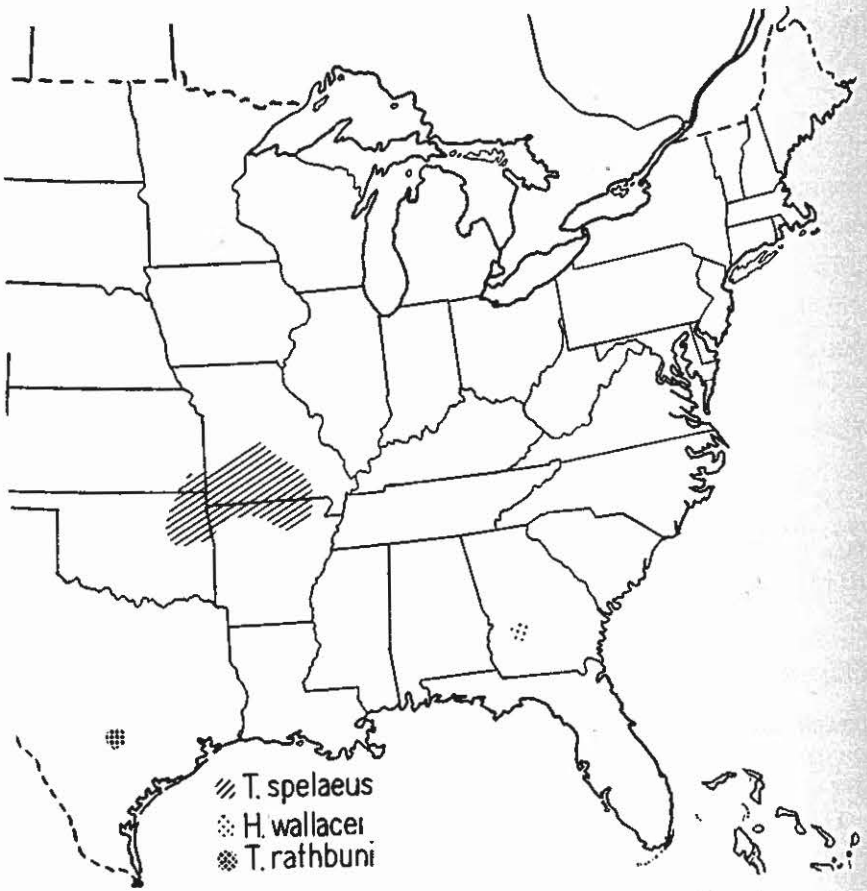
TYPE LOCALITY. Rock House Cave, Missouri.

RANGE. Ozark Plateau in Missouri, Oklahoma, Kansas, and Arkansas.

HABITAT. The adults are mainly limited to the caves and underground passages of the limestone regions in the Ozarks and, while freely entering water, are more terrestrial than other true cave salamanders. The larvae are found in springs and streams, both in the open and in caves.

SIZE. The species may attain a length of 5 5/16″ (135 mm.), but this is exceptional. The average of 7 adults which vary from 2 7/8″ (72 mm.) to 4 3/4″ (120 mm.) is 3 3/4″ (95 mm.). The proportions of an adult from Cave Springs Caverns, Carter County, Missouri, are as follows: total

length 3 5/16″ (84 mm.), tail 1 9/16″ (40 mm.); head length 13/32″ (10 mm.), width ¼″ (6 mm.).



MAP 43.—Distribution of blind salamanders, *Typhlotriton spelæus*, *Haideotriton wallacei*, and *Typhlomolge rathbuni*.

DESCRIPTION. This pale denizen of the caves has a ghostly appearance when seen in its natural surroundings by the light of a torch or lamp. The strongly depressed head is long and slender, widest at the angle of the jaws, and gently tapering to the gular fold. In front of the eyes the sides converge more abruptly to the sharply truncated snout, which, in some individuals, is slightly convex between the nostrils. There is a

slight swelling in the parotoid region, and a sinuous groove extending from below the eye to the gular fold, and from this a short oblique groove to the angle of the jaw. Viewed from the side, the commissure of the mouth is gently and evenly arched. The snout is swollen in the region of the nasolabial grooves and produced into blunt cirri below the nostrils, particularly in the males. The eyes are small and dark, partly or completely covered by the fused lids, and separated equally from each other and the nostril of the same side. The trunk is slender and rounded and with little evidence of an impressed median line except in some preserved material. There are 16 well developed costal grooves, or 17 if 2 that run together in the groin are counted, and about 4 intercostal spaces between the toes of the appressed limbs. The legs are rather slender, the hind somewhat larger than the fore. Toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; toes of the fore feet 1–4–2–3, all toes slightly webbed at base. The tail is long and slender, oval in section at base, rounded below, and provided with a low keel above. The tongue is small, roughly oval in outline, and with the margins thin. It is attached by a central pedicel, from which a thin membrane extends along the median line to the anterior margin and to the floor of the mouth. Vomerine teeth in series of 11–17. In a male, the series arise behind the middle of the inner naris, extend inward and forward, then abruptly backward parallel with the adjacent series, from which they are distant about ⅔ the diameter of an inner naris. In some the vomerine series are continuous with the parasphenoids, in others widely separated. Parasphenoid teeth in 2 elongate patches separated by about the diameter of an inner naris.

COLOR. The general color in life is pale flesh, with tinges of orange pigment in small round spots scattered over the dorsal surface of the tail and on the lower sides and feet, imparting a yellowish cast in these regions. A few individuals are sparsely pigmented over the dorsal surfaces generally and have a light gray appearance. The males may usually be recognized by the greater development of cirri and by the presence of papillae along the margins of the vent.

BREEDING. Nothing is known of the breeding habits and eggs.

LARVAE. Unlike the adults, which are only slightly pigmented and usually restricted to the caves, the larvae are highly pigmented and are

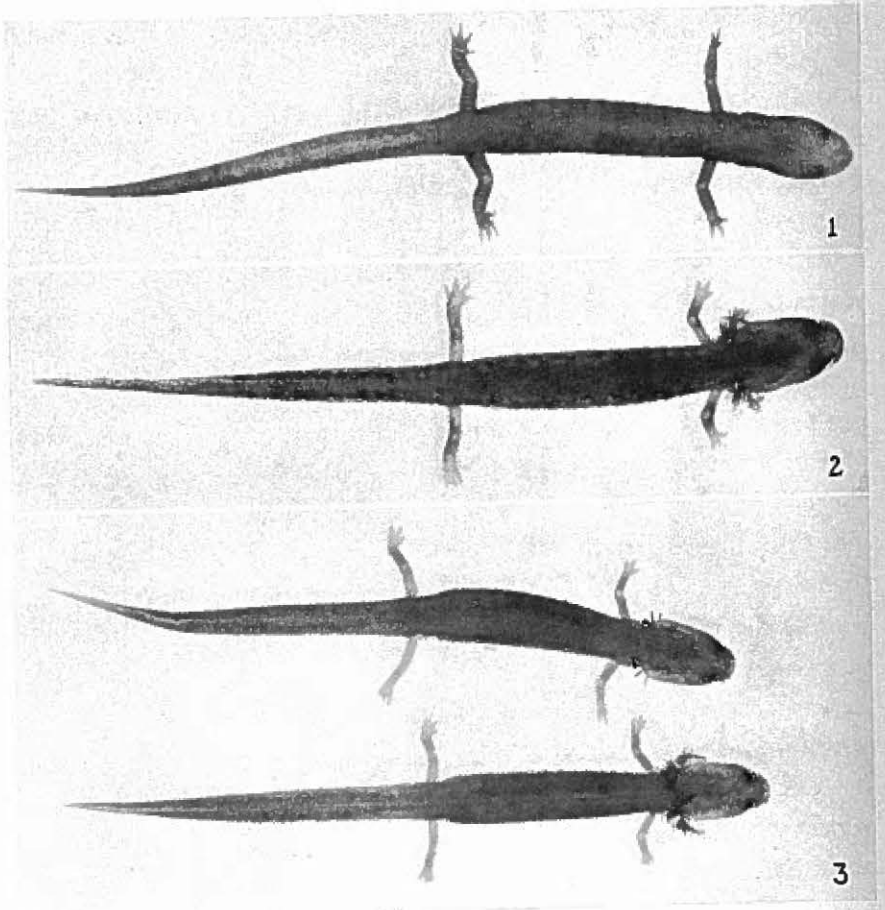


FIG. 104. *Typhlotriton spelæus* Stejneger. (1) Adult, actual length about 3¾″ (95 mm.). Marvel Cave, Stone County, Missouri. (2) Large larva from spring. Stone County, Missouri. (3) Large larvae. From River Cave, Camden County, Missouri. [Collected by James Kezer and photographed by Arthur L. Smith.]

most frequently taken in open streams. The smallest larva mentioned by Dunn had a total length of 24 mm., and the largest 93 mm. In my own collection the range is from 23 to 96 mm., the smaller individual

taken April 30, 1927, at York Spring, Imboden, Arkansas, by Byron C. Marshall. Other specimens taken at the same time and place measure 28, 30, 35, and 35 mm. respectively. The fully grown larvae have a ground color of light grayish-lavender on the trunk and head, with small scattered light yellow flecks and an iridescent cast on the trunk above. The legs are pale, dirty white, the belly and throat dull white. The tail is broadly keeled above, from a point opposite the insertion of the hind legs to the bluntly rounded tip, and below about ½ the distance to the vent, thence to the vent as a low ridge. The general pigmentation of the sides of the trunk is continued on the tail, and the fins are lightly tinged with gray along the margins. Beginning at a point behind the gills, there is a dorsolateral series of small light spots which continues well above the insertion of the hind legs onto the sides of the tail. In some, a secondary row is developed at a lower level. The gills are short, strongly compressed, wide at the base but abruptly tapering, and with slender, darkly pigmented filaments. The head of the larva is decidedly different from that of the adult and the eyes are fully developed and functional. The head is widest in front of the gills, tapers gradually to just in front of the eyes, then slightly to the bluntly rounded snout. In some individuals, a narrow light line extends from the eye to the nostril.

GEORGIA BLIND SALAMANDER. *Haideotriton wallacei* Carr. Fig. 105. Map 43.

TYPE LOCALITY. From a 200′ well at Albany, Dougherty County, Georgia.

RANGE. Known only from the type locality.

HABITAT. Subterranean waters.

SIZE. The only known specimen, a sexually mature female, had the following measurements as given by Carr (1939, p. 335): total length 3″ (75.5 mm.), tail 1 11/32″ (33.5 mm.); head length 17/32″ (12.5 mm.), width 11/32″ (8 mm.).

DESCRIPTION. This subterranean species is blind, white, and semi-

transparent. The head is broad but not strongly depressed as in *Typhlomolge,* the sides slightly concave between the angle of the mouth and the gular fold, the snout very broadly rounded. The mouth is small and nearly terminal. Neither eyes nor eye spots developed. The gills

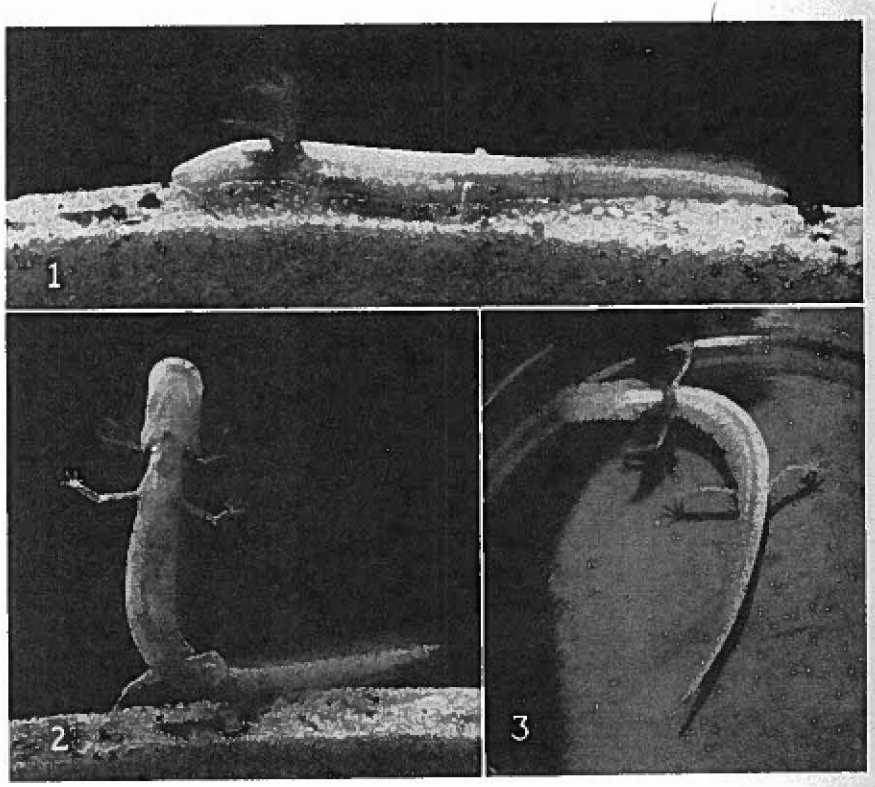


FIG. 105. *Haideotriton wallacei* Carr. (1) Adult female, type specimen; lateral view. (2) Same, ventral view. (3) Same, dorsal view. From a deep well at Albany, Georgia. [Photographs through the courtesy of A. F. Carr.]

are very long and slender, the 3rd longest, and when appressed to the sides reaching the 3rd costal groove. Neck markedly narrower than head and trunk. Trunk subcylindrical. Eleven costal grooves. Legs long and slender; toes 5-4, those of the hind feet 1-5-2-(3-4) in order of length from the shortest; toes of the fore feet 1-4-2-3. Tail moderately compressed, the dorsal fin arising above the vent and continuing with-

out widening to the bluntly rounded tip. Lower tail fin narrower. Vent without papillae.

COLOR. "In life, body pale, pinkish white, vaguely opalescent; viscera and eggs plainly evident through body wall; limbs transparent, the larger blood vessels readily discernible; tail and fin very faintly suffused with yellow; gills blood red. After preservation, dull white, with widely scattered clusters of dark pigment cells" (Carr, 1939, p. 335).

BREEDING. Nothing is known.

Through the courtesy of Mr. A. F. Carr, the describer, I have been given the privilege of reproducing his excellent photographs of this remarkable salamander.

TEXAS BLIND SALAMANDER. SAN MARCOS SALAMANDER. WHITE SALAMANDER.

Typhlomolge rathbuni Stejneger. Figs. 103b, 106. Map 43.

TYPE LOCALITY. Artesian well, 188′ deep, at San Marcos, Hays County, Texas.

RANGE. Known from Hays, Kendall, and Comal Counties, and reported from Crockett County, Texas.

HABITAT. Known only from wells and underground streams in caves.

SIZE. The largest specimen seen by Dunn, a male, had a total length of $5\frac{13}{32}''$ (136 mm.), tail length, $2\frac{13}{32}''$ (60 mm.). Most specimens are considerably shorter, 4 sexually mature individuals varying from $3\frac{13}{32}''$ (85 mm.) to $4\frac{13}{32}''$ (110 mm.) and averaging $3\frac{13}{16}''$ (97 mm.). The proportions of an adult male from San Marcos, Texas, are as follows: total length $3\frac{15}{16}''$ (100 mm.), tail $1\frac{25}{32}''$ (45 mm.); head length $\frac{19}{32}''$ (15 mm.), width $\frac{17}{32}''$ (13 mm.).

DESCRIPTION. This is a blind, white salamander with long, slender legs, flattened snout, and permanent, pinkish gills. Viewed from above, the head is very broad, widest just in front of the gills, curving gently forward to the eyes, where there is a slight constriction, then evenly and gently to the broadly truncated snout. The snout is much flattened and in front of the eyes has a depth about ⅓ that of the head at the gills. The eyes are small black dots wholly covered by the skin. A broad

sinuous groove extends from the eye to the lateral extension of the gular fold. The commissure of the mouth is sinuous and the angle of the mouth lies immediately below the eye. The gills are slender, the filaments long and slender and without pigment. The trunk is deeper than wide and has a low median dorsal ridge. There are 12 costal

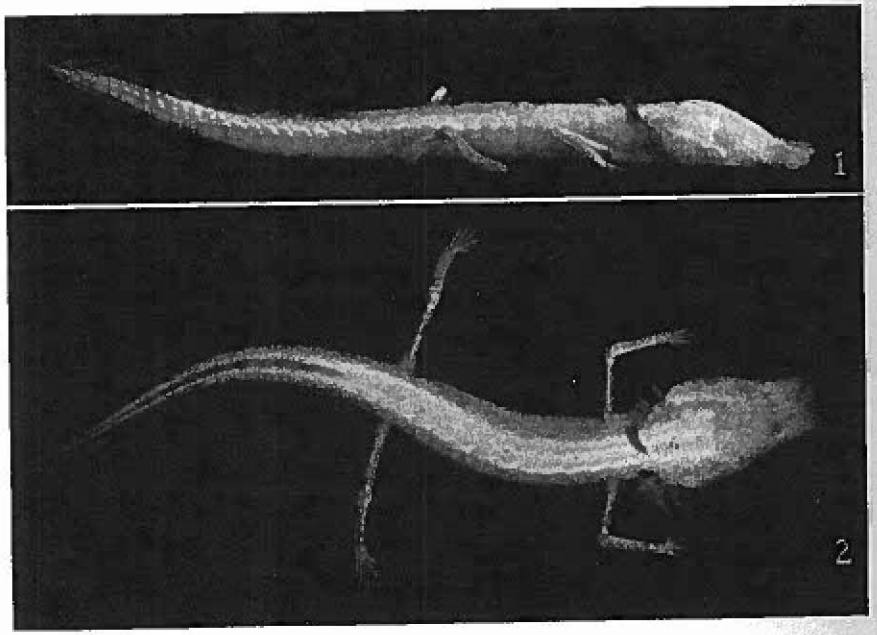


FIG. 106. *Typhlomolge rathbuni* Stejneger. (1) Juvenile, actual length 2 9/16" (65 mm.). (2) Same, dorsal view. Ezell's Cave, San Marcos, Texas.

grooves, counting 1 in the axilla and 2 that run together at the groin, and about 6 intercostal spaces between the toes of the appressed limbs. The legs are extremely long and slender; toes 5–4, those of the hind feet 1–5–2–3–4 in order of length from the shortest; toes of the fore feet 1–4–2–3, all without webs. The tail is subquadrate in section at the base, strongly compressed toward the pointed tip. The dorsal tail fin arises at a point above the vent and is widest at about the distal third; the ventral fin extends about ½ the distance to the vent and is continued forward as a low, fleshy ridge. The tongue is crescent-shaped, free in front and for

a short distance on the sides. The vomero-palatine teeth form an inverted U-shaped series, narrowly interrupted at the mid-line and at about halfway down the sides.

COLOR. The snout is dull white, very slightly suffused with darker except in a blotch below each eye, where all pigment is lacking; the remainder of the head, the trunk, and the tail are iridescent, with pastel shades of pink, lavender, and pale blue in a broad dorsal band; the band limited on each side by a faint row of elongate pale spots. The dorsal keel of the tail is lightly mottled with pale brownish blotches, and on the sides below the dorsal band there is just the slightest indication of pigment. The belly is uniformly dull white except for a midventral band, where it is iridescent. The heart in the region of the throat shows through as a pinkish spot. The legs appear opaque white, but in reality are lightly pigmented.

BREEDING. Nothing is known of the breeding habits under natural conditions. Eigenmann (1909, p. 31) reported that a specimen in captivity laid a few eggs about March 15, 1896, and Dunn (1926, p. 255) examined a female collected in the early fall of 1916 that had the spermatheca packed with sperm.

In this permanently larval form the sexually immature individuals resemble those that have attained full growth. Eigenmann (*ibid.*, p. 31) mentions a specimen only 30 mm. long.

On March 31, 1936, I visited Ezell's Cave, San Marcos, Texas, where many specimens have been collected, but the width of my shoulders did not conform to the diameter of the shaft leading to the underground waters and I failed to reach the proper level. A second attempt was made at Johnson's well, not the original which had been capped by concrete, but one recently opened a short distance away. Here, with the aid of a rope, I descended to the water level, and saw a fine large specimen resting quietly on a ledge a foot or two below the surface. My maneuvering disturbed the creature and it disappeared in the shadowy depths. The same or another individual was momentarily glimpsed in the deep recesses of a side channel, but it too darted away and was lost when

an attempt was made to direct it into a dip net. Three living examples were secured for me by Mr. W. E. Ezell in Ezell's Cave, and I have seen other living specimens from New Braunfels, Comal County, and from Boerne, Kendall County.

Genus GYRINOPHILUS

KEY TO THE SPECIES AND SUBSPECIES OF GYRINOPHILUS

1. Back strongly clouded or mottled, light yellowish-brown, with reddish tinges to light salmon (purplish in preservatives); sides with darker reticulations enclosing pale spots; light line from eye to naris bordered below with a darker band; entire venter flesh in life (yellow in preserved specimens) sometimes with a few small scattered dark dots on the belly and more numerous spots on the throat and margin of the lower jaw; length to 7 19/32″ (193 mm.), rarely to 8⅝″ (219 mm.). Ontario, Canada opposite Buffalo, New York, through the eastern states to Virginia, Tennessee, and possibly Alabama .... *porphyriticus porphyriticus* p. 367

   Back lightly, if at all, clouded or mottled; uniformly reddish suffused with dusky; or with dark dots, flecks, or spots on a lighter ground .. 2

2. Back uniformly reddish in life, with a faint chevron-like middorsal pattern of darker lines; or sometimes with a few small, scattered, dark flecks on the back and sides; internal nares large, nearly circular in outline; venter flesh color without darker markings; length to about 6¼″ (154 mm.). Unglaciated area of southern Ohio .... *porphyriticus inagnoscus* p. 373

   Back not uniformly reddish in life with chevron-like middorsal pattern; back with conspicuous dark dots, flecks, or spots on a lighter ground; or, back with few or no black dots but with dorsolateral series 3

3. Dark spots of back and sides few, small, and widely separated, usually forming a dorsolateral series, never extending below the level of the legs; venter immaculate; throat never blotched or reticulate, margin of lower jaw with a few small dark dots; light line from eye to naris indistinct, only lightly bordered with darker below; internal nares small, oval in outline; length to 6 15/32″ (164 mm.). Northeastern Kentucky, southern Ohio, northwestern West Virginia .... *porphyriticus duryi* p. 370

   Dark spots or flecks numerous, scattered generally on back and sides; margin of lower jaw and sometimes the throat with dark spots or strongly mottled black and white 4

4. Dark spots of black and sides dark brown to black, often fusing to form elongate blotches; venter of adults usually with scattered black dots; throat mottled or reticulated, black and white; length to 8½″ (204 mm.). Southwestern Virginia through eastern Tennessee, western North Carolina, and possibly to Georgia and South Carolina, above 3500′ ..... *danielsi danielsi* p. 361

   Dark spots of back and sides small, brown, usually separate, occasionally forming indistinct chevrons; venter usually immaculate, occasionally with a few dark dots; margin of lower jaw with dark spots, dots, or reticulations; throat never heavily marked as in typical *danielsi;* light line from eye to naris heavily bordered with brown below, lightly margined above; length to 6 5/16″ (160 mm.). Northwestern South Carolina, western North Carolina, northeastern Georgia, and eastern Tennessee, below 3500′ ..... *danielsi dunni* p. 365

MOUNTAIN PURPLE SALAMANDER. *Gyrinophilus danielsi danielsi* (Blatchley). Fig. 107. Map 44.

TYPE LOCALITY. Mt. Collins and Indian Pass, Sevier County, Tennessee.

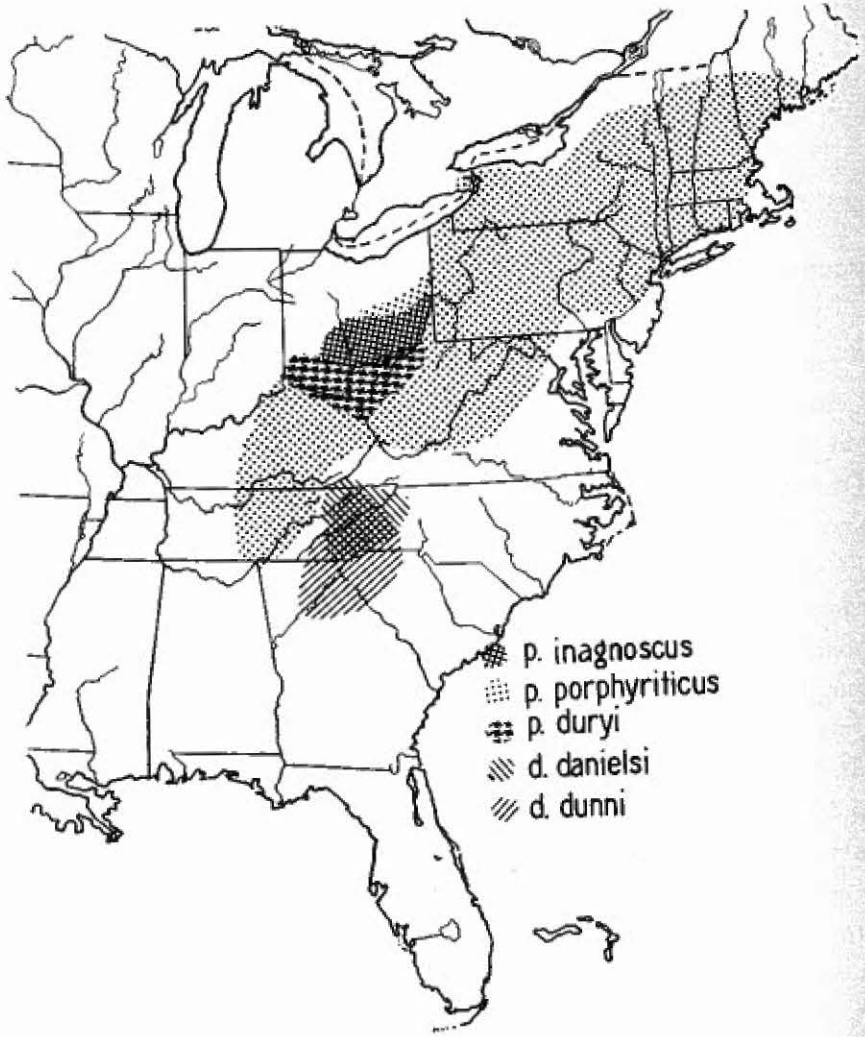
RANGE. Mainly confined to the southern section of the Blue Ridge Mountains from near Cumberland Gap, Kentucky, through eastern Tennessee, western North Carolina, and possibly to Georgia and South Carolina.

HABITAT. Reaches its best development in high mountain streams, where it hides by day beneath stones or other sheltering object. Occasionally wanders some distance from the stream and may be found beneath logs or bark.

SIZE. Seventeen adults taken at an elevation of 6000′ and above on Mt. Mitchell, North Carolina, varied in length from 4¾″ (120 mm.) to 8 1/16″ (204 mm.) and averaged 6⅛″ (155.5 mm.). The 10 largest averaged 6 15/16″ (172.7 mm.).

DESCRIPTION. Daniels' salamander is somewhat larger than its northern relative, *G. porphyriticus,* and is more strikingly marked. The head is broad and somewhat flattened, widest immediately behind the eyes, the sides converging slightly to the lateral extensions of the gular fold and more abruptly to the nostrils. The snout is depressed, the end broadly and evenly rounded. The eye is of moderate size, with the pupil small, black, and slightly elongate longitudinally; iris gold, brassy immediately surrounding the pupil, and crossed horizontally by a broad coppery-red band. A short vertical groove from the angle of the jaw to

the long sinuous groove which extends from the eye to the lateral extension of the gular fold. The strong, muscular trunk is rounded on



MAP 44.—Distribution of the subspecies of *Gyrinophilus porphyriticus* and *G. danielsi*.

the sides and somewhat flattened above and below. Costal grooves usually 17 but occasionally 18. About 6 intercostal spaces between toes of appressed limbs. Tail rounded below; keeled above, beginning about

opposite posterior end of vent and becoming knife-like above on the distal third. Legs strong, toes 5–4, those of the hind feet 1–5–2–3–4 or 4–3 in order of length from the shortest; fore feet 1–4–2–3; all slightly

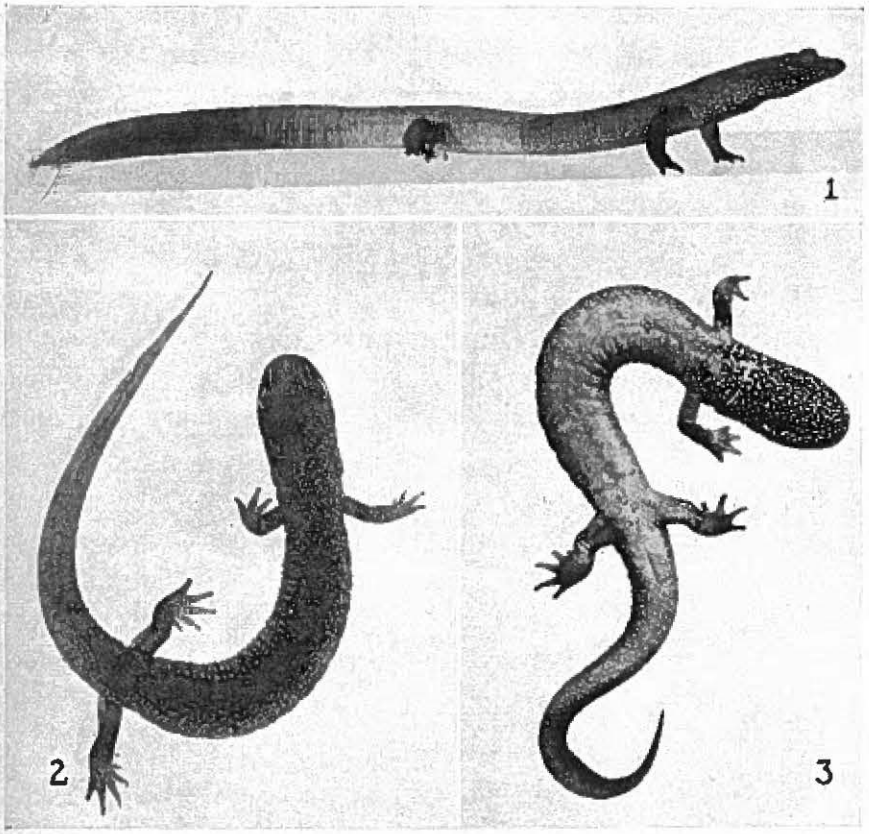


FIG. 107. *Gyrinophilus danielsi danielsi* (Blatchley). (1) Adult female, actual length 8 1/32" (204 mm.). (2) Same, dorsal view. (3) Same, ventral view. Steprock Creek, Mount Mitchell, North Carolina; altitude, 6000'. [Photographs by E. J. Stein and S. C. Bishop.]

webbed at base. Tongue moderate in size, roughly circular in outline, the margins smooth, the center with fine papillae. Vomerine teeth continuous with the parasphenoid. The vomerine form strongly arched series which arise just outside and behind the inner nares, slant gently inward and forward, then turn sharply backward, their inner arms

nearly parallel. The teeth form a single line, 9 or 10 to the bend, and 19–21 in each series. Parasphenoid teeth in 2 well separated, slender, club-shaped patches.

COLOR. This is a reddish or salmon-colored salamander, marked above with irregular flecks and spots of black. The ground color varies considerably, being brighter in recently transformed individuals and becoming tan or brownish in older ones. There are frequently tinges of orange-red on the legs and along the mid-line of the back. In water a bluish or purplish bloom or cast covers the dorsal surfaces. The sides are lighter than the back, and the deep brown or black flecks are smaller and become fewer and farther apart toward the belly and on the sides of the tail. The belly and under surface of the legs are flesh-colored in life, with scattered spots of tan and brown pigment, and sparsely scattered whitish flecks. Back of the hind legs the ground color may be slightly darker, light tan with darker markings. The entire throat and, in some old individuals, the region back of the gular fold, as well as the lower edge of the upper lip, may be finely reticulated with black and white in about equal proportions. In younger individuals these reticulations may be almost lacking. In most individuals there is a dark line extending from the anterior angle of the eye to the nostril which is bordered above by white. This dark line may be extended back of the eye along the groove which runs to the lateral extension of the gular fold. Feet reddish, toes tipped with black.

BREEDING. Nothing is known of the mating habits. A large female guarding her hatching young was found Oct. 22, 1923, in Steprock Creek, at an altitude of about 6000′, on Mt. Mitchell, North Carolina. The eggs had apparently been attached separately to the lower surface of the rock (Bishop, 1924, p. 90).

LARVAE. The recently hatched larvae are slender and delicate, and average about 1″ in length. The ground color is pale lavender, marked with small flecks of light yellow. A slightly darker median dorsal line extends from the head to the hind legs. A definite line separates the color of the back and upper sides from that of the venter, which is pale

yellow, colored by the yolk. In their color both the larvae and the adults of *danielsi* differ from those of *G. porphyriticus* in being speckled or finely spotted rather than faintly reticulated.

CAROLINA PURPLE SALAMANDER. *Gyrinophilus danielsi dunni* Mittleman and Jopson. Fig. 108. Map 44.

TYPE LOCALITY. Clemson, Oconee County, South Carolina.

RANGE. Northwestern South Carolina, western North Carolina, northeastern Georgia, and eastern Tennessee.

HABITAT. The type specimen was collected in a small stream running through a shallow wooded ravine. In general this form is found at elevations less than 3500′.

SIZE. Adults attain an extreme length of 6 5/16″ (160 mm.) but the average is considerably less, the type series of 16 adults averaging 4 29/32″ (125 mm.) (Mittleman and Jopson, 1941, p. 2). The proportions of an adult male paratype from Sunburst, Haywood County, North Carolina, are as follows: total length 4 7/8″ (124 mm.), tail 1 31/32″ (50 mm.); head length 3/4″ (19 mm.), width 3/8″ (10 mm.).

DESCRIPTION. The head is rather narrow, the sides behind the eyes nearly parallel to the lateral extensions of the gular fold, and in front tapering to the bluntly rounded snout. The eye is small, its long diameter about twice in the snout, the iris narrowly ringed with brassy and crossed horizontally by a reddish-brown band. Above the pupil the iris may be brassy, below silvery-white. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line passing well back of the angle of the jaw. The trunk is rounded above and on the sides and with a slightly impressed median line. There are 18 costal grooves, counting 1 each in the axilla and groin, and 5–8 intercostal spaces between the toes of the appressed limbs. The tail is subquadrate in section at base, becoming trigonal at about the basal fourth and compressed and slightly keeled above distally. The legs are of moderate size. Toes 5–4, those of the hind feet 1–5–2–(4–3), slightly webbed at base; toes of the fore feet

1–4–2–3. The tongue is of moderate size, thin at the margin behind, the surface spongy. Vomerine teeth 12 or more in each series, which arise outside the outer margin of the inner nares, curve forward toward the mid-line, then angle sharply backward to meet the parasphenoids,

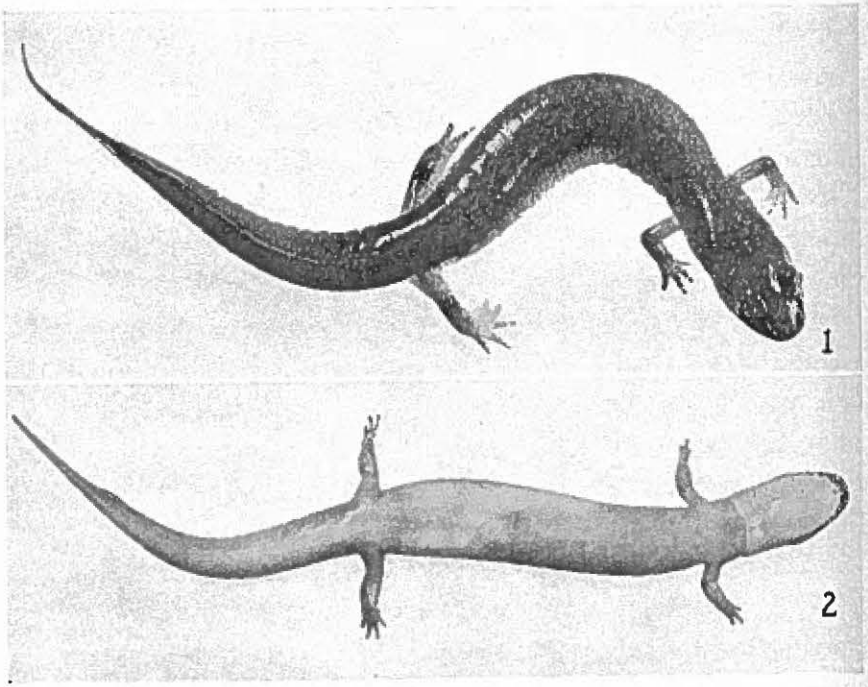


FIG. 108. *Gyrinophilus danielsi dunni* Mittleman and Jopson. (1) Adult female, actual length 5 5/16″ (136 mm.). (2) Same, ventral view. Type, from life. Clemson, Oconee County, South Carolina.

with which they are continuous. Parasphenoid teeth in 2 long, very slender, widely separated patches.

COLOR. In life the ground color above varies from orange-yellow to light reddish. Scattered generally over the dorsal and lateral surfaces are many small, separate, brown flecks. A slight concentration of this dark pigment is sometimes noticeable along either side of the dorsal ridge of the tail, and rarely the brown flecks form an indistinct herringbone pattern on the dorsum of the trunk. A light line extending from the anterior angle of the eye to the margin of the lip is bordered heavily below by dark brown or black and lightly above. The margins of the jaw, both upper and lower, are mottled with black and white. The legs are colored above like the back, the toes sometimes narrowly banded with black. On the lower sides the brown chromatophores are smaller and usually more widely separated, fading out entirely at about the lower level of the legs. Ventral surfaces salmon-pink in life, usually without darker markings. In preservatives the ground color above fades to dull tan with light brown markings, the ventral surfaces dull yellow. Sexual differences are not well marked externally, but the vent of the male is densely lined with short papillae, which makes identification possible.

BREEDING. Nothing is known of the breeding habits of this form.

LARVA. A larva collected by Arnold Grobman and M. B. Mittleman at a locality 2 miles east of Stockville, Buncombe County, North Carolina, is apparently this species. It is 63 mm. in total length and colored essentially like the adults, with the addition of conspicuous sense organs on the head and an indistinct series of small light spots dorsolaterally. The tail is provided with a broad fin above and below and tapers abruptly to a sharp point.

This is the form which I described but did not name (1924, p. 90) and which Stejneger listed as *Gyrinophilus porphyriticus dunni* (1937, p. 30).

NORTHEASTERN PURPLE SALAMANDER. *Gyrinophilus porphyriticus porphyriticus* (Green). Figs. 1c, 49d, 109. Map 44.

TYPE LOCALITY. French Creek, near Meadville, Crawford County, Pennsylvania.

RANGE. From New England states westward to Ontario, Canada, opposite Buffalo, southward through the mountains of the eastern states to Virginia, Tennessee, and possibly Alabama.

HABITAT. The purple salamander frequents cool springs and streams, or occupies little natural or excavated cavities beneath logs or stones at the margins. While the larvae are entirely aquatic, the adults are fre-

quently found some distance from water but usually in damp situations.

SIZE. Adult males vary in length from 5½ to 7⅝″ (140–193 mm.) and the females from 4¾″ to 7⅛″ (120–180 mm.). Individuals may transform at a length of 3 15/16″ (100 mm.), but a well-fed giant living in the outlet from a fish-rearing station had attained a length of 8⅝″ (219 mm.).

DESCRIPTION. The Purple salamander is moderately stout and is strong and active. Viewed from above, the head is long and slender, with the sides behind the eyes nearly parallel, in front tapering slightly to the bluntly truncated snout. The eyes are of moderate size and are limited behind by a vertical crescentic fold. A sinuous horizontal groove from the posterior angle of the eye to the lateral extension of the gular fold, and a short vertical groove from the angle of the jaw to the horizontal groove. The trunk is rounded on the sides, somewhat flattened below, and marked above by a median impressed line. Costal grooves usually 17, rarely 18 if an imperfect groove in axilla is present and counted; 7–7½ intercostal spaces between toes of appressed limbs. Tail moderately long, rounded below, compressed above, and with a knife-like edge toward the tip. Legs stout, toes 5–4, those of the hind feet 1–5–2–3–4 or 4–3 in order of length from the shortest; fore feet 1–4–2–3; all slightly webbed at base. Tongue moderate, nearly circular in outline, boletoid. Vomerine teeth usually continuous with parasphenoid. They are in 2 strongly arched series which arise behind and slightly outside the inner nares, extend inward and gently forward, then bend sharply backward to form inverted L-shaped patches. The teeth form a single line 7 or 8 to the bend, 17–20 in each complete series. Parasphenoid teeth in 2 well separated club-shaped patches.

COLOR. The adult Purple salamander, belying its name, is light yellowish-brown with reddish tinges, or light salmon. Usually the back is darker than the sides and is clouded or mottled, and the sides are marked with darker reticulations enclosing pale spots. The venter is flesh-colored in life, and in old individuals there are often small, scattered, dark dots on the belly and many on the throat and along the

margin of the lower jaw. The tips of the toes and joints often conspicuously darker than the rest of the legs. A conspicuous light line extending from the anterior angle of the eye to the nostril is bordered on the outside by gray. The color of the recently transformed individual is

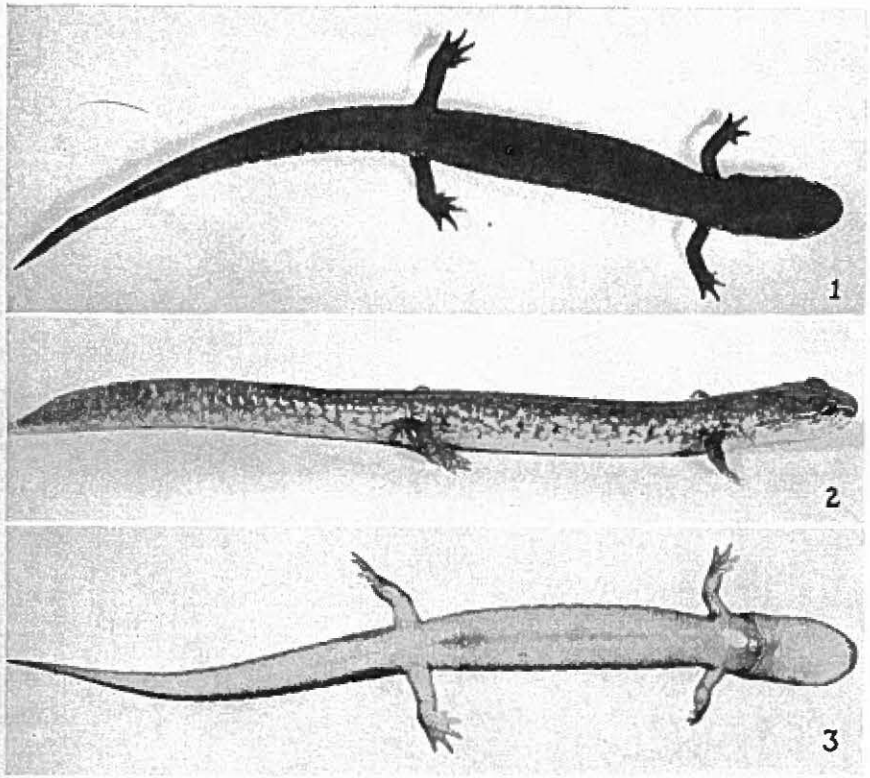


FIG. 109. *Gyrinophilus porphyriticus porphyriticus* (Green). (1) Adult male, actual length 7⅛″ (181 mm.). Voorheesville, New York. (2) Adult male, lateral view; actual length 5 27/32″ (150 mm.). (3) Same, ventral view. Allegany State Park, New York.

much brighter, salmon-red, and the darker reticulations are poorly developed.

BREEDING. Little is known of the mating habits under natural conditions. Preliminary activities were observed Oct. 8, 1924, when male and female grasped one another and wrestled vigorously. A spermatophore ready for deposition was recovered from the vent of a male taken Oct.

28, 1933, and sperm have been found in the spermathecae of females taken from June to November. The egg-laying season may be an extended one, since females with large eggs have been taken in April, May, and June, and in October and November (Bishop, 1941), and eggs supposedly of this species were found August 8 (Green, 1925, p. 32). The dissection of mature females has indicated that eggs may vary in number from 44 to 132. The individual egg is a light yellow sphere about 3½ mm. in diameter. In addition to the vitellus it is surrounded by 3 distinct envelopes which give it a total diameter of approximately 9 mm. The eggs are attached singly, by a flange-like enlargement of the outer envelope, to the lower surface of a support in water.

LARVAE. The recently hatched larvae have a length of about 1″. I have collected them in April and July in spring-fed runs in swamps, and from beneath stones in springs. They are light brown above, yellowish-white below, and with a narrow, dark, pigmented band from the back of the head to the base of the dorsal tail fin. Probably 3 years are spent as larvae, sexual maturity being attained at a length of about 5½″.

KENTUCKY PURPLE SALAMANDER. *Gyrinophilus porphyriticus duryi* (Weller). Fig. 110. Map 44.

TYPE LOCALITY. Cascade Caverns, near Grayson, Carter County, Kentucky.

RANGE. Northeastern Kentucky, south-central Ohio, and north-central West Virginia.

HABITAT. Although the type locality for this subspecies is Cascade Caverns near Grayson, Kentucky, the animal is not restricted to this kind of habitat. In the caverns it is to be searched for beneath flakes of rock, pieces of wood, or other debris, in damp situations. Outside of caves it has been found beneath stones, bark, and logs in the vicinity of streams or springs, and usually at fairly low elevations.

SIZE. The average length of 6 adults from Kentucky is 5 13/16″ (148 mm.) with extremes of 5¼″ (133 mm.) and 6 15/32″ (164 mm.). The proportions of a female which I collected at the type locality, Cascade Caverns near Grayson, Kentucky, are as follows: total length 5⅞″ (148.5 mm.), tail 2 7/16″ (61.5 mm.); head length 13/16″ (20 mm.), width ⅜″ (9.5 mm.).

DESCRIPTION. This is the smallest, slenderest, and palest in color of the five representatives of Gyrinophilus. The head is only moderately widened, and slenderer than in *G. d. danielsi*. It is widest just back of the eyes, the sides gently converging behind to the lateral extensions of the gular fold and more abruptly in front to the bluntly rounded snout. The head is slightly depressed. Eye moderate and less protuberant than in its near relatives; iris tinged with gold and brassy. A depressed horizontal line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this to the angle of the jaw, the angle of the mouth distant anteriorly from this point about the diameter of the eye. Trunk slender, rounded on the sides, flattened below, and with an impressed median dorsal line extending from a Y-shaped mark on the dorsum of the head to the base of the tail. There are 17 well developed costal grooves, or 18 if an imperfectly developed one in the groin is counted; 6½–7½ intercostal spaces between the toes of the appressed limbs. The tail is slender, rounded below, and keeled above to a point opposite the posterior end of the vent. Legs well developed but relatively short and stocky; toes 5–4, short, blunt, those of the hind feet 1–5–2–3–4 in order of length from the shortest; fore feet 1–4–2–3. Tongue roughly circular in outline and with the margins smooth. Vomerine teeth in strongly arched series which arise behind the outer margin of the inner nares, curve inward and forward to a point opposite the middle of the nares, and then sharply backward to join the parasphenoid about opposite the middle of the eye. There are 8 or 9 single teeth in each series to the bend and about an equal number to the point where they join the parasphenoid; parasphenoid teeth in 2 well separated, slender, club-shaped patches.

COLOR. The ground color in life varies from salmon-pink to light brownish-pink. In some the dorsal surface is very slightly darker than

the sides. In some individuals from the type locality, there is a fairly well defined single row of small dark brown or blackish spots on either side, extending from the side of the head onto the basal half of the tail; in others there are numerous small scattered spots on the sides of the head, trunk and tail, and upper surface of the legs, but few or none on

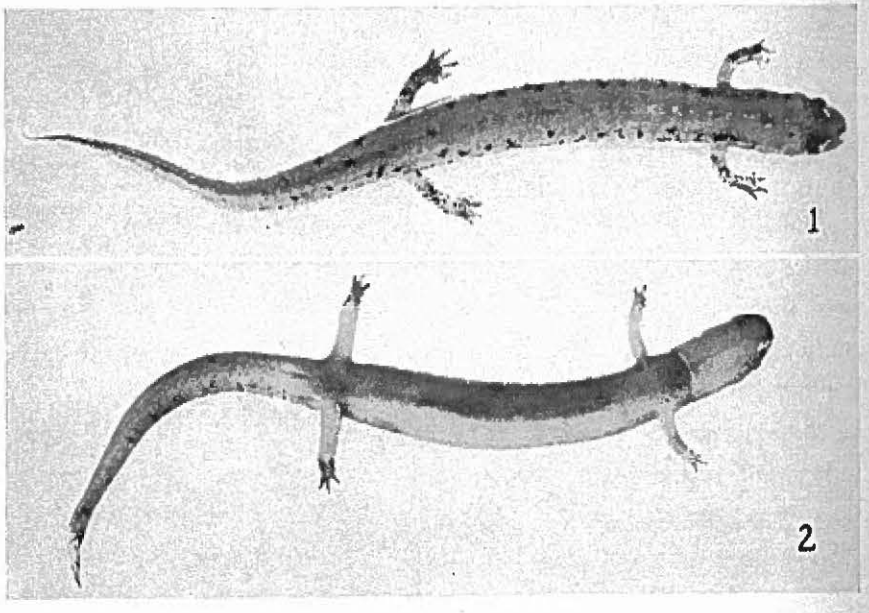


FIG. 110. *Gyrinophilus porphyriticus duryi* (Weller). (1) Adult, actual length about 5″ (128 mm.). (2) Same, ventral view. Cascade Caverns, Carter County, Kentucky.

the dorsal surfaces. In a few individuals the small dark spots are scattered more or less generally over the dorsal as well as the lateral surfaces. The ventral surfaces, with the exception of the lower lip and occasionally the throat and gular region, are free from the dark spots. The throat and belly are flesh color, tinged with bluish where the color of the liver strikes through; ventral surface of the tail with tinges of orange. The light, dark-bordered line extending from the eye to the nostril, which in the other forms of Gyrinophilus is quite conspicuously developed, is here only faintly indicated.

BREEDING. Nothing is known of the breeding habits of this subspecies,

but it is to be expected that the eggs will be attached to the lower surface of some support in water, as are those of its near relatives.

LARVAE. The larvae are very light and are marked dorsally with a dusky reticulate pattern, somewhat as in *G. porphyriticus,* but paler. In large larvae the adult pattern is suggested by the presence of a few poorly defined dark dots.

Supposed intergrades between *danielsi* and *duryi* were reported by King (1939, p. 554) from eastern Tennessee.

OHIO PURPLE SALAMANDER. *Gyrinophilus porphyriticus inagnoscus* Mittleman. Fig. 111. Map 44.

TYPE LOCALITY. Salt Creek, 4 miles southwest of Bloomingville, Good Hope Township, Hocking County, Ohio.

RANGE. The unglaciated parts of Ohio south to but not in the southern tier counties bordering the Ohio River. Apparently avoids the limestone regions.

HABITAT. Apparently less aquatic than typical *porphyriticus.* It has been collected from beneath logs, rocks, and debris at varying distances from water, but is perhaps found in greatest numbers in the vicinity of rocky, woodland streams.

SIZE. I have not seen enough material to be able to give average measurements of any significance, but the general impression is that of a slender salamander of moderate size. The proportions of an adult male from Salt Creek Township, Hocking County, Ohio, are as follows: total length $4\frac{13}{16}$″ (121 mm.), tail $2\frac{1}{32}$″ (51 mm.); head length $\frac{11}{16}$″ (18 mm.), width $\frac{3}{8}$″ (10 mm.). The measurements of an adult female from the same locality are: total length $5\frac{3}{4}$″ (146 mm.), tail $2\frac{15}{32}$″ (63 mm.); head length $\frac{25}{32}$″ (20 mm.), width $\frac{13}{32}$″ (11 mm.). It is evident that this salamander attains a size somewhat larger than is indicated by the measurements given above. The female measured has a trunk length of 82 mm. Other individuals of both sexes, with mutilated tails, have trunk lengths of 85 and 87 mm. respectively.

DESCRIPTION. This is a comparatively slender salamander which does

not attain the size of the typical subspecies. The head is narrow, widest at the angle of the jaws, the sides behind this point converging gently to the lateral extensions of the gular fold, in front more abruptly to the short and bluntly rounded snout. The eye is of moderate size, the horizontal diameter about equal to the distance from the anterior angle to the naris of the same side; iris brassy, suffused with dusky, bright golden-yellow next to the pupil. Lips mottled, light and dark. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to the angle of the jaw. Gular fold prominent. Trunk rounded on the sides and back, slightly flattened below. There are usually 18 costal grooves, counting 1 each in the axilla and groin, occasionally 17 or 19, and 6–7 intercostal folds between the toes of the appressed limbs. Tail broadly oval in section at base, becoming sharp-edged and keeled above immediately behind the vent; ventral tail fin confined to the distal fourth or third. Legs moderately stout, toes 5–4, those of the hind feet 1–5–2–(4–3) in order of length from the shortest; toes of the fore feet 1–4–2–3. Tongue small, broadly oval in outline, the surface spongy. Vomerine series continuous with parasphenoids. The series arise behind or just outside the outer margin of the inner naris and usually extend obliquely forward toward the mid-line, where they are separated by about the width of a naris, then turn abruptly backward, forming nearly parallel lines to the parasphenoids. The number of vomerine teeth is variable; in the few males examined they were fewer, larger, and more widely separated on the transverse limb of the series (7–9); smaller and more numerous (9–12) on the backward extension. Vomerine teeth of females small, 9–11 on either transverse limb, total 17–19. Parasphenoid teeth in long, slender, club-shaped patches, well separated. Internal nares large, nearly circular in outline.

COLOR. A recently killed specimen was Pompeiian Red (Ridgway, 1912) above, evenly and lightly suffused with dusky, slightly darker on the snout; lower sides of head and trunk pale salmon color. Upper surface of the legs and feet like the back but more strongly suffused with

dusky. The light line from eye to nostril bordered above and below by dusky. Throat, belly, and venter of tail light flesh color. The dorsal extensions of the costal grooves turn forward and meet at the mid-line of the back at an acute angle. These grooves are more strongly marked with dusky than the adjacent surfaces and often form a fairly regular

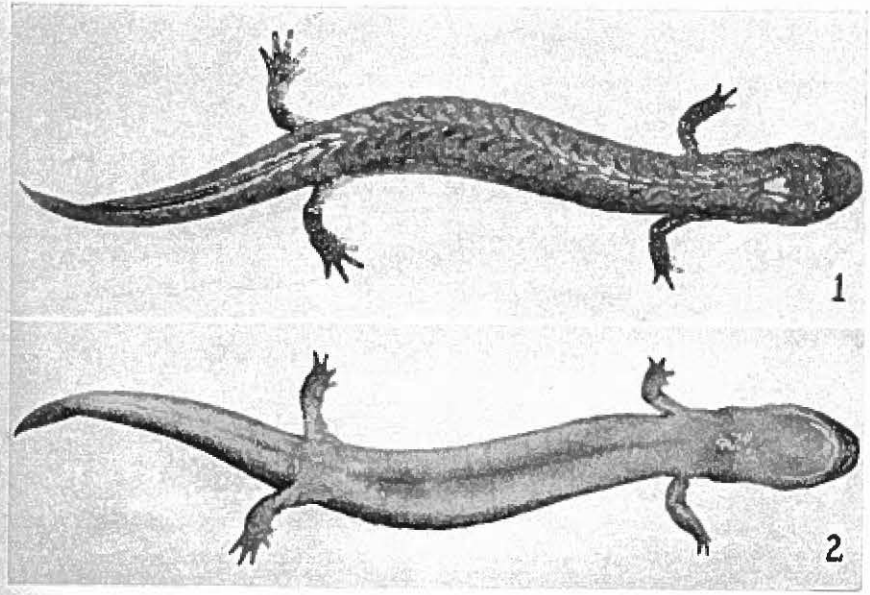


FIG. 111. *Gyrinophilus porphyriticus inagnoscus* Mittleman. (1) Adult male, actual length 4⅛″ (104 mm.). (2) Same, ventral view. Tail tip regenerated. Near Cambridge, Guernsey County, Ohio. [Photographs of a preserved specimen.]

chevron-like pattern. On some specimens the sides of the head and trunk are irregularly marked with small dark flecks. Usually there is very little suggestion of the reticulated pattern of typical *porphyriticus*.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent, which, in the male, is larger and lined anteriorly with short papillae; vent of female short, the sides at the opening thrown into folds.

BREEDING. Nothing is known of the breeding habits of this subspecies, and the larvae have not been described.

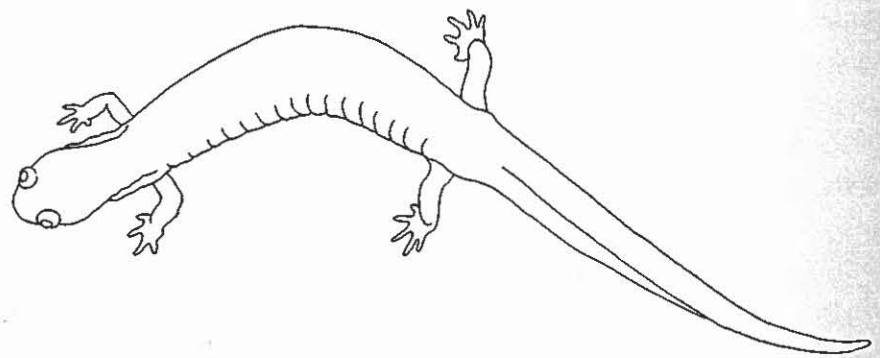


FIG. 112. Outline of *Pseudotriton montanus montanus* to show the form of the body, the short snout, and the character of the limbs. [H.P.C. *del.*]

GENUS PSEUDOTRITON

KEY TO THE SPECIES AND SUBSPECIES OF PSEUDOTRITON

1. Dorsal ground color clear, brilliant red to dark chocolate-brown; dorsal and lateral black spots small to large, round, well separated, never fused, but sometimes lost in dark ground color of old individuals; vomerine series broadly curved and usually obtusely angled at about the middle of the length, closely approximated at mid-line; snout short, usually strongly convex above; horizontal diameter of eye 1¼–1½ in snout; no light, dark-bordered line from eye to nostril (*flavissimus, montanus*) 2

   Dorsal ground color bright coral-red to dark purplish-brown; dorsal and lateral black spots small and well separated in young individuals, becoming enlarged and tending to fuse in old, dark specimens; vomerine series usually right-angled at about the middle of the length, occasionally curved, well separated at mid-line; snout longer, less convex above; horizontal diameter of eye 1½–2 in snout; at least a suggestion of a light, dark-bordered line from eye to nostril (*ruber*) 6

2. Costal grooves 18 3

   Costal grooves 16 or 17 4

3. Adults with ground color purplish-brown above, clouded with dull yellow; sides of trunk with short dull yellow dashes sometimes forming irregular lines; venter yellowish-white with small reddish-brown dots; length to 4 5/32″ (105 mm.). Peninsular Florida and possibly from Valdosta, Georgia ..... *flavissimus floridanus* p. 381

4. Ground color above clear, light coral-pink, brownish salmon or bright red, but never purplish-brown clouded with yellow; dorsal and lateral dark spots small to large, but always present and well separated;

   venter immaculate 5

   Ground color above dull, light to dark chocolate-brown; dorsal and lateral dark spots usually distinct, sometimes obscure in old individuals, but when present extending well onto lower sides; venter with at least a few, often many, small, brown, widely separated dots; iris of eye dark brown; length to 7″ (178 mm.). Carlisle, Pennsylvania, southward through Maryland to South Carolina and northwestern Georgia ..... *montanus montanus* p. 383

5. Ground color above light brownish salmon; dorsal and lateral dark spots small; sides of head, trunk, and tail light salmon; usually 16 costal grooves; length to 3 29/32″ (99 mm.). Georgia westward in the Coastal Plain of Alabama, Mississippi, and Louisiana ..... *flavissimus flavissimus* p. 378

   Ground color above bright coral-pink to brilliant red; dorsal dark spots usually large (occasionally small in juveniles), well separated, never reaching below dorsal insertion of legs; usually 17 costal grooves, occasionally 16; length to 6⅛″ (156 mm.). Unglaciated plateau region of southern Ohio, central and eastern Kentucky, southwestern West Virginia, western Virginia, and eastern Tennessee ..... *montanus diastictus* p. 386

6. Adults coral-red (juvenile) to dark purplish-brown above (old individuals); dorsal and lateral dark spots irregular in size and shape and tending to fuse in old adults; ground color of back distinctly darker than ground color of venter in preserved specimens; venter often strongly spotted 7

   Adults clear red; dark spots of back and sides well separated, larger dorsally; venter flesh in life, immaculate or with a few small, scattered fleckings on throat and belly; ground color of back and sides not greatly darker than that of belly in preserved specimens 8

7. Adults with dorsal dark spots tending to fuse; venter salmon-red in life, with small, round, brown or black spots; ventral surface of legs and tail usually immaculate; no whitish flecks around snout and on the head in adults; iris tinged with brassy; vomerine series broadly curved in some, right-angled in others; the section before the bend long and not widely separated from its fellow of the opposite side; length to 6½″ (165 mm.). Albany County, New York, southward to northern Georgia, westward to Alabama, Tennessee, Kentucky, and Ohio ..... *ruber ruber* p. 389

   Adults with dorsal spots usually distinct, occasionally somewhat fused and lost in general dark ground color; belly usually strongly spotted; venter of legs and tail not immaculate; many whitish flecks around snout and on the head in old individuals; section of vomerine series before the bend short and widely separated from its fellow of the opposite side; iris tinged with brassy, silver, and black; length to 5 25/32″ (148 mm.). Gulf Coastal Plain of northwestern Florida,

Georgia, Alabama, Mississippi, and Louisiana ..... *ruber vioscai* p. 399

8. Margin of lower jaw black, usually in a solid bar, but occasionally broken; tail spotted above and on sides nearly or quite to the tip; throat and area between fore legs usually spotted or dotted; length to 4 29/32″ (125 mm.). Southwestern North Carolina, northwestern South Carolina, eastern Tennessee, and northern Georgia .... *ruber schencki* p. 396

Margin of lower jaw flecked or spotted with brown or black but never heavily barred; distal half of tail usually unspotted; throat and area between fore limbs usually immaculate; length to 4 17/32″ (116 mm.). From Abington and Whitetop Mountain, Virginia, to the valley of the French Broad in North Carolina, Roan Mountain in Tennessee ..... *ruber nitidus* p. 393

GULF COAST RED SALAMANDER. *Pseudotriton flavissimus flavissimus* Hallowell. Fig. 113. Map 45.

TYPE LOCALITY. Liberty County, Georgia.

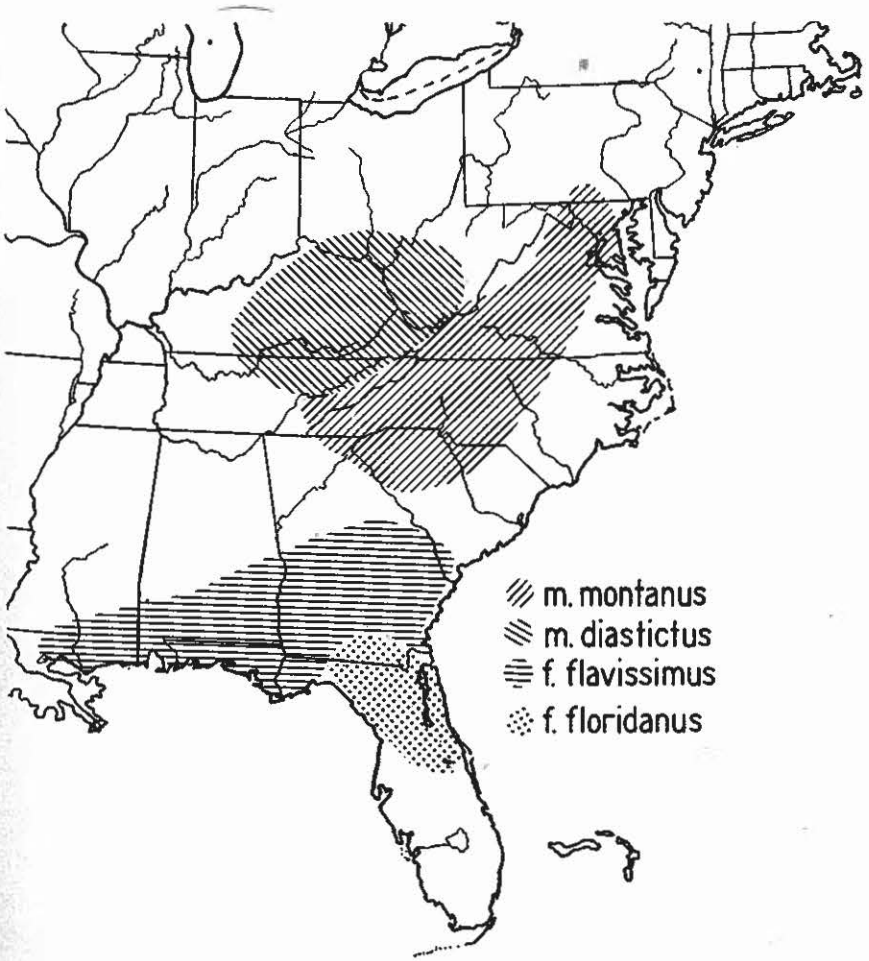
RANGE. From Liberty and Lowndes Counties, Georgia, westward in the Coastal Plain of Alabama, Mississippi, and Louisiana.

HABITAT. Little is known of the habitat preferences. Allen (1932, p. 5) reported specimens found under the bark of a rotten log and ploughed up in a field. Mr. Henry Dietrich sent me 4 specimens which he collected under wood in sphagnum moss beside a small branch near Lucedale, Mississippi.

SIZE. The average length of 10 adults of both sexes from Mississippi and Alabama is 3 7/16″ (87.8 mm.), the extremes 3 1/8″ (80 mm.) and 3 29/32″ (99 mm.). The proportions of an adult female from near Lucedale, Mississippi, are as follows: total length 3 13/32″ (87 mm.), tail 1 11/32″ (34 mm.); head length 17/32″ (13 mm.), width 11/32″ (8 mm.).

DESCRIPTION. This is a small, slender salamander. Viewed from above, the sides of the head back of the eyes are nearly parallel or slightly converging to the lateral extensions of the gular fold, in front converging abruptly to the bluntly pointed snout. The eye is moderate, the long diameter about 1½ in the snout. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line passing behind the angle of the

jaw. Trunk slender, slightly compressed dorsally, rounded on the sides. There are usually 16 costal grooves, sometimes 17 counting 1 in the axilla and 2 that run together in the groin, and 6–7½ intercostal folds



MAP 45.—Distribution of the subspecies of *Pseudotriton montanus* and *P. flavissimus*.

between the toes of the appressed limbs. Tail short, comprising 36–44 per cent of the total length, broadly oval in section at base, becoming compressed and slightly keeled above beginning a short distance behind the vent, and strongly compressed distally; below rounded on basal

half and thin-edged distally. Legs short and only moderately stout. Toes 5–4, rather short and thick, those of the hind feet 1–5–2–(4–3), the 1st very short in some; toes of the fore feet 1–4–2–3. Tongue small, boletoid, elongate oval in outline. Vomero-parasphenoid teeth in continuous series. Vomerine teeth 12–15 in series that arise behind the middle or inner margin of the inner nares, extend toward the mid-line

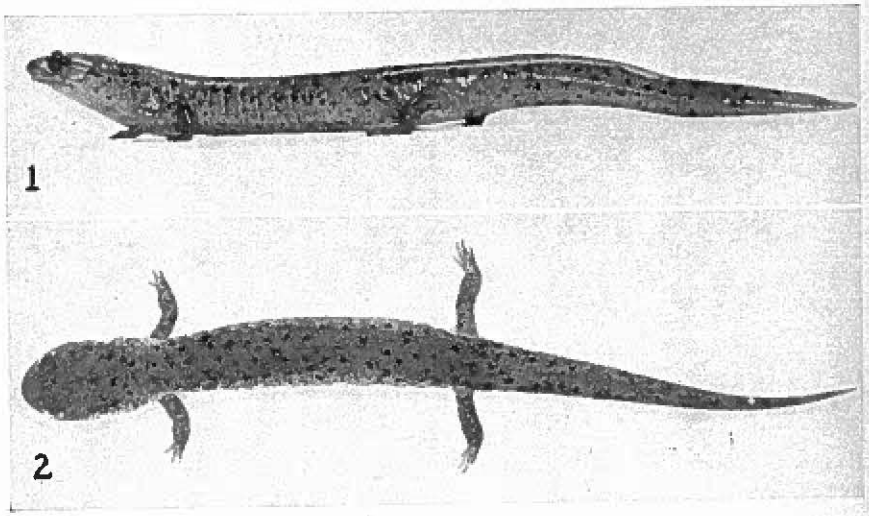


FIG. 113. *Pseudotriton flavissimus flavissimus* Hallowell. (1) Adult female, actual length 3⅜″ (86 mm.). (2) Same, dorsal view. Near Lucedale, Mississippi. [Henry Dietrich, collector.]

in a nearly straight line or shallow curve before turning sharply backward to run nearly parallel to the parasphenoids. Parasphenoid patches long and narrow, divergent behind.

COLOR. The ground color in life is a clear, light, brownish-salmon above, from the tip of the snout to near the tip of the tail. The sides of the head, trunk, and tail, below a line which extends to the margin of the upper jaw on the head and just above the legs on the trunk, are lighter salmon, with tinges of yellow-orange on the tail. The dorsal and lateral surfaces of the head, trunk, and limbs, and the sides of the tail are sparsely marked with small, round, black dots. The ventral

surface of the head and trunk is clear salmon-pink, which in some specimens gradually fades into the pale yellowish-orange color of the ventral surface of the tail. In preservatives, many specimens are pale yellowish-brown above and dull yellow below. Many specimens have the lower lip tinged with dusky.

This subspecies differs markedly from *P. m. floridanus* in color and pattern, having a relatively clear background color, as compared with the clouded condition in *floridanus,* and black spots on a lighter ground instead of light dashes on a dark ground. The venter of *flavissimus* may be entirely free from the dark specks which are characteristic of *floridanus.*

BREEDING. Nothing has been reported on the breeding habits, and eggs are unknown.

LARVAE. I have not seen the larvae.

FLORIDA RED SALAMANDER. *Pseudotriton flavissimus floridanus* Netting and Goin. Fig. 114. Map 45.

TYPE LOCALITY. Gainesville, Alachua County, Florida.

RANGE. Apparently restricted to peninsular Florida. Dunn (1926, p. 293) records a specimen from Valdosta, Georgia, having 18 costal grooves, which may be this form.

HABITAT. Carr (1940, p. 49), under the name *P. m. flavissimus,* records this subspecies from springs, seepage areas, and small, sand-bottomed hammock streams.

SIZE. The few adults I have seen varied in length from 2 27/32″ (72 mm.) to 4 5/32″ (105 mm.) and averaged 3⅝″ (92 mm.). The proportions of an adult male from Alachua County, Florida, are as follows: total length 3¾″ (95 mm.), tail 1⅜″ (35 mm.); head length ½″ (12.5 mm.), width 5/16″ (8 mm.). A female from the same locality measures: total length 3 9/32″ (83 mm.), tail 1 5/16″ (33 mm.); head length 15/32″ (12 mm.), width 9/32″ (7.5 mm.).

DESCRIPTION. This is a dwarfed, peninsular-Florida derivative of *P. flavissimus.* The head is slightly convex above, the sides back of the

eyes nearly parallel, in front converging to the bluntly pointed snout. Eye moderate, the horizontal diameter about 1½ in the snout. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold, and a short vertical groove from this line to the angle of the jaw. Trunk slender, rounded; costal grooves 18, and 6–8 intercostal folds between the toes of the appressed limbs. Tail short, comprising 40–47 per cent of the total length, subquadrate in

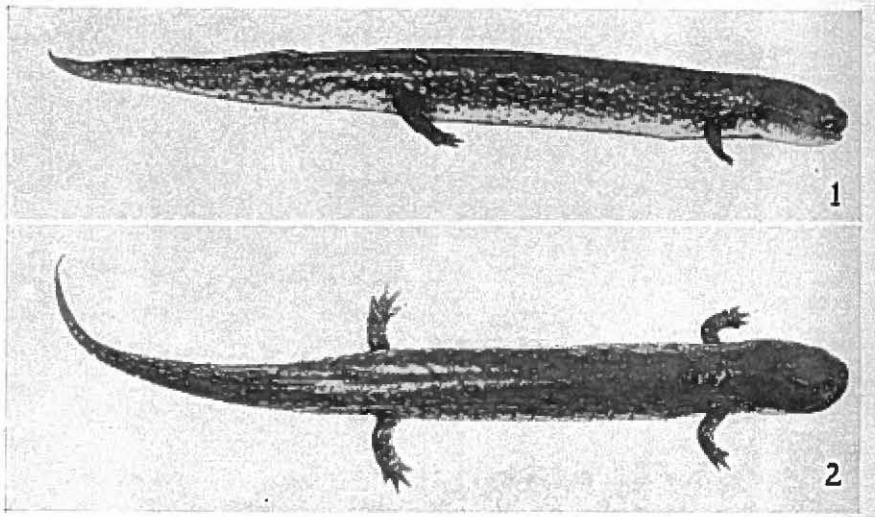


FIG. 114. *Pseudotriton flavissimus floridanus* Netting and Goin. (1) Adult male, actual length 3²³⁄₃₂″ (95 mm.). (2) Same, dorsal view. Alachua County, Florida. [Photographs of a preserved specimen.]

section at base, becoming sharp-edged above a short distance behind the vent, and slightly keeled distally; rounded below to about the distal third and strongly compressed. Legs moderately short and stout. Toes short, those of the hind feet 1–5–2–4–3 in order of length from the shortest; toes of the fore feet 1–4–2–3. Tongue small, nearly circular in outline, boletoid. Vomero-parasphenoid series continuous. The vomerine series arise behind the middle or outer margin of the inner nares, curve inward toward the mid-line, then posteriorly, where they are usually narrowly

separated but occasionally meet; 11–17 teeth in each series. Parasphenoid teeth in long, narrow patches, nearly contiguous at the anterior end but evenly separated by about ½ the width of a patch behind this point.

COLOR. In preserved specimens the dorsal surface of the head, trunk, and tail is purplish-brown clouded with dull yellow. The sides of the trunk to the level of the legs are marked with short, dull yellow dashes which are in contrast with the dark ground color. In some the light marks tend to form irregular longitudinal lines. The sides of the head and tail are mottled, blotched, or clouded with dull yellow. The venter is yellowish-white, with separate, small, reddish-brown dots scattered generally over the surface and sometimes concentrated in series along the sides of the trunk at the line which separates the darker sides from the pale venter. In an occasional old individual these dark brown dots are present in limited numbers on the sides. The margin of the lower jaw is usually marked with brown; legs above colored like the back.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent, which in the male is lined anteriorly with short papillae forming pigmented patches. The vent of the female is margined by narrow vertical folds.

BREEDING. Nothing has been published.

LARVAE. Carr (1940, p. 50) records a small larva only 22 mm. long, found in the sandy bottom of a rill from a seepage area near Gainesville, Florida.

BAIRD'S RED SALAMANDER. *Pseudotriton montanus montanus* Baird. Figs. 112, 115. Map 45.

TYPE LOCALITY. South Mountain, near Carlisle, Pennsylvania.

RANGE. From near Carlisle, Pennsylvania, and Maryland southward to South Carolina and northeastern Georgia, mainly in the Piedmont but extending into the Coastal Plain in the northern parts of the range.

HABITAT. This species is usually more aquatic than *P. ruber* and often lives in or about muddy springs. Frequently it occurs in the wet, low

grounds bordering streams, where it may be found hiding beneath logs, bark, and other objects on the ground. Occasionally a specimen may be found in a somewhat drier situation, but this is unusual.

SIZE. This species occasionally attains a length of 7″ (178 mm.) and is thus larger than its relative *P. ruber,* but this is exceptional and the average is considerably less. Twelve adults of both sexes from eastern Virginia and North Carolina average 4 15/16″ (126 mm.) with extremes of 6″ (153 mm.) and 3 21/32″ (93 mm.). The proportions of a sexually mature male from Raleigh, North Carolina, are as follows: total length 4 27/32″ (124 mm.), tail 2 1/32″ (52 mm.); head length 5/8″ (16 mm.), width 11/32″ (9 mm.). An adult female from the same locality measures: total length 5 5/32″ (132 mm.), tail 1 3/4″ (45 mm.); head length 19/32″ (15 mm.), width 3/8″ (10 mm.).

DESCRIPTION. The head is oval when viewed from above, and strongly convex, widest at the angle of the jaws, the snout short and bluntly rounded. The eye is of moderate size, the long diameter about 1 1/4 in the snout; iris black or dark brown, in this respect differing from *P. ruber,* which has the iris flecked with silvery, brassy, or gold. The trunk is stout and well rounded on the sides and above. There are usually 17 costal grooves, counting 1 in the axilla and 2 that are crowded in the groin, occasionally 16 or 18, and 5–7 intercostal spaces between the toes of the appressed limbs. The tail is nearly circular in section at base, becoming sharp-edged above opposite the posterior end of the vent, and compressed and keeled distally; venter of tail rounded at base; thin-edged at the distal third. Legs short and stout. Toes 5–4, those of the hind feet 1–5–2–(4–3) in order of length from the shortest; toes of the fore feet 1–4–2–3. Tongue small, circular in outline, boletoid. Vomero-parasphenoid teeth in continuous series. The vomerine teeth usually 11–13 in series that arise behind the middle or outer margin of the inner nares and curve inward and backward toward the mid-line, not sharply angled as usually found in *P. ruber.* Parasphenoid teeth in club-shaped patches, slender, and nearly or quite in contact anteriorly and divergent posteriorly.

COLOR. The color and pattern vary with age, young individuals having a clearer ground color and fewer and smaller black spots. In adults of large size the ground color above varies from light reddish-brown or purplish-brown to chocolate, often lighter on the tail and with the sides of the head, trunk, and tail brighter, salmon color. The belly varies

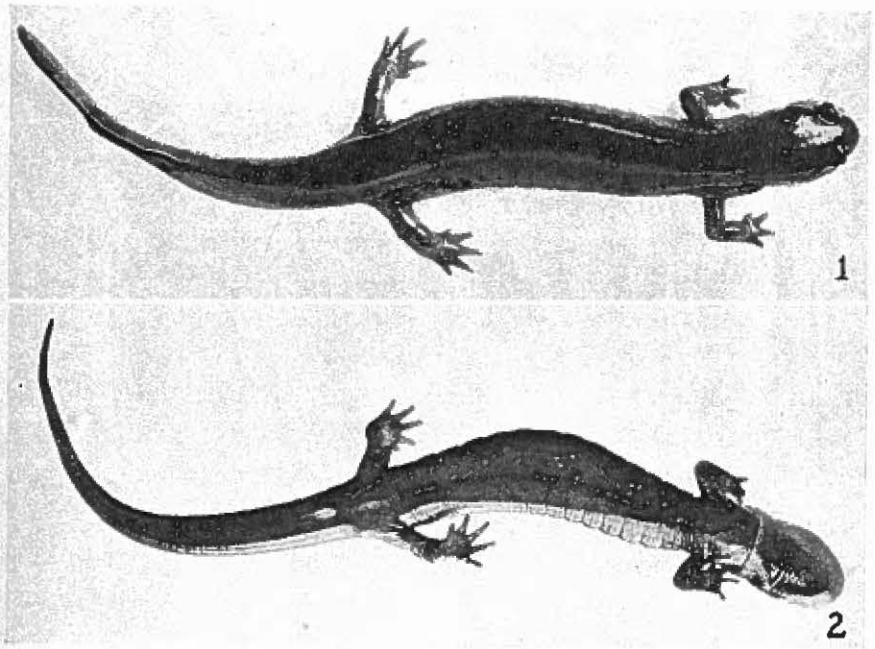


FIG. 115. *Pseudotriton montanus montanus* Baird. (1) Adult female, old dark individual; actual length 4 15/16″ (122 mm.). Raleigh, North Carolina. (2) Another individual, ventral view. Mount Vernon, Virginia.

from salmon-red to a dusky orange-red. Scattered over the dorsal surfaces are rounded black spots variable in size but usually smaller and more widely separated than in *P. ruber.* The spots are continued on the sides of the head, on the trunk to the lower level of the legs, and on the tail often to the ventral surface. In young individuals the venter may be almost immaculate, in older ones the throat, belly, and ventral surface of the tail are often spotted or flecked with brown or black. In old individuals the ground color may become so dark as to nearly obscure the

rounded black spots, and in animals of this type the margins of the jaws are frequently entirely black.

BREEDING. For knowledge of the breeding habits we are mainly indebted to C. S. Brimley. The eggs have been found on a number of occasions, in November, December, and January, in the leafy trickle from a little spring near Raleigh, North Carolina. The unpigmented white eggs were attached to dead leaves or other objects lying in the bed of the trickle and on one occasion were attended by a large female (Brimley, 1939, p. 19). A few eggs sent by Dr. Brimley to E. R. Dunn measured 6 mm. in diameter and were provided with an attachment stalk 4 mm. long (Dunn, 1926, p. 290). These measurements probably include the envelopes. The breeding season may be even more extended than indicated above. In a collection from Raleigh, made Feb. 24, 1923, is a female distended by eggs which have a diameter of approximately 3½ mm.

LARVAE. Larvae attain a length of at least 2 13/16″ (72 mm.) but may transform when considerably smaller. A juvenile from Raleigh, North Carolina, had completed transformation at a length of only 2⅝″ (67 mm.), and others were still sexually immature at a length of 3 21/32″ (93 mm.). The larvae I have examined are light brownish above, with darker pigment, in small irregular flecks, scattered over the dorsal and lateral surfaces but entirely lacking on the ventral.

CENTRAL RED SALAMANDER. *Pseudotriton montanus diastictus* Bishop. Fig. 116. Map 45.

TYPE LOCALITY. Cascade Caverns, Carter County, Kentucky.

RANGE. So far as now known, limited to the unglaciated plateau region of southern Ohio, central and eastern Kentucky, southwestern West Virginia, western Virginia, and eastern Tennessee.

HABITAT. Perhaps somewhat less aquatic than *P. m. montanus*. Of the two living examples I have seen, one was taken in a cave near Mill Creek, near Greenbrier, Kentucky, and the other from beneath a large block of

wood in a slightly damp situation near the entrance to Cascade Caverns, Carter County, Kentucky.

SIZE. The average length of 13 adults of both sexes from West Virginia and Kentucky is 5 5/16″ (135 mm.), the extremes 3 13/16″ (97 mm.) and 6⅛″ (156 mm.). The proportions of an adult male are as follows: total length 5 9/16″ (142 mm.), tail 2 7/16″ (62 mm.); head length 1 1/16″ (18

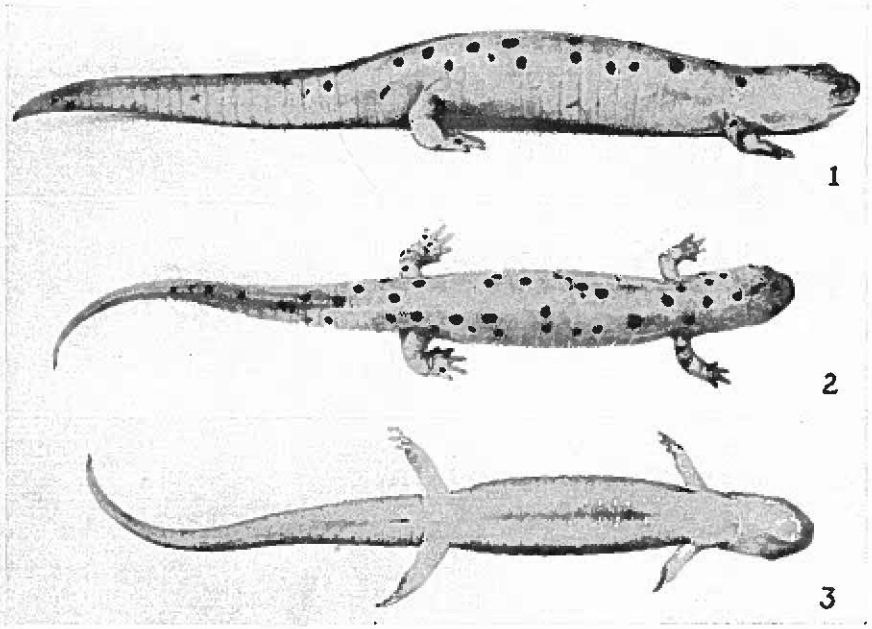


FIG. 116. *Pseudotriton montanus diasticticus* Bishop. (1) Adult male, actual length 5 9/16″ (142 mm.). (2) Same, dorsal view. (3) Same, ventral view. Type. Cascade Caverns, Carter County, Kentucky. [Photographs of a preserved specimen.]

mm.), width 11/32″ (11 mm.). The measurements of an adult female are: total length 6″ (153 mm.), tail 2 17/32″ (65 mm.); head length 25/32″ (20 mm.), width 15/32″ (12 mm.).

DESCRIPTION. The head is small and comparatively slender, the sides back of the eyes nearly parallel, in front tapering to the truncated snout. Back of head between eyes slightly depressed or broadly rounded over, not highly convex as in typical *montanus*. The eye is small, the hori-

zontal diameter about 1½ in the snout; an impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to the angle of the jaw. Trunk not so stout as in typical *montanus;* usually 17 costal grooves, counting 1 in the axilla and 2 that run together in the groin, occasionally 16, and 5½–6½ intercostal folds between the toes of the appressed limbs in adults. Tail subquadrate in section at base, becoming broadly oval a short distance behind the vent, and compressed and sharp-edged above distally; no ventral tail keel. Legs stout, toes 5–4, those of the hind feet 1–5–2–(3–4) in order of length from the shortest; toes of fore feet 1–4–2–3. Vomero-parasphenoid teeth in series that arise behind or just outside the outer margin of the inner naris and curve inward toward the mid-line, then backward for a short distance before joining parasphenoid. Parasphenoid patches long and club-shaped, separated by more than the diameter of a naris.

COLOR. The clearness of the ground color is in strong contrast to the clouded condition which is usually characteristic of *P. m. montanus.* In life, younger individuals may be light coral-pink, the older adults clear brilliant red to clear brown above, the lower sides and belly lighter, flesh to salmon. Scattered over the dorsal surface of the head, trunk, tail and legs, and sides of trunk and tail to the upper level of the legs, are rounded black spots, fewer, larger, and more uniform in size than in typical *montanus.* The ventral surfaces are entirely without darker spots or markings except for an occasional dark line along the margin of the lower jaw. In many specimens the black spots are somewhat concentrated dorsolaterally, the mid-line of the back being relatively free. The dark spots on the sides of typical *montanus* reach a lower level and, in old individuals, frequently cover the entire venter.

BREEDING. Nothing has been published on the breeding habits of this race as distinguished from *P. m. montanus.*

LARVAE. A larva at the point of transformation, from Boyd County, Kentucky, has a total length of 3 21/32″ (93 mm.), tail 1 15/32″ (38 mm.). It is sparsely spotted above, immaculate below.

NORTHERN RED SALAMANDER. *Pseudotriton ruber ruber* (Latreille). Figs. 101a, 117. Map 46.

TYPE LOCALITY. The United States, probably near Philadelphia.

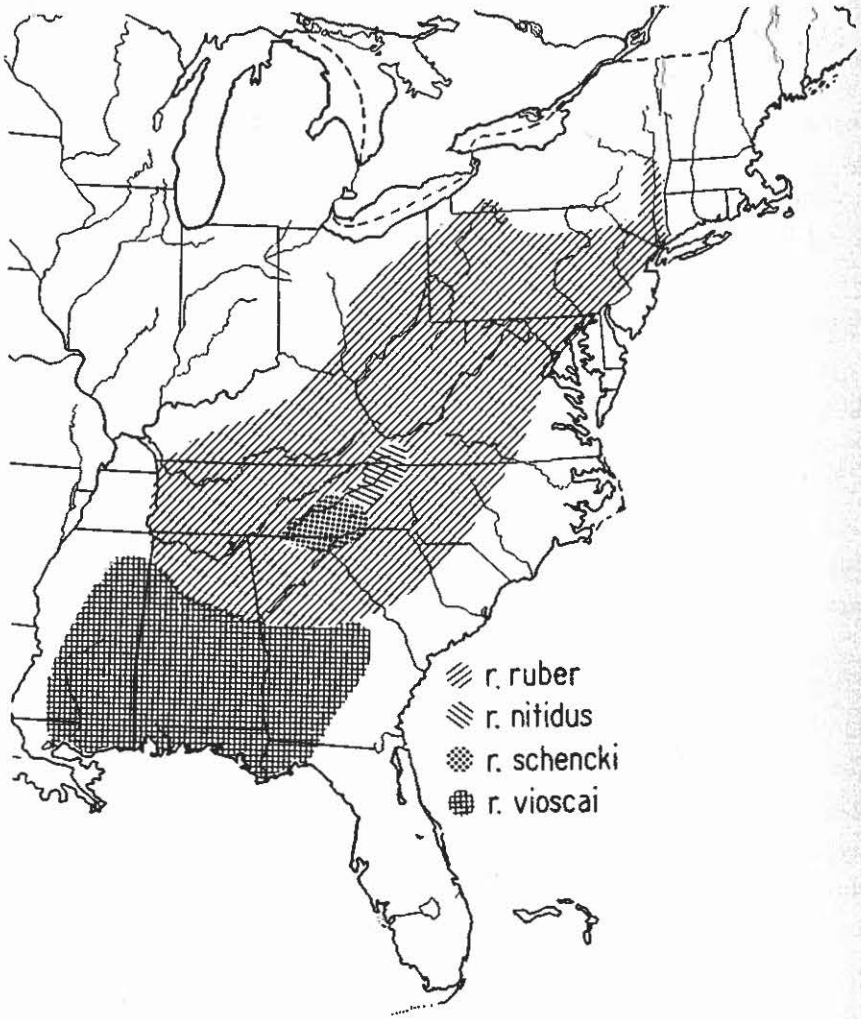
RANGE. From Albany County, New York, southward to northern Georgia, westward to Alabama, Tennessee, Kentucky, and Ohio. In the Coastal Plain only from northern Virginia northward.

HABITAT. Found in and about clear, cold springs and small streams of wooded ravines, swamps, open fields, and meadows. The adults are often terrestrial during the summer months and may be found hiding beneath logs, bark, and stones, some distance from the water.

SIZE. This salamander attains an extreme length of about 6½″ (165 mm.) but this is much beyond the average. Twenty adults of both sexes from various northeastern localities average 5″ (128 mm.), the extremes 5 29/32″ (151 mm.) and 4 3/32″ (103 mm.). The females in this series are a little longer than the males. The proportions of an adult male from Columbia, South Carolina, are as follows: total length 4 17/32″ (116 mm.), tail 1 23/32″ (44 mm.); head length 21/32″ (17 mm.), width 13/32″ (11 mm.). A female from the same locality measures: total length 4 19/32″ (118 mm.), tail 1 11/16″ (43 mm.); head length 11/16″ (18 mm.), width 6/16″ (10 mm.).

DESCRIPTION. The head is widest immediately behind the eyes, the sides behind this point nearly parallel or slightly converging to the lateral extension of the gular fold, in front tapering rather abruptly to the bluntly rounded snout. The eye is rather small, the long diameter about twice in the snout, the iris tinged with brassy. An ill-defined impressed line from the posterior angle of the eye to the lateral extension of the gular fold, and a short vertical line crossing this at the angle of the jaw. The trunk is stout and in old individuals well rounded, with a slightly impressed median dorsal line. There are usually 16 costal grooves, occasionally 17, and 5–7 intercostal folds between the toes of the appressed limbs. The legs are rather short and stout. Toes 5–4, short, those of the hind feet 1–5–2–(3–4) in order of length from the shortest;

toes of fore feet 1–4–2–3. Tail subquadrate in section at base, becoming broadly oval in section a short distance behind the vent, and sharp-edged



MAP 46.—Distribution of the subspecies of *Pseudotriton ruber*. (*P. r. ruber* also recorded from Burlington, Vermont.)

and keeled above at about the basal third. Tip of tail strongly compressed, but no true ventral keel. Tongue boletoid, roughly circular in outline. Vomero-parasphenoid teeth usually forming continuous series,

occasionally a break on one side or the other. The vomerine series arise outside the outer margin of the inner naris, extend inward toward the mid-line, then turn sharply backward, where they continue, narrowly separated, until they join the parasphenoids. The parasphenoids some-

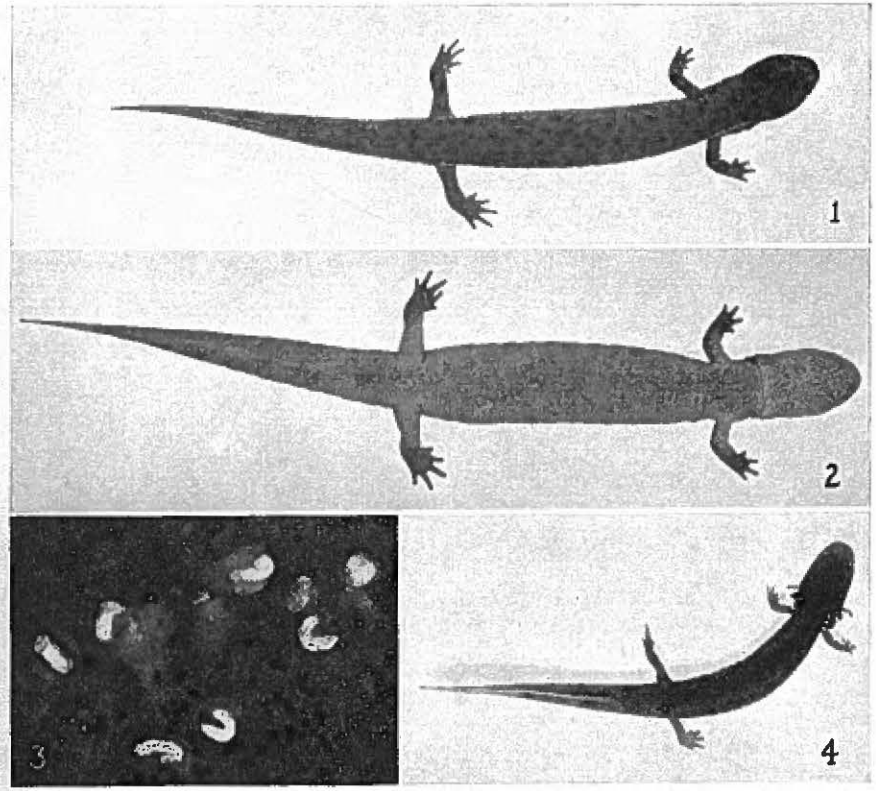


FIG. 117. *Pseudotriton ruber ruber* (Latreille). (1) Adult, dorsal view; actual length about 5″ (122 mm.). (2) Adult female, ventral view; actual length 5 13/16″ (147 mm.). (3) Portion of egg cluster. (4) Larva. Voorheesville, New York.

times in club-shaped patches; often they extend anteriorly as a narrow line for some distance before joining the vomerine.

COLOR. At transformation, and sometimes a little before, the ground color above is a beautiful coral-red, the lower sides and venter lighter, flesh color. Scattered over the dorsal surface of the head, trunk, and

basal half of the tail are many small rounded black spots in strong contrast with the bright ground color. At this stage, the dark spots are usually absent on the lower sides, the belly, and the distal half of the tail. With increase in age and size, there is a gradual extension and darkening of the ground color and fusion of the dark spots, old individuals becoming purplish-brown above and well speckled with small brown or black spots on a salmon-red ventral color. Often the margin of the chin is flecked with black. Sexual differences are not well marked externally. The vent of the male is lined anteriorly with short papillae which are normally absent in the female.

BREEDING. In the northern parts of its range at least, the egg-laying season is apparently initiated by falling temperatures. The first lot of eggs found were attached to the lower surface of a flat stone which was well imbedded below the surface of the water in the bank of a spring near Voorheesville, New York, October 3, 1924. Additional lots were taken in November 1930 by Dr. V. C. Twitty and Dr. Crawford Hutchinson near Woodstock, Ulster County, New York. The eggs are without pigment and are attached separately in little clusters, the entire complement numbering 72 or more. Often several females select the same stone for attachment, but the groups belonging to different individuals may usually be recognized by differences in color and stage of development. Individual eggs are approximately 4 mm. in diameter and are surrounded by envelopes as follows: 1st, a thin tenuous vitelline membrane closely appressed to the yolk; 2nd, a layer enclosing a thin, clear jelly; and, 3rd, an outer tougher layer which is drawn out to form the attachment stalk. The egg with its envelopes measures about 6 mm. in diameter.

LARVAE. Larvae at hatching have a length of 13–15 mm. They are lightly pigmented above on the head to the lower level of the eyes, on the trunk to the level of the legs, on the tail to the ventral keel. The gills, buds of the legs, ventral surface of the head and trunk, dull yellow without pigment. Larvae may attain a length of $4\frac{5}{16}''$ (110 mm.), but usually transform when considerably smaller, 3″ (77 mm.) to $3\frac{3}{4}''$ (96

mm.). Large larvae have a ground color light reddish-brown, with tinges of orange at the base of the dorsal tail fin and sometimes on the snout. The dark pigment spots are usually larger on the trunk than on the head, legs, and distal part of the tail. On several occasions I have found half-grown larvae which had acquired the bright red characteristic of recently transformed individuals.

DUNN'S RED SALAMANDER. *Pseudotriton ruber nitidus* Dunn. Fig. 118. Map 46.

TYPE LOCALITY. Whitetop Mountain, Virginia.

RANGE. The northern part of the Southern Blue Ridge at elevations to 5000′. From Abington and Whitetop Mountain, Virginia, to the valley of the French Broad in North Carolina and Roan Mountain in Tennessee.

HABITAT. This subspecies has been found under logs in wooded areas and open pastures, and in and about springs and streams.

SIZE. The average length of 12 adults of both sexes from western North Carolina is $3\frac{15}{32}''$ (88 mm.), the extremes $2\frac{29}{32}''$ (74 mm.) and $4\frac{17}{32}''$ (116 mm.). The six females average $3\frac{9}{16}''$ (91 mm.), the males $3\frac{11}{32}''$ (85 mm.). The proportions of a male from Swannanoa, North Carolina, are as follows: total length $4\frac{17}{32}''$ (116 mm.), tail $1\frac{5}{8}''$ (42 mm.); head length $\frac{5}{8}''$ (16 mm.), width $\frac{3}{8}''$ (10 mm.). A female from Cave River, North Carolina, has the following measurements: total length $4\frac{15}{32}''$ (114 mm.), tail $1\frac{11}{16}''$ (43 mm.); head length $\frac{17}{32}''$ (14 mm.), width $\frac{11}{32}''$ (9 mm.).

DESCRIPTION. This subspecies is smaller than typical *ruber* and differs otherwise in shape, proportions, color, and pattern. The head is broadly oval in outline, the sides behind the eyes curving to the lateral extensions of the gular fold and in front to the broadly rounded snout. The eye is small, the horizontal diameter about twice in the snout. Eye limited behind by a fold which arises from the lower posterior margin of the lower lid and extends upward behind upper lid. A slightly impressed line from the posterior angle of the eye to the lateral extension of the

gular fold; a short vertical groove from this line to the angle of the jaw. Trunk relatively slender, rounded, and with only a slight mid-dorsal impressed line. There are 16 costal grooves, counting 1 each in the axilla and groin and 3–6, usually 5, intercostal folds between the

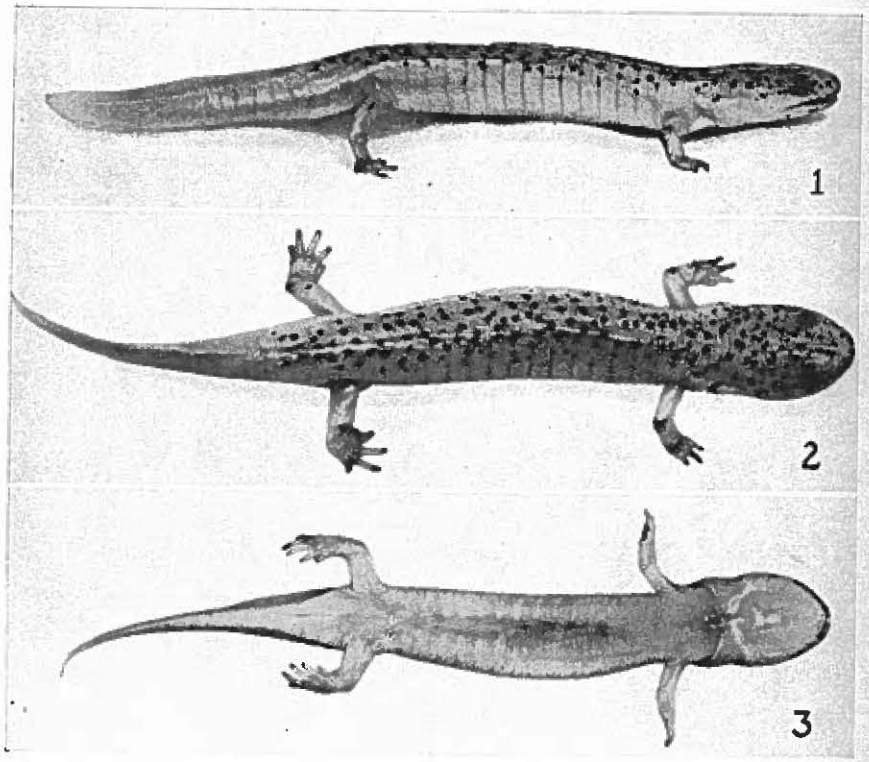


FIG. 118. *Pseudotriton ruber nitidus* Dunn. (1) Adult male, actual length 3¼″ (83 mm.). (2) Same, dorsal view. (3) Same, ventral view. Weaversville, Buncombe County, North Carolina. [Photographs of a preserved specimen.]

toes of the appressed limbs. Legs stout, rather short. Toes 5–4, short and blunt-pointed, those of the hind feet 1–5–2–(3–4) in order of length from the shortest; toes of the fore feet 1–4–2–3. Tongue small, boletoid, nearly circular in outline. The vomero-parasphenoid series continuous. Vomerine series arise behind outer margin of inner naris, extend inward toward the mid-line, then turn sharply backward, where they are

separated by about the diameter of an inner naris. Fewer teeth on vomerine than in *P. r. ruber*. Parasphenoid teeth usually in 2 long, slender, club-shaped patches somewhat divergent posteriorly.

COLOR. The general ground color above is red, below lighter, flesh color. The ground color, unlike that of *P. r. ruber*, does not become greatly darkened with age. Scattered over the dorsal surface of the head, trunk, and basal half of the tail are many separate, small, black spots, usually a little larger on the trunk than on the head or tail. On the sides of the head the dark spots extend to the margins of the jaws, on the trunk and tail to the upper level of the limbs. On some individuals there is a single row of small black dots along the margin of the lower jaw. The ventral surfaces are without black spots, except as noted on the lower lip. The dark spots remain separate through life and do not tend to fuse as in old individuals of *P. r. ruber*. There are no well marked sexual differences, but the males may usually be recognized by the form of the vent, which is larger than that of the female and provided within, anteriorly, with vertical imbricated folds. Adult *nitidus* resembles some juvenile *P. r. ruber*, but differs conspicuously from adult *ruber* in its smaller size, clear spotting, lack of black spots on the distal half of tail, and immaculate venter.

BREEDING. Nothing is known of the breeding habits of this salamander. A female (Univ. Mich. No. 76323) from Banners Elk, North Carolina, taken Sept. 4, 1934, has large eggs apparently ready to be deposited.

LARVAE. Dunn (1926, p. 283) records a larva 68 mm. long as the largest he had encountered, and the smallest transformed individual as 69.5 mm. in total length. Dunn (*ibid.*) writes: "A larva A.N.S. 4389, Roan Mt., Tenn., 4,000 feet, very near transformation is chiefly noticeable for having a narrow dark mid-dorsal line; the absence of spots on the tail is marked."

BRIMLEY'S RED SALAMANDER. *Pseudotriton ruber schencki* (Brimley). Fig. 119. Map 46.

TYPE LOCALITY. Sunburst, North Carolina.

RANGE. The southern part of the Southern Blue Ridge, ranging to above 5000′ altitude. Southwestern North Carolina, northwestern South Carolina, eastern Tennessee, and northern Georgia. Also recorded from Ohio but probably erroneously.

HABITAT. I have collected this salamander under the moss covering the gravelly bed of a small trickle. Brimley (1939, p. 22) reported it mostly from beneath logs in pastures near running water, but occasionally from streams, and Dunn (1926, p. 286) found it in swampy springs and one specimen beneath a log some distance from water.

SIZE. This subspecies attains an extreme length of 4 29/32″ (125 mm.). The average length of 25 adults of both sexes, mainly from western North Carolina, is 3 7/8″ (99 mm.), the extremes 4 25/32″ (122 mm.) and 2 21/32″(68 mm.). Eleven adult females average 4 1/8″ (105 mm.) and 13 adult males average 3 21/32″ (93 mm.). The proportions of an adult male from Cullosaja, North Carolina, are as follows: total length 4″ (102 mm.), tail 1 9/16″ (40 mm.); head length 5/8″ (16 mm.), width 3/8″ (10 mm.). A female from the same locality measures: total length 4 5/16″ (110 mm.), tail 1 11/16″ (43 mm.); head length 21/32″ (17 mm.), width 3/8″ (10 mm.).

DESCRIPTION. The head is widest at the angle of the jaws, the sides behind the eyes converging slightly to the lateral extensions of the gular fold and in front curving more abruptly to the bluntly pointed snout. The eye is small, the long diameter fully twice in the snout. Eye limited behind by a fold which arises from the lower, posterior margin of the lower lid and extends upward behind posterior margin of upper lid. An impressed sinuous line from the posterior angle of the eye to the gular fold; a short vertical groove from this line passes behind the angle of the jaw. Trunk moderately stout, rounded above and on the sides,

flattened beneath, the middorsal line slightly impressed. There are 16 costal grooves, counting 1 each in the axilla and groin, and 4–5½ intercostal folds between the toes of the appressed limbs. Legs short

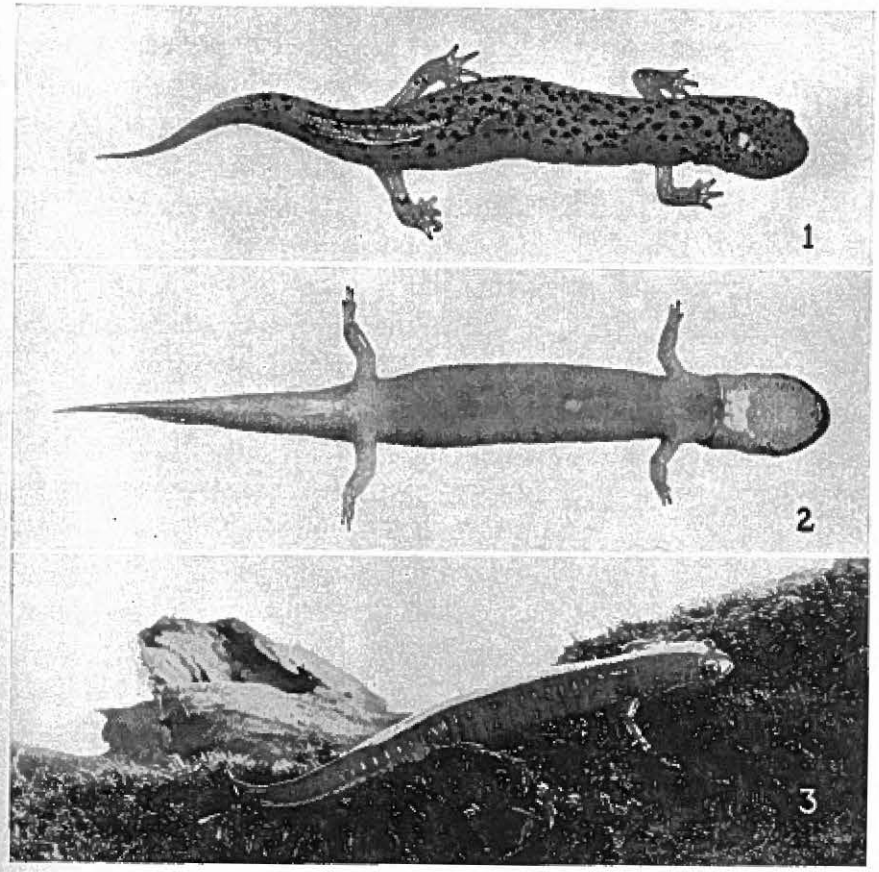


FIG. 119. *Pseudotriton ruber schencki* (Brimley). (1) Adult male, actual length 3 19/32″ (92 mm.). (2) Same, ventral view. Jocassee, South Carolina. (3) Male, actual length 3 9/32″ (84 mm.). Elkmont, Tennessee.

and stout. Toes short, blunt-pointed, 5–4, those of the hind feet 1–5–2–(3–4) in order of length from the shortest; toes of the fore feet 1–4–2–3. Tongue small, broadly oval in outline. Vomero-parasphenoid teeth in continuous series. Vomerine teeth 10–15 in each series, the usual num-

ber about 12. The vomerine series arise behind or just outside the outer margin of the inner naris and usually extend inward and slightly forward before turning abruptly backward to join the parasphenoids. Parasphenoid teeth usually in long, club-shaped patches, narrow and line-like anteriorly in many specimens and somewhat divergent posteriorly. In sexually mature males the vent is sometimes lined anteriorly with short papillae, that of the female thrown into folds.

COLOR. This subspecies attains a somewhat larger size than *P. r. nitidus* and differs otherwise mainly in having the chin black and the tail spotted nearly to the tip. The general ground color is red, and this form, like *nitidus,* does not darken greatly with age. Scattered over the surface of the head, trunk, and tail are many separate, rounded, black spots which are larger on the trunk and back of the head than on the lower sides, snout, and legs. The black spots extend on the sides of the head to involve both jaws, on the trunk to the level of the legs, and on the tail to the ventral third. The ventral surfaces are lighter than the dorsal, flesh color in life, and may be quite free from black spots, except for a black bar which follows the margin of the lower jaw, and scattered fleckings on the throat. In some specimens the entire venter, with the exception of the tail, is minutely dotted with black, often more highly concentrated along the mid-line of the belly.

BREEDING. Very little is known. Adult females in the University of Michigan collection from Pisgah National Forest No. 52516–7, taken July 26, 1926, and No. 81051 from Dillsboro, North Carolina, taken August 6, 1936, have ovarian eggs which appear ready to be laid, and males taken at the same time and place have the testes enlarged.

LARVAE. The larvae may attain a length of nearly 3″ before losing the gills, or transform at a length of 2 9/32″ (58 mm.) (Univ. Mich. No. 76321). A larva 51 mm. long from near Chatsworth, Georgia, taken with a transformed individual and presumably of this subspecies, is finely specked with black over the same surfaces as the adults. The gills of this specimen are small, pigmented on the rachises, and with long, slender, unpigmented filaments.

VIOSCA'S RED SALAMANDER. *Pseudotriton ruber vioscai* Bishop. Fig. 120. Map 46.

TYPE LOCALITY. Ten miles west of Bogalusa, Louisiana.

RANGE. Mainly limited to the Gulf Coastal Plain of northwestern Florida, Georgia, Alabama, Mississippi, and Louisiana.

HABITAT. Specimens taken at the type locality, Bogalusa, Louisiana, were found in and about springs and spring-fed streams or under logs on nearby hillsides. At Marianna, Florida, we took several large adults under logs and bark near springs, and Coleman J. Goin (Copeia, No. 4, 1939, p. 231) reports it in northwestern Florida from the cool deep ravines near the Apalachicola River.

SIZE. The average length of 19 sexually mature individuals of both sexes is 5″ (128 mm.), the extremes 5 25/32″ (148 mm.) and 3 7/8″ (99 mm.). There appears to be no difference in the average length of males and females. The proportions of an adult male from Bogalusa, Louisiana, are as follows: total length 4 1/2″ (115 mm.), tail 1 9/16″ (40 mm.); head length 5/8″ (16 mm.), width 3/8″ (10 mm.). An adult female from Marianna, Florida, measures: total length 5 11/32″ (137 mm.), tail 2 1/8″ (54 mm.); head length 23/32″ (19 mm.), width 1/2″ (13 mm.).

DESCRIPTION. This subspecies attains an average size equal that of the typical race, *P. r. ruber.* The head is widest at the angle of the jaws, and has the sides back of this point nearly parallel or slightly converging to the lateral extension of the gular fold; in front of the eyes the sides converge abruptly to the bluntly pointed snout. The eye is of moderate size, the long diameter about 1 1/2 in the snout. The iris is mottled with brassy, silver, and black. There is a sinuous impressed line from the posterior angle of the eye to the gular fold, and a short vertical groove from this line to the angle of the jaw. The trunk is stout, well rounded, and with an impressed middorsal line. There are usually 16 costal grooves, counting 1 in the groin and 1 often imperfectly developed in the axilla, and 5–6 1/2 intercostal spaces between the toes of the appressed limbs. The legs are short and stout; toes 5–4, rather more slender in

this subspecies than others, those of the hind feet usually 1–5–2–4–3 in order of length from the shortest; toes of the fore feet 1–4–2–3. The tail is broadly oval or nearly circular in section at base, becoming com-

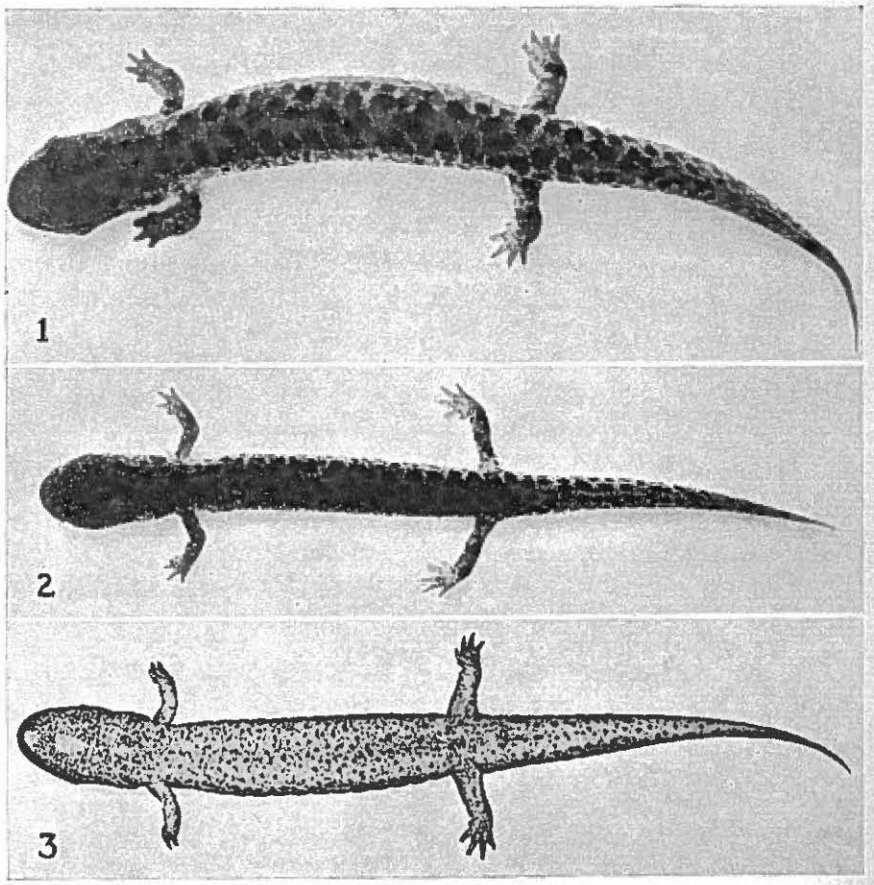


FIG. 120. *Pseudotriton ruber vioscai* Bishop. (1) Adult male, actual length 5¾″ (147 mm.). (2) Adult female, actual length 4½″ (115 mm.). Bogalusa, Louisiana. (3) Adult female, ventral view; actual length 5⁷⁄₁₆″ (139 mm.). Marianna, Florida.

pressed and keeled above a short distance behind the vent and strongly compressed distally. The tail is rounded below at base, becoming thin-edged at about the distal third. Tongue small, boletoid. Vomero-parasphenoid teeth in continuous series. The vomerine teeth 12–15 in each

series, the usual number about 13. The vomerine series arise behind or just outside the outer margin of the inner naris, slant inward or obliquely backward toward the mid-line, then sharply backward, where they are separated by about the diameter of a naris. The parasphenoid patches are narrow anteriorly, sometimes reduced to a single line of teeth, posteriorly wider and slightly divergent. Sexual differences are not well marked externally, but the mature males may usually be distinguished by the form of the vent, which is lined internally at the anterior end with short papillae.

COLOR. In life, the ground color is dark salmon on the dorsal surface of the trunk and tail; the lower sides and venter much lighter. Scattered over the dorsal surface of the head, trunk, and tail are many fairly large, separate, blue-black blotches. Around the snout, on the sides of the head, and between the eyes there are many very small white flecks; the lips of both jaws are dark. On the sides of the trunk and tail the dark spots are smaller. Legs and feet with large spots above, smaller ones below. The ventral surfaces are spotted, those of the throat smaller and closer together than elsewhere. The ground color darkens with age and the black spots become less distinct but rarely fuse as in *P. r. ruber*. Preserved specimens become dark purplish-brown, the dark spots fading to deep brown, the ventral surfaces dull yellow. Occasionally, the dark dorsal spots suggest a herringbone arrangement. This subspecies differs from *P. r. nitidus* and *P. r. schencki* in its larger size, strongly spotted venter, tail spotted to tip, and darker ground color.

BREEDING. Nothing is known of the breeding habits. An adult female, (Univ. of Michigan No. 81182), taken August 31, 1935, at Pensacola, Florida, has very large ovarian eggs.

LARVAE. Larvae, some apparently recently hatched, were collected at the type locality, Bogalusa, Louisiana, March 19, 1936. The smallest, 25 mm. in total length and still retaining considerable yolk, was marked above with a very fine reticulated pattern of purplish-brown over a dull yellow background. On each side of the back, and extending onto the tail, there was a fairly regular row of faint yellow spots. The legs were

light gray spotted with yellow. The gills were well developed, long and slender, the filaments without pigment. Belly unpigmented, dirty white. A 62-mm. larva had the ground color dull tan with flecks of brown pigment of irregular size and shape scattered over the dorsal surfaces and forming a mottled pattern on the sides of the tail. The belly was bluish-white.

Genus EURYCEA

KEY TO THE SPECIES AND SUBSPECIES OF EURYCEA

1. Costal grooves 19–20 2
   Costal grooves 17 or less 4
2. Neotenic, adults with gills; usually dull yellow above, lightly suffused with dusky in a broad band lighter than adjacent sides, sometimes nearly uniformly dusky above or with remnants of paired larval spots; venter of trunk and head immaculate, yellowish; gills short, pigmented; lateral-line sense organs abundant along sides of trunk and on head; length to 2 13/32″ (61 mm.). Known only from vicinity of Proctor, Oklahoma ..... *tynerensis* p. 444
   Not neotenic, adults without gills 3
3. Grayish or brownish above in a broad band limited either side by a poorly defined black line, or, with upper sides darker than back; venter evenly pigmented, gray over dull yellow; vomerine teeth 9–11; length to 3 5/32″ (81 mm.). Known only from the vicinity of Gore, Oklahoma ..... *griseogaster* p. 418
   Yellowish above, suffused with brownish in a broad dorsal band slightly lighter than adjacent sides; rarely with a series of dark flecks dorsolaterally; belly and venter of tail bright lemon-yellow, throat flesh; vomerine teeth 6–10; length to 3 17/32″ (90 mm.). Missouri, Arkansas, Kansas, and (?) Jemez Mountains, New Mexico ..... *multiplicata* p. 435
4. Toes of appressed limbs never separated by more than 2 intercostal folds, often meeting or overlapping; 14 costal grooves; long, slender, mostly terrestrial species 5
   Toes of appressed limbs separated by 3–7 intercostal folds; body and tail not particularly long and slender; semi-aquatic or aquatic species; 15–17 costal grooves (except in *cirrigera*, which normally has 14) 8
5. With a narrow, black, middorsal line within a tan or yellow dorsal band; upper sides black; venter mottled, gray and dull yellow; sides of tail with imperfect vertical black bars and narrow yellow interspaces; length to 7 3/16″ (183 mm.). Virginia to northwest Florida westward through Alabama and Mississippi to Louisiana; western Tennessee ..... *longicauda guttolineata* p. 425
   Without a narrow, black, middorsal line within a broad tan or yellow dorsal band 6
6. Venter more or less spotted or mottled; back and tail with a median tan or yellow band within which are many small brownish or blackish spots; sides below light dorsal band dark brown with scattered light flecks or spots; length to 5 25/32″ (148 mm.). Southern half of Missouri, Arkansas, eastern Oklahoma, and southeastern Kansas ..... *longicauda melanopleura* p. 428
   Venter immaculate; ground color of back and sides yellow to orange or reddish-orange 7
7. Without a definite broad dorsal band; back and sides of head, trunk, and tail with many small, irregular or rounded, separate black spots, rarely a dorsolateral linear series; venter light yellow; length to 6 11/32″ (161 mm.). Illinois, Indiana, Ohio, West Virginia, Kentucky, and possibly Alabama, westward to Arkansas, Oklahoma, and Missouri ..... *lucifuga* p. 431
   With a definite broad dorsal band limited either side by elongate dots or dashes and enclosing small, irregular, separate black spots; sides of head and trunk with separate black spots; sides of tail with vertical, black, crescentic or dumbbell-shaped bars; venter yellow; length to 7 5/32″ (182 mm.). New York south to Georgia, west to Arkansas, and north to Missouri and Illinois ..... *longicauda longicauda* p. 421
8. With a definite dorsolateral black stripe on either side of a light dorsal band; not neotenic 9
   Without a definite dorsolateral black stripe on either side of a light dorsal band; neotenic 12
9. With 14 costal grooves; dorsolateral dark stripe usually continued on the tail to its tip; adult males with prominent cirri; sides below dark stripe often brown and white mottled or with a series of white spots in a line above the legs; belly yellowish; length to 3 27/32″ (98 mm.). Coastal Plain and Piedmont, North Carolina, south through western Florida, west through Alabama and southern Louisiana; western Tennessee ..... *bislineata cirrigera* p. 408
   With 15 or more costal grooves; dorsolateral dark stripe not continuous on tail to its tip as a solid line; cirri on males small 10
10. Dorsolateral dark stripe heavy, black, with straight upper edge, continuous on basal half or two-thirds of tail, broken into a series of spots on distal half; sides below dorsolateral band marked with definite black spots of irregular size and shape; length to 4 11/16″ (120 mm.). Whitetop Mountain, Virginia, southward through North Carolina and South Carolina to northern Georgia ..... *bislineata wilderae* p. 415
    Dorsolateral dark stripe more or less irregular and invaded by small

light areas, not reaching tip of tail; sides below dorsolateral stripe mottled 11

11. Dorsal band dull yellowish ochre, suffused with dusky, and marked with small separate black dots; sides below dorsolateral stripe dark, strongly mottled to lower level of the legs; base of tail of sexually active male often with a well developed glandular hump above and slightly behind vent; length to 4⅜″ (112 mm.). South central Quebec on both sides of the St. Lawrence River ..... *bislineata major* p. 411

Dorsal band bright greenish-yellow to orange-yellow or brownish, not strongly suffused with dusky, but with small black flecks often arranged in a linear series along the mid-line; sides below dorsolateral dark strip uniformly grayish or mottled but lighter than in *major* and extending only to upper level of the legs; glandular protuberance on base of tail above in adult males when present, small; length 3 25/32″ (97 mm.). Eastern Quebec and New Brunswick to Illinois, North Carolina, and Tennessee. Also reported from South Carolina ..... *bislineata bislineata* p. 404

12. Uniformly light brown above except for a dorsolateral series of small, separate, yellowish flecks; belly and throat white, venter of tail often with chromatophores to mid-line; eyes normal, partly surrounded by black; gills with separate dark brown chromatophores; size small to 2″ (51 mm.). Known from a small lake at the head of San Marcos River, San Marcos, Texas ..... *nana* p. 439

Light yellowish above in a mottled or reticulated pattern; throat, belly, and mid-line of tail below without pigment; eyes normal in individuals from open streams, much reduced in cave specimens; gills pigmented in open streams, white or only lightly pigmented in cave specimens; size larger, to 3 11/16″ (94 mm.). Known from the type locality, 5 miles north of Helotes, from Helotes Creek and from a cave near Boerne, all in Texas ..... *neotenes* p. 441

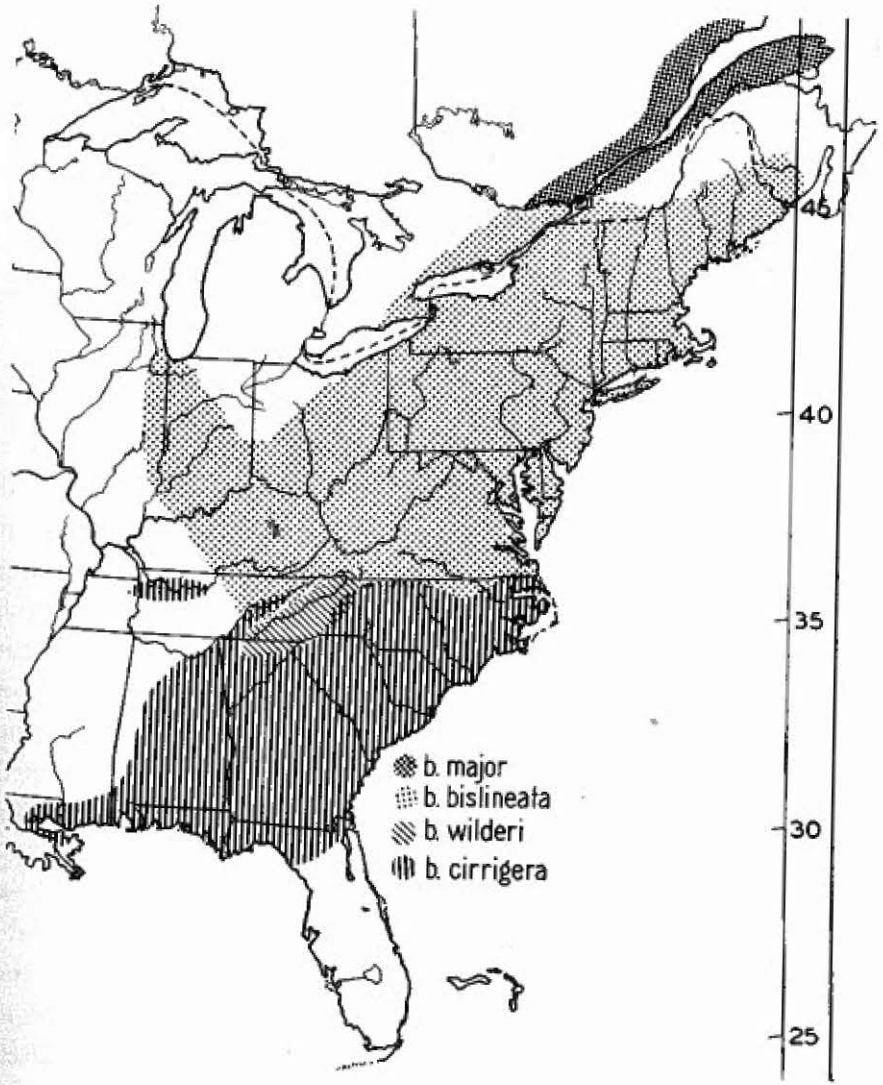
NORTHERN TWO-LINED SALAMANDER. *Eurycea bislineata bislineata* (Green). Fig. 121. Map 47.

TYPE LOCALITY. Probably the vicinity of Princeton, New Jersey.

RANGE. Quebec, New Brunswick, to Illinois, North Carolina, and Tennessee. Also reported from South Carolina.

HABITAT. This is essentially a species of the brooksides, where it hides beneath stones and logs in the well saturated soil. It is at home in the water, where it resorts for the egg-laying season, and swims freely, assuming the habits of the larvae. Occasionally found in drier situations some distance from water.

SIZE. Twenty adult males from New York localities vary in length from 2 21/32″ (67 mm.) to 3⅝″ (92 mm.) and average 3″ (78.8 mm.). A similar series of females vary from 2 13/32″ (61 mm.) to 3 13/16″ (97 mm.). The proportions of an adult male from New York are as



MAP 47.—Distribution of the subspecies of *Eurycea bislineata*.

follows: total length 3 15/32″ (88 mm.), tail 1 31/32″ (50 mm.); head length 11/32″ (9 mm.), width 3/16″ (5 mm.). A female measures: total length 3 7/32″ (82 mm.), tail 1 9/16″ (40 mm.); head length 5/16″ (8 mm.), width 3/16″ (5 mm.).

DESCRIPTION. The body is slender and subcylindrical. In the female, the sides of the head are nearly parallel back of the eyes and converge in front to the bluntly rounded snout. The head of the male may be widened back of the eyes, the snout somewhat swollen in the region of the nasolabial grooves, and, in some, the margin of the upper lip produced into small blunt cirri below the nostrils. There is an impressed line extending from the posterior angle of the eye to the lateral extension of the gular fold, and a short vertical groove passing behind the posterior angle of the eye to the angle of the mouth. The eyes are small, the long diameter equal to the length of the snout. The trunk is rounded above and slightly flattened below. There are 15 costal grooves in the majority of individuals, or 16 counting 1 in the axilla and 2 that run together in the groin, and about 3–4 intercostal spaces between the toes of the appressed limbs. Tail subquadrate in section at base, compressed and tapering to the slender tip; it is thinner above than below and often keeled. Legs well developed, toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; toes of fore feet 1–4–2–3. Tongue small and oval in outline and with a central pedicel. Vomerine teeth in series of 7–12, in the male forming an irregular line which arises behind the inner margin of the inner naris, arches gently toward the mid-line, then turns sharply backward, where it is narrowly separated from its fellow of the opposite side. The parasphenoid teeth are in elongate separate patches, widely separated from the vomerine.

COLOR. The ground color is variable and may be dull greenish-yellow to bright orange-yellow and brown. There is a broad dorsal light band which originates on the snout, widens back of the eyes to nearly the full width of the head, and continues along the trunk and the tail to its tip. Within the dorsal light band are many small, irregular, black spots and, in some individuals, a fairly regular median line. The dorsal

band is limited either side by a dorsolateral black stripe which originates back of the eye and continues along the trunk and onto the tail. In most, the black stripe breaks up into short dashes on the tail and may be

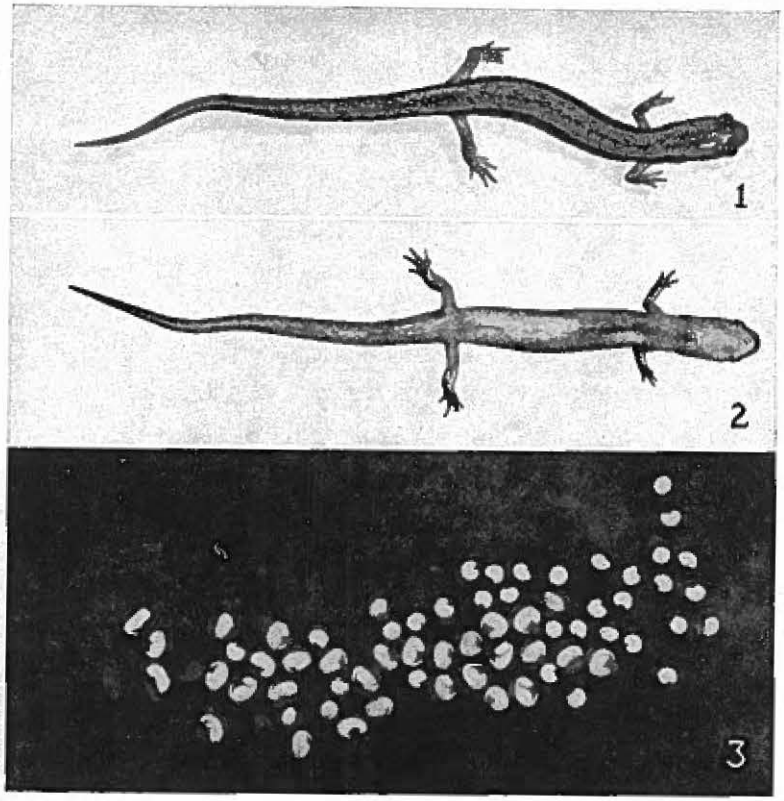


FIG. 121. *Eurycea bislineata bislineata* (Green). (1) Adult male, actual length 2 15/16″ (75 mm.). (2) Same, ventral view. Tufa Glen, Rochester, New York. (3) Eggs, slightly reduced. Stamford, New York, June 25.

limited to the basal half. Below the black stripes the sides are mottled, darkest next to the stripes, and fading on the lower sides to the bright yellow venter. Legs and feet lightly mottled above. In some individuals a row of small, round, light spots extends along the upper side below the black stripe and represents the remnant of the larval pattern. The sexes at the breeding season may usually be distinguished by the form

of the head, as indicated above. The lower jaw of the male is usually more pointed and the snout more swollen, and often there are short cirri.

BREEDING. The breeding season usually extends from January to April (Noble, 1929, p. 2). The males nose one another and the females until the latter are stimulated to follow the males and pick up the spermatophores. The complete spermatophore consists of a gelatinous base capped by an elongate head (*ibid.*, p. 3). The eggs are attached singly to the lower surface of a support in running water. They may be found as early as April and with well developed embryos in August. The average number deposited is about 30, and often the complements of several females are deposited on the same stone. The eggs are without pigment, white to pale yellow. The egg has a diameter of 2.5–3 mm. and is surrounded by 2 definite envelopes which give a total diameter of about 4.5–5 mm., the outer envelope drawn out to form an attachment disk.

LARVAE. The newly hatched larva has a length of about 12 mm. There is a broad dorsal light band, below which a dark band encloses a series of small round light spots. Larvae may attain a length of 2 15/16″ (68 mm.) before transforming at an age of 2–3 years. The gills are pigmented.

SOUTHERN TWO-LINED SALAMANDER. *Eurycea bislineata cirrigera* (Green). Figs. 49b-c, 122. Map 47.

TYPE LOCALITY. New Orleans, Louisiana.

RANGE. Lowlands of eastern North Carolina, south through northwestern Florida, west through Alabama and southern Louisiana; western Tennessee (Stejneger and Barbour, 1939, p. 24).

HABITAT. This is mainly a Coastal-Plains form, and is found under rocks, logs, and leaves in the river and creek swamps and the outlets of springs. Mainly terrestrial, but enters the water for the egg-laying season.

SIZE. Attains a total length of 3 27/32″ (98 mm.), but the average is nearer 3⅜″ (86 mm.). In a female from Marianna, Florida, 98 mm.

long, the tail comprises 58.1 per cent of the total (57 mm.); head length 11/16″ (9 mm.), width 7/16″ (6 mm.). A fully mature male from the same locality had the following proportions: total length 3⅝″ (94

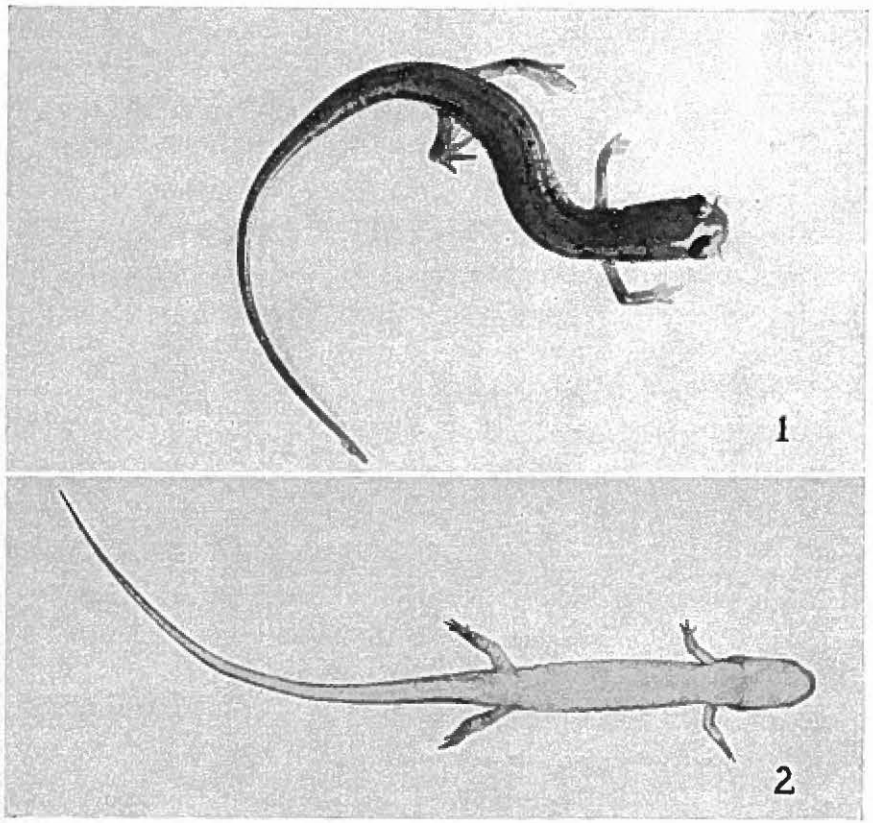


FIG. 122. *Eurycea bislineata cirrigera* (Green). (1) Adult male, actual length about 3¼″ (83 mm.). Pensacola, Florida. (2) Adult female, ventral view; actual length 3 21/32″ (93 mm.). Marianna, Florida. [Photograph of a preserved specimen.]

mm.), tail 2⅛″ (54 mm.); head length 11/16″ (9 mm.), width 7/16″ (6 mm.).

DESCRIPTION. Very closely related to *Eurycea b. bislineata*, but differs in its lower costal groove count, in the greater development of cirri, and to some extent in color and pattern. The head is moderately long and with the sides back of the eyes parallel or slightly widened just

in front of the gular fold. In front of the eyes, the snout of the male is broadly truncated, swollen at the nostrils, the nasolabial grooves continued to the tip of the well developed cirri; in the female the snout is bluntly pointed. The eyes are of moderate size and protuberant. A sinuous groove from the posterior angle of the eye to the lateral extension of the gular fold, but no definite vertical groove back of the eye to the angle of the jaw. The trunk is nearly cylindrical, slightly flattened below, and provided dorsally with a slightly impressed median line. There are 14 costal grooves, counting 1 each in the axilla and groin, and 3–4 intercostal spaces between the toes of the appressed limbs. Tail long and slender, roughly oval in section at the base, strongly compressed and sharp-edged above distally, but without a free fin. Legs well developed, toes 5–4, those of the hind feet 1–5–2–4–3 in order of length for the shortest; toes of fore feet 1–4–2–3. Tongue small, oval, and provided with a central pedicel; vomerine teeth behind and wholly between the inner nares; the series are short in most, comprising 5 or 6 teeth, in others to 10 or more, and curving inward and backward toward the mid-line, where they are narrowly separated. Parasphenoid teeth in 2 elongate patches widely separated from the vomerine.

COLOR. There is a broad median dorsal light band which arises on the snout and continues along the trunk to the tip of the tail. The band varies in color from light yellowish to russet, and encloses numerous small black specks, which on some individuals form a single median line. The light dorsal band is limited either side by a narrow dark-brown-to-black stripe extending from the hind angle of the eye, along the trunk, and onto the tail. In most specimens this dark stripe continues to the tip of the tail, where it becomes lost in the general darkening of the sides; in a few it breaks up into a series of dashes. Usually the tail base above has a spot of color brighter than the surrounding areas. Sides below lateral dark stripe usually dark brown mottled with yellow, and often with a row of small circular light spots above the legs and an imperfect row at the junction of the lower sides and belly. Legs brown, mottled above. Belly yellowish, under sides of throat and

legs flesh color, venter of tail greenish-yellow. The sexes may be distinguished by the greater development of cirri and more squarely truncated snout in the male, and by the presence in some males of enlarged premaxillary teeth.

BREEDING. Carr (1940, p. 49) reported gravid females taken in Liberty and Jackson Counties, Florida, Nov. 17. The males at this time were with swollen cirri. A large female sent me by Professor William M. Barrows from Pensacola, Florida, was distended with eggs Jan. 20, 1925. Carr (*ibid.*) reported the discovery of a lot of 50 eggs, "cemented in one layer to the under surface of a stone in running water," but did not give the date. Dunn (1926, p. 310) reported some larvae hatched April 12 from eggs found April 4. At Raleigh, North Carolina, Brimley (1939, p. 18) found eggs in March and April attached to the lower surfaces of stones in rapid water. The eggs were white and securely attached.

LARVAE. The larvae hatch in about a month and may attain a length of 75 mm. before transforming a year or two later. The larvae are characterized by a light dorsal stripe and a double row of light spots on the sides, the upper ones larger than the lower. The tail is keeled above to the base.

GREATER TWO-LINED SALAMANDER. *Eurycea bislineata major* Trapido and Clausen. Fig. 123. Map 47.

TYPE LOCALITY. Ouiatchouan River, Lake St. John County, Quebec, Canada.

RANGE. South central Quebec, Canada, on both sides of the St. Lawrence River.

HABITAT. Along the Ouiatchouan River, Lake St. John County, Quebec, Trapido and Clausen took many specimens from beneath limestone slabs during September.

SIZE. This subspecies averages conspicuously larger than the typical form. Trapido and Clausen (1938, p. 119) found 16 specimens from the Ouiatchouan River to average $3\frac{13}{16}''$ (96.06 mm.) in total length. Of

this the tail comprised from 53–60 per cent. Fully adult females seem to average a little larger than the males. Seven females, each with fully developed eggs in the ovaries, varied in length from 3 9/16″ to 4 7/16″ (90–112 mm.); 7 males with prominent, glandular protuberances at the base of the tail varied in length from 3½″ to 4 5/16″ (89–109 mm.). The proportions of a male from Val Jalbert are as follows: total length 4 5/16″ (109 mm.), tail 2 9/16″ (65 mm.); head length ½″ (12.5 mm.), width 5/16″ (7.5 mm.). A female from the same locality measures: total length 4 9/32 (109 mm.), tail 2 11/32″ (60 mm.); head length 14/32″ (11 mm.), width 9/32″ (6.5 mm.).

DESCRIPTION. Quite similar to *Eurycea b. bislineata,* but larger and with a proportionally longer tail. The fully adult males have a glandular enlargement at the base of the tail above, like that found in some males of the typical subspecies but more conspicuous. The head of the female is rather slender, widest immediately back of the eyes, the sides nearly parallel. The snout is short and bluntly rounded. In the male the head is actually and proportionally larger and longer. Back of the eyes the head widens conspicuously, the sides converging behind to the lateral extensions of the gular fold; the snout is a little longer and slightly more pointed. The eyes are of moderate size, protuberant, and with a dark horizontal bar, the iris above and below the bar brassy. A sinuous groove from the posterior angle of the eye to the lateral extension of the gular fold, and a short groove immediately behind the eye to the angle of the mouth. The trunk is moderately stout, nearly cylindrical, slightly flattened below, and with a median impressed line above. Tail subquadrate in section at the base, compressed distally and uniformly tapering to the slender tip. Costal grooves usually 16, occasionally 17 or 15. About 4–5 intercostal spaces between the toes of the appressed limbs. Legs well developed, apparently stouter than in typical *E. b. bislineata.* Toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; fore legs, 1–4–2–3. Tongue small, oval in outline. Vomerine series short, 6–7 in the female, 5–6 in the male, the series arising between and slightly behind the inner nares and curving in-

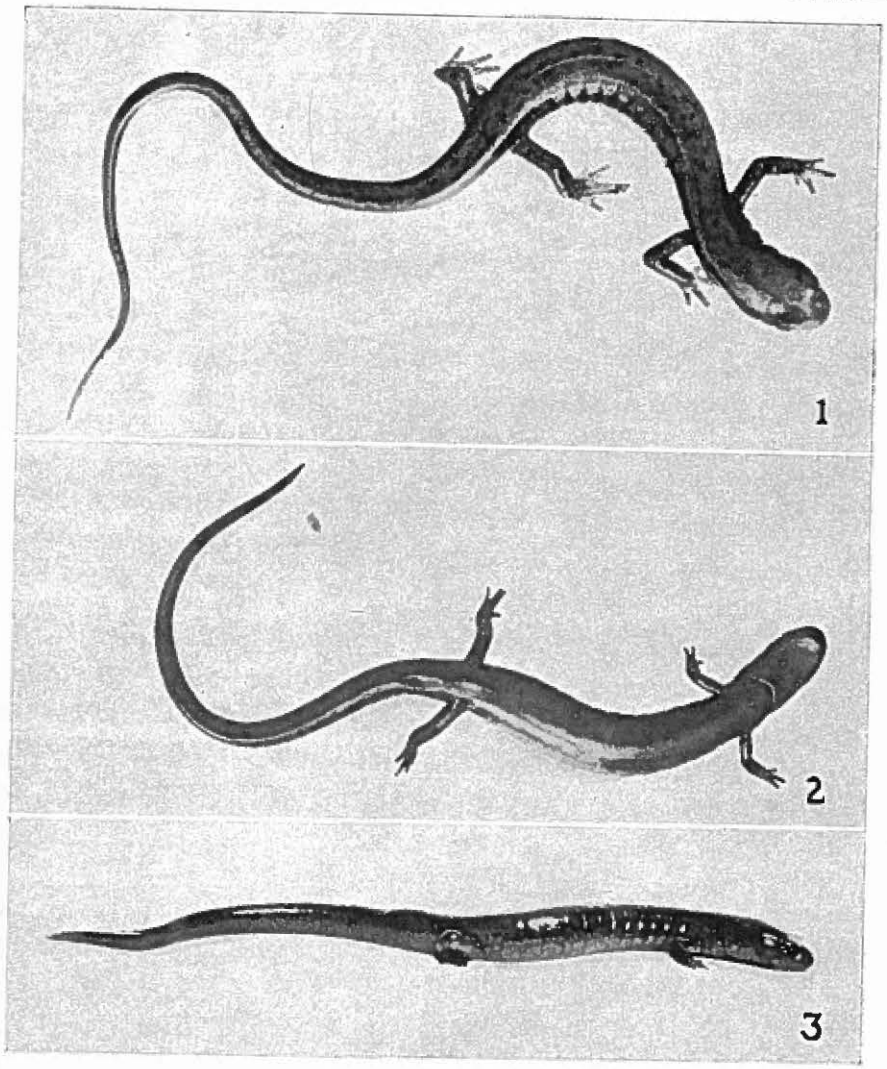


FIG. 123. *Eurycea bislineata major* Trapido and Clausen. (1) Adult female, actual length 4 5/16″ (109 mm.). (2) Same, ventral view. (3) Adult male, actual length 3¾″ (95 mm.). Val Jalbert, Lake St. John County, Quebec. [Harold Trapido, collector.]

ward, then sharply backward. Parasphenoid teeth in 2 slender, club-shaped patches which are separated the entire length.

COLOR. The ground color of the dorsal band in life is quite uniformly dull yellowish ochre somewhat obscured by a finely reticulate pattern

of gray, except on the basal half of the tail, which is usually much brighter. Small, irregular, dark brown or black spots are scattered irregularly over the surface within the band on the trunk, but are fewer or absent on the tail. The dorsal band is limited on either side by a narrow black stripe which originates at the eye and extends along the upper side of the trunk and basal half of the tail. The sides below the dorsolateral dark stripe are usually dark brown somewhat mottled and blotched with lighter. In some individuals there is a well defined line of small light spots quite conspicuous against the darker brown of the sides and probably marking the position of the lateral-line sense organs. The legs above are usually mottled like the sides but are slightly lighter. The throat and ventral surface of the trunk are dull flesh color, lightly pigmented with gray, but becoming yellowish toward the hind legs, and often quite bright yellow-orange on the basal half of the tail. The tip of the tail beneath becomes strongly suffused with dusky.

SEXUAL DIFFERENCES. Sexual differences are well marked. As indicated above, the sexually mature males have a glandular protuberance at the base of the tail above. The vent of the male has fleshy lips and the margins are grooved, while in the female the opening of the vent lies in a groove and the sides of the vent are smooth along the posterior half. The tip of the lower jaw of the male frequently has a small depressed area, and the chin is a little more pointed than in the female.

BREEDING. Nothing has been published on the breeding habits of this subspecies. Adult females collected for me at the type locality, Val Jalbert, Quebec, Sept. 28, 1939, by Mr. Harold Trapido, have the ovarian eggs well developed, individual eggs having a diameter of 2–3 mm.

LARVAE. Larvae of all sizes from 15 to 70 mm. in length have been found by Trapido and Clausen (1940, p. 244), and the smaller figure probably represents, approximately, the length at hatching. The general color is darker than in typical *bislineata,* and the dorsal pattern consists of a median, longitudinal, light band with irregular edges. Dark pigment encroaches on the sides of the throat and, in large specimens, frequently on the belly. The dorsal fin of the tail arises abruptly at a point opposite the vent, and the tail tip is bluntly rounded.

BLUE-RIDGE TWO-LINED SALAMANDER. *Eurycea bislineata wilderae* Dunn. Fig. 124. Map 47.

TYPE LOCALITY. Whitetop Mountain, Virginia.

RANGE. The Southern Blue Ridge region from Whitetop Mountain, Virginia, south through North Carolina, South Carolina, and Tennessee to Rabun and Gilmer Counties, Georgia (Stejneger and Barbour, 1939, p. 24).

HABITAT. In and along the margins of mountain springs and streams, where they hide beneath sheltering objects such as stones, logs, bark, and other debris. Occasionally found far from open water under logs, bark, moss, and leaves in damp situations. Most abundant above 2000′ and extending to the summits of the highest mountains.

SIZE. Adults commonly vary from 2⅜″ (60 mm.) to 3 17/32″ (90 mm.). The average length of 17 adult males from Mt. Le Conte, Tennessee, is 3¾″ (94.4 mm.), with extremes of 3⅛″ (80 mm.) and 4 5/16″ (110 mm.). Eight adult females from North Carolina and Tennessee average 3 17/32″ (90 mm.) and vary from 2 25/32″ (71 mm.) to 4 5/32″ (106 mm.). King (1939, p. 559) records a specimen 4¾″ (120 mm.). In the male the tail comprises 52.3–61.3 per cent of the total length, the higher percentage from the largest specimens. In the females measured the range was 52.1–58.2 per cent. The proportions of an adult male from Mt. Le Conte are as follows: total length 4⅛″ (105 mm.), tail 2 11/32″ (60 mm.); head length 7/16″ (11 mm.), width ¼″ (6 mm.).

DESCRIPTION. Closely related to typical *E. b. bislineata,* but averages larger and with colors and pattern more distinct. The head of the female is slender, the sides behind the eyes nearly parallel, and the snout bluntly pointed. The male has the head conspicuously swollen back of the eyes, the snout broader and slightly swollen in the region of the nasolabial grooves; in some males the cirri are developed, in others lacking. A sinuous groove from the posterior angle of the eye to the

lateral extension of the gular fold, and a vertical fold immediately behind the eye to the angle of the mouth. Eyes of moderate size and protuberant. The trunk is rounded above and on the sides, flattened below. There are 15 costal grooves, counting 1 each in the axilla and groin, and 3–5 intercostal spaces between the toes of the appressed limbs. Tail subquadrate in section at base, rounded below, and becoming sharp-edged and compressed distally. No free tail fin developed in the adults. The legs are well developed and stouter than in typical *E. b. bislineata.* Toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest, the innermost rudimentary, webbed at base; toes of fore feet 1–4–2–3. Tongue broadly oval and with a central pedicel. Vomerine series short, usually in imperfect series, 4–7, which arise, usually between the inner nares but occasionally back of the inner margin of the inner nares, and curve inward and backward, separated by about ½ the width of an inner naris and from the parasphenoid by about 3 times that distance. Parasphenoid teeth in long and slender patches separated by about the diameter of an inner naris.

COLOR. Generally brighter than in *E. b. bislineata,* the ground color varying from yellow to light brown. The broad dorsal light band arises on the snout and continues along the trunk and the tail to its tip. The dorsal band may be almost immaculate, finely specked with black or with larger black spots of irregular size and shape. In a few individuals a single broken middorsal line is present. The dorsal band is limited either side by a definite black stripe which originates back of the eye, passes along the side above the legs, and continues along the side of the tail, where it usually is broken or lacking on the distal half. The sides below the dorsolateral stripes may be yellow without darker markings, with small scattered flecks, or with larger irregular black spots so numerous that a strongly mottled pattern is developed. When present and well developed, the darker markings of the sides extend to the lower level of the legs, and the legs themselves are well spotted. The entire ventral surface is yellow, without darker markings. The dark markings of the lower sides may be continued on the tail as a series of dots or

small blotches, and when present are mainly limited to the basal half. The markings of the sides of the trunk and tail, below the dark dorsolateral stripes, are much more diffuse in *E. b. bislineata* than in *E. b. wilderae,* and this difference provides one of the best recognition marks. Sexual differences are well developed. The head of the male is swollen back of the eyes, the snout is broader, and there is a glandular hump at

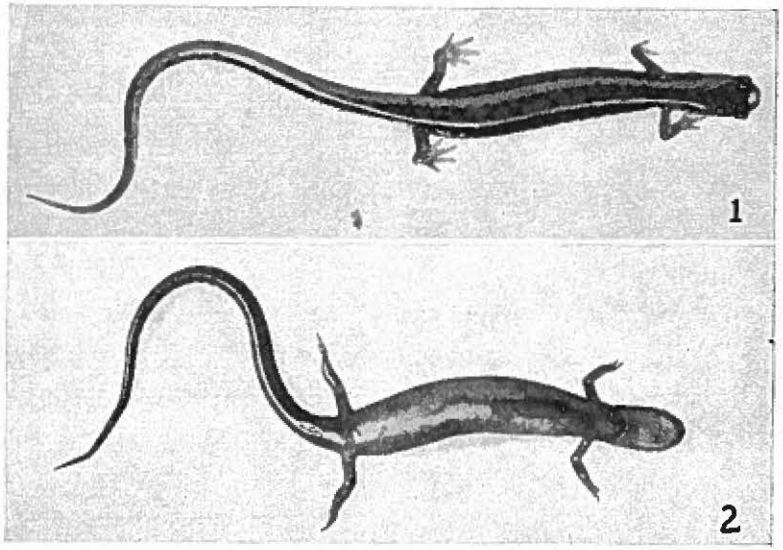


FIG. 124. *Eurycea bislineata wilderae* Dunn. (1) Adult female, actual size. (2) Same, ventral view. Mount Le Conte, Tennessee.

the base of the tail above, quite conspicuous in large specimens. The margins of the vent of the male are slightly raised and crossed by narrow grooves; the vent of the female is a simple slit.

BREEDING. Not much has been published. Dunn (1920, p. 135) writes: "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 *bislineata.*"

LARVAE. Larvae reported by Dunn (1926, p. 312) ranged in size from 17 to 51 mm. In my own series the range is 30–55 mm. Small larvae have a narrow middorsal light line, bordered either side by a darker

stripe, within which is a series of small round white spots. A second row of light spots extends on the sides above the level of the legs, and sometimes a third poorly developed row at the lower edge of the pigment of the sides. Dunn (*ibid.*) records a transformed individual 36 mm. in total length. My smallest fully transformed specimen is 40 mm. long.

GRAY-BELLIED SALAMANDER. *Eurycea griseogaster* Moore and Hughes. Fig. 125. Map 48.

TYPE LOCALITY. Swimmer's Creek, 1 mile above junction with Illinois River and about 10 miles northeast of Gore, Oklahoma.

RANGE. Known only from the type locality.

HABITAT. Found beneath stones in pools of relatively quiet water (Moore and Hughes, Copeia No. 3, p. 139, 1941).

SIZE. The average length of 19 adults of both sexes is 2¾″ (69.7 mm.), the extremes 1 29/32″ (48 mm.) and 3 3/16″ (81 mm.). (*Ibid.*) The proportions of an adult male are: total length 2¾″ (70 mm.), tail 1⅛″ (29 mm.); head length 15/32″ (12 mm.), width 3/16″ (5 mm.). An adult female has the following measurements: total length 2 13/16″ (72 mm.), tail 1 7/32″ (31 mm.); head length ½″ (12.5 mm.), width 5/32″ (4 mm.).

DESCRIPTION. The head is widest opposite the angle of the jaws, the sides behind this point converging slightly to the lateral extensions of the gular fold, in front more abruptly to the truncated snout. The trunk is slender, somewhat flattened above, and with a median dorsal groove, the sides rounded. There are usually 20 costal grooves, occasionally 19, and 7–9 intercostal folds between the toes of the appressed limbs. Tail subquadrate in section at base, becoming compressed a short distance behind the vent, the dorsal keel narrow and extending from a point above the vent to the tip. Ventral fin confined to the distal half. Legs small and slender. Toes 5–4, slightly webbed at base, flattened and blunt-pointed; those of hind feet 1–5–2–4–3 in order of length from the shortest; toes of fore feet 1–4–2–3. Tongue small, nearly circular in outline. Vomerine teeth 9–11, in series which arise behind the middle of the inner nares, curve inward, then sharply backward toward the mid-

line, where they are narrowly separated. Parasphenoid teeth in 2 elongate patches separated the entire length by about the diameter of a naris and from the vomerine by a little more.

COLOR. The general color above is gray, with tinges of tan on some

MAP 48.—Distribution of *Eurycea tynerensis*, *E. griseogaster*, *E. nana*, and *E. neotenes*.

preserved specimens. A broad median dorsal band is present in most individuals which is lighter than the adjacent sides and limited either side by an irregular and faintly developed dark line extending from the side of the head onto the base of the tail. The dark pigment of the sides fades somewhat toward the lighter venter, which is dotted with sepa-

rate black chromatophores. In life this salamander is said to be "blotched with silvery patches particularly noticeable about the lateral line organs" (*ibid.*, p. 140).

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of

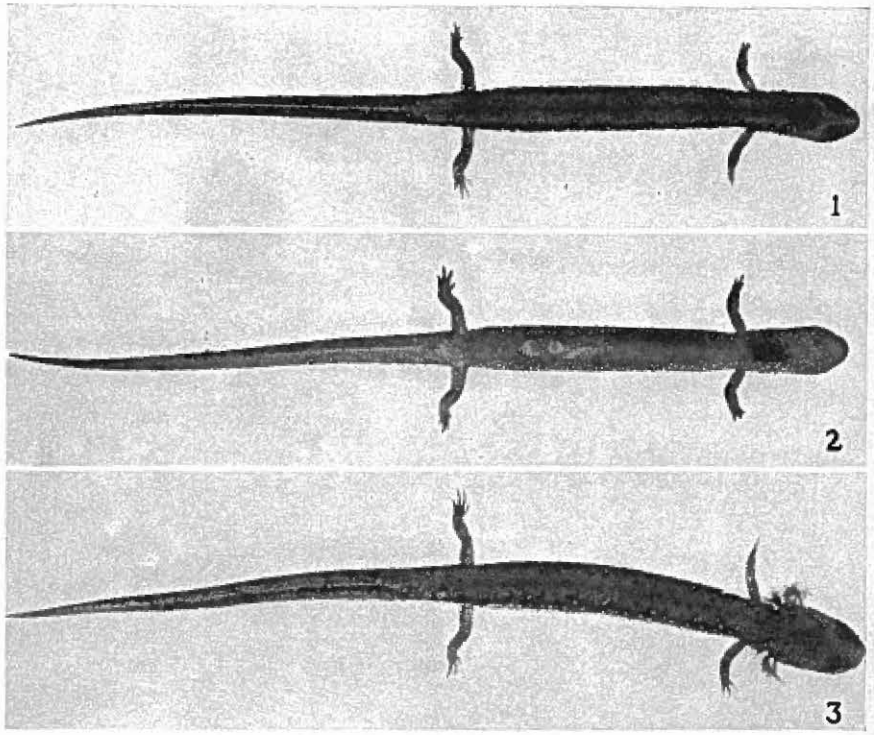


FIG. 125. *Eurycea griseogaster* Moore and Hughes. (1) Adult, actual length about 2¾″ (70 mm.). (2) Same, ventral view. (3) Larva. Swimmer's Creek, near Gore, Sequoyah County, Oklahoma. [Photographs by Arthur L. Smith.]

the vent, which is larger in the male, pigmented within, and has the sides thrown into narrow ridges. In the female the vent is bordered by a narrow, smooth, flange-like area, and is relatively smooth or shallowly, obliquely ridged within.

BREEDING. Nothing has been reported on the breeding habits.

LARVAE. The larvae in general resemble the adults but are more uniformly colored and usually have an immaculate venter. The known

specimens vary in length from 13 to 72 mm. The gills are well developed and highly pigmented, the filaments long and slender. The dorsal tail keel is wider than in the adult, highest toward the tip; ventral fin confined to the distal half.

This species is related to *E. multiplicata* and *E. tynerensis,* both of which are found in Oklahoma, but neither at the locality where *E. griseogaster* was taken. *E. griseogaster* attains a larger size than *E. tynerensis,* has a more generally pigmented venter, and is not neotenic. From *E. multiplicata* it differs in its general darker coloration, evenly pigmented venter, relatively shorter tail, and in lacking yellow on the tail venter and posterior part of belly.

I am greatly indebted to Professor George A. Moore for a series of larvae and adults.

LONG-TAILED SALAMANDER. *Eurycea longicauda longicauda* (Green). Fig. 126. Map 49.

TYPE LOCALITY. Probably from the vicinity of Princeton, New Jersey.

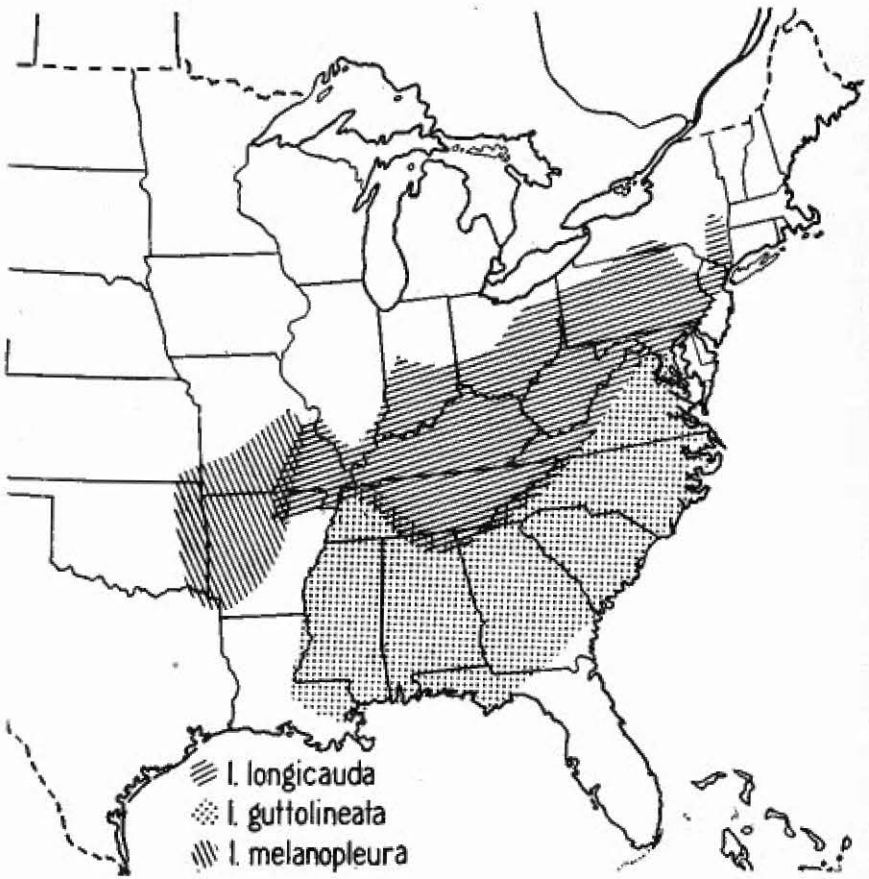
RANGE. Southern-tier counties in New York, south to Georgia, west to Arkansas, and north to Missouri and Illinois.

HABITAT. The adults are mainly terrestrial and are found in and beneath old rotting logs and under stones. Often they abound in crevices of shale banks and beneath stones and rock fragments near the margins of streams. Like some other species of the genus, they enter caves. The larvae are aquatic, and adults sometimes enter the water and swim freely.

SIZE. The average length of 18 mature individuals of both sexes is $4\frac{13}{16}$″ (123 mm.) with extremes of $3\frac{13}{32}$″ (87 mm.) and $7\frac{5}{32}$″ (182 mm.). The 182-mm. specimen, a female from Pine Ridge, Kentucky, has a tail length of 4¾″ (121 mm.); head length ⅝″ (16 mm.), width $\frac{5}{16}$″ (8 mm.). An adult male from the same locality has a total length of $5\frac{15}{16}$″ (152 mm.), tail $3\frac{11}{16}$″ (94 mm.); head length $\frac{9}{16}$″ (14 mm.), width $\frac{5}{16}$″ (8 mm.). In the female the tail comprises 67 per cent of the total length, in the male 61.8 per cent, and the tail in both sexes is pro-

portionally longer in the larger specimens than in the smaller ones. The smallest fully transformed individual I have examined was 1¾" (45 mm.) long.

DESCRIPTION. The long tail and vertical dark bars on the sides of the



MAP 49.—Distribution of the subspecies of *Eurycea longicauda*.

tail serve to distinguish this species from its near relatives. The head is long and somewhat flattened above, widest immediately back of the eyes, the sides behind the eyes converging gently to the lateral extensions of the gular fold and in front abruptly to the rounded snout. The snout is swollen in the region of the nasolabial grooves, and some males

and a very few females develop short cirri, more slender and pointed in the male. The eyes are large and strongly protuberant, the iris brassy. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold, and a short groove from the eye to a point just in front of the angle of the mouth. The slender trunk is well rounded above and on the sides, flattened below, and without much evidence of an impressed median line above in most specimens. There are 14 costal grooves, counting 1 each in the axilla and groin, and 1–2 intercostal spaces between the toes of the appressed limbs. The legs are rather long and slender. Toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; toes of the fore feet 1–4–2–3. The tail is very long and slender; rounded below, sharp-edged above; broadly oval in section at base. The tongue is small, oval in outline, thin at the margin, and attached near the front by a pedicel. Vomerine teeth in series of 7–12; the series arise behind the inner margin of the inner naris and curve inward and backward toward the mid-line, where they are separated by about the width of a naris, and from the parasphenoid by about twice that distance. Parasphenoid teeth in 2 elongate patches narrowly separated.

COLOR. The ground color varies from yellow to bright orange; specimens from the North are usually brighter than those from further south. In most specimens, there is a median dorsal band which is limited either side by a series of elongate black spots. Between these dorsolateral lines the dorsal surface has many irregular black spots of various sizes, which in some form a regular median series and in others are scattered generally over the surface. The sides below the dorsolateral lines have the spots smaller approaching the venter. The spots are few on the dorsum of the head and may be entirely lacking on the snout. The base of the tail above is marked as on the trunk, but distally, along the thin edge, the black spots fail to cross the middle line. The sides of the tail are marked with short, vertical, crescent or dumbbell-shaped, black bars, the lighter interspaces slightly wider than the bars. Sides of the head with a few scattered black spots. The venter and lower surface of the

limbs usually immaculate; the belly yellowish along the sides, bluish along the midventral line, and with greenish tinges below the liver. Legs and toes well spotted above and on the sides. The sexes may be distinguished by the form of the vent, which in the male has a flange-like area around it and a few papillae along the margins. Some males develop short pointed cirri, in contrast to the very blunt ones on a few females. The covering of the testis is gray or black; the ovaries are white.

BREEDING. Little is known. Morse (1901, p. 115) reported the species

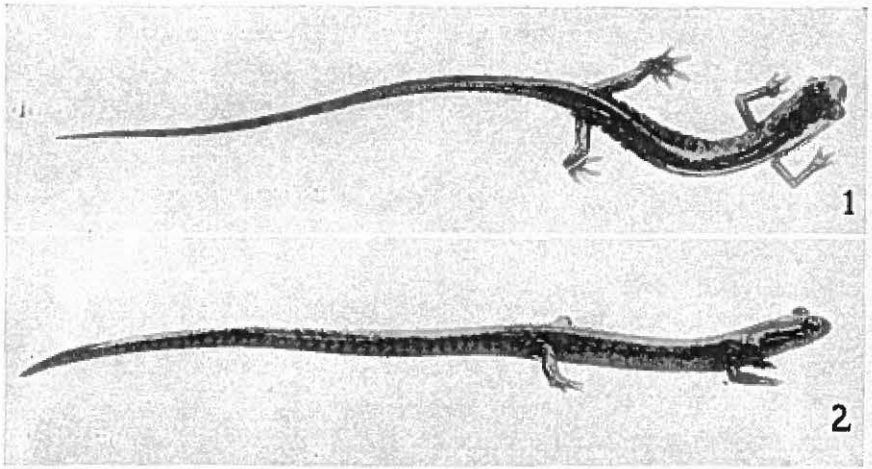


FIG. 126. *Eurycea longicauda longicauda* (Green). (1) Adult, actual length about 4½" (115 mm.). (2) Same, lateral view. Port Allegany, Pennsylvania.

as found "in May under stones at the edge of the water together with its eggs; the eggs are attached to the under side of a hollow stone."

LARVAE. The very young larvae, 19 mm. long, have been taken in February in Arkansas. These were uniformly pigmented above, with small black chromatophores. In larger specimens, 25 mm. long, a row of small, round, pigment-free spots appears on the upper sides, and a second row on the lower sides between the legs. Larvae attain a length of at least 60 mm. In a specimen of this size the light dorsal band had a few black spots and many fine ones scattered over the surface. The band is limited on either side by elongate black spots which are con-

tinued along the tail to its tip. The sides of the trunk and tail have many small, irregular, pigment-free spots which are arranged more or less in lines. On the sides of the tail the light areas form vertical series which probably mark the light interspaces of the adult.

THREE-LINED SALAMANDER. *Eurycea longicauda guttolineata* (Holbrook). Fig. 127. Map 49.

TYPE LOCALITY. "Carolina in the middle country."

RANGE. From Fairfax County, Virginia, to northwest Florida, west through Alabama and Mississippi to Louisiana; western Tennessee. Includes the East Gulf and Atlantic Coastal Plain and Piedmont, southern Blue Ridge, and extreme southern part of Appalachian Valley.

HABITAT. Most abundant in river-bottom swamps and the vicinity of springs and streams where seepage keeps the ground moist. Occasionally found some distance from water. It is nocturnal and mainly terrestrial as an adult, but is perfectly at home in the water.

SIZE. Attains a length of 7 7/32" (183 mm.). The average length of 15 sexually mature adults of both sexes from various localities is 6 5/32" (156.4 mm.), the extremes 5 3/32" (129 mm.) and 7 7/32" (183 mm.). The females average a little longer than the males. The tail of the female may comprise 58.1–64.4 per cent of the total length, and in the male the range is 59.8–64 per cent. The proportions of an adult female are as follows: total length 6 23/32" (170 mm.), tail 4⅛" (105 mm.); head length 1 1/16" (17.5 mm.), width 1 1/32" (9 mm.). An adult male has the following measurements: total length 6 15/32" (164 mm.), tail 4⅛" (105 mm.); head length 21/32" (17 mm.), width 5/16" (8 mm.).

DESCRIPTION. The head is widest immediately behind the eyes, the sides behind gently converging to the lateral extensions of the gular fold and in front abruptly to the bluntly rounded snout. The eyes are large and strongly protuberant, the iris veined and lined. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold, and, in some specimens, a short vertical groove from this line to the angle of the jaw. The trunk is subcylindrical, flattened be-

low. There are 14 costal grooves, counting 1 each in the axilla and groin, and ½–2 intercostal spaces between the toes of the appressed limbs. The tail is broadly oval in section at base, soon becoming rounded below and sharp-edged above, and distally much compressed and sharp-pointed. Legs and feet well developed, toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest, webbed at base; toes of the fore feet 1–4–2–3. Tongue broadly oval in outline, the pedicel attached near the center. Vomerine series moderately long; in the female usually with 11–14 teeth; in the male 8–12. The series may arise behind the middle or inner margin of the inner nares or lie wholly between the nares. They curve inward and backward toward the mid-line, where they are separated by about the width of a naris. The parasphenoid teeth in 2 elongate patches, usually separated from the vomerine by about twice the diameter of a naris, but occasionally continuous. The male has the snout somewhat more strongly swollen in the region of the nasolabial grooves, and often there are short cirri. The vent of the male has a flange-like margin, that of the female is a simple slit.

COLOR. This is one of our most graceful and beautiful salamanders. It is marked above by a broad tan or yellow median band which arises on the snout and extends the length of the trunk and the tail to its tip. Within the light band there is a narrow, middorsal, deep brown or black stripe or series of fused spots, which arises on the head opposite the angle of the jaw and continues along the trunk to the base of the tail. The head, in front of the stripe and including the snout, usually has a few scattered black spots, but may be almost immaculate. The light dorsal band is limited either side by a broad black stripe which arises back of the eye and continues along the trunk and the tail to its tip. The lateral dark band is usually invaded by a series of small, rounded, yellow spots on the trunk and basal part of the tail, or narrow light lines extend along the costal grooves to give a segmented appearance. Below the lateral dark band there is a narrower light stripe extending from the base of the gills along the side of the trunk, passing above the legs and onto the tail, where it frequently breaks up into spots. The lower sides

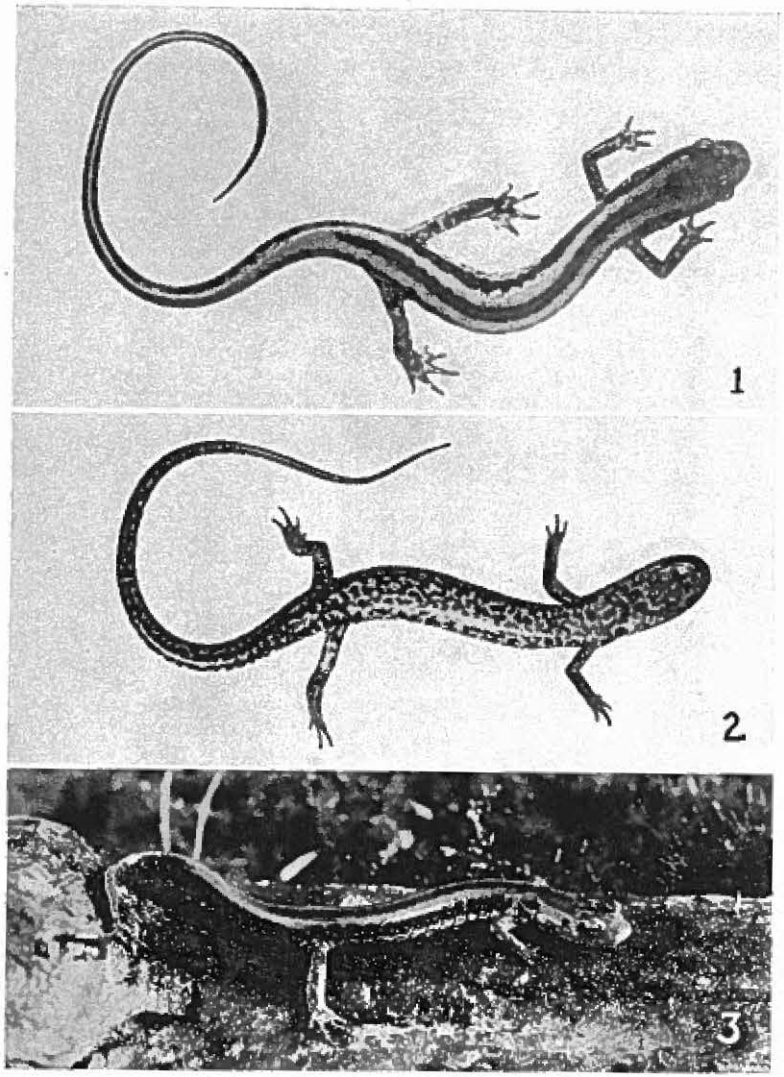


FIG. 127. *Eurycea longicauda guttolineata* (Holbrook). (1) Adult male, actual length 5 7/16″ (138 mm.). (2) Same, ventral view. Neuse River, Raleigh, North Carolina. (3) Adult male, actual length 5″ (127 mm.). Davis Lake, Mobile, Alabama.

and ventral surfaces are usually strongly mottled with dull greenish-gray on a dull yellow ground. The upper surface of the legs is mottled with yellow and black.

BREEDING. Brimley (1939, p. 18) has found gravid females in November, and eggs, presumably of this form, have been reported by Dunn (1927, p. 105).

LARVAE. The larvae attain a length of at least 50 mm. A series taken June 18, 1940, on the Cherokee Indian Reservation, North Carolina (Univ. Mich. No. 86764), vary in length from 22 to 39 mm. The pattern of the larva is essentially that of the adult, except that in the smaller individuals there is a double row of small, round, pigment-free spots within the dorsal light band, and the light stripe of the lower sides is narrow and line-like. In larger larvae, there is an indication of the mid-dorsal dark line. In other words, the dorsal surface is light with a dark mid-line, the lateral surfaces are dark with a light longitudinal line. A dark bar from the nostril passes through the eye and widens on the side of the head. The legs and feet are strongly mottled, and usually there is a pigment-free band across the bases of the toes. The dorsal tail fin arises above the vent and is strongly mottled; the ventral fin is narrow and lightly mottled.

COPE'S CAVE SALAMANDER. *Eurycea longicauda melanopleura* (Cope). Figs. 101e, 128. Map 49.

TYPE LOCALITY. Raley's Creek, White River, Missouri.

RANGE. Mainly limited to the Interior Highlands except the southeastern portion. Southern half of Missouri, northern and southwestern Arkansas, eastern Oklahoma, southeastern Kansas. Also recorded from Texas.

HABITAT. Found under rocks at the margins of streams and springs and in the twilight regions of caves; usually on land, but occasionally in the water.

SIZE. Twelve sexually mature individuals of both sexes averaged $4\frac{17}{32}''$ (116 mm.) and varied from $3\frac{5}{8}''$ (92 mm.) to $5\frac{25}{32}''$ (148 mm.). Dunn (1926, p. 319) records a transformed individual only $1\frac{25}{32}''$ (44 mm.) in total length. The proportions of an adult female from Imboden, Arkansas, are as follows: total length $5\frac{9}{32}''$ (135 mm.), tail $3\frac{5}{32}''$ (80

mm.); head length $\frac{9}{16}''$ (14.5 mm.), width $\frac{9}{32}''$ (7.5 mm.). An adult male from the same locality measures: total length $4\frac{15}{16}''$ (126 mm.),

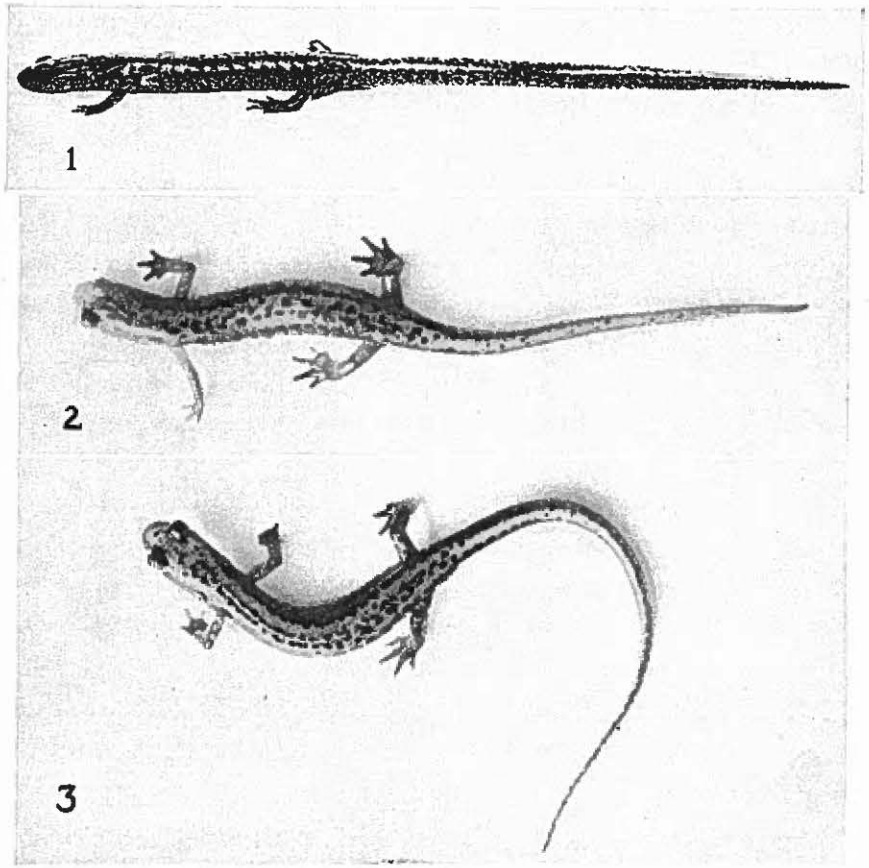


FIG. 128. *Eurycea longicauda melanopleura* (Cope). (1) Adult, actual length about $5\frac{1}{8}''$ (131 mm.). Spout Spring, Ravenden, Arkansas. (2) Same, dorsal view. (3) Another individual, dorsal view. [Photograph by R. Redman.]

tail $3\frac{1}{16}''$ (78 mm.); head length $\frac{17}{32}''$ (13.5 mm.), width $\frac{9}{32}''$ (7.5 mm.).

DESCRIPTION. Closely related to the Long-tailed salamander, which it resembles in general body form. The sides of the head back of the eyes nearly parallel, in front of the eyes converging to the bluntly pointed

and truncated snout. The eyes are large and prominent, the iris brassy above. A slightly impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to the angle of the jaw in some individuals. The trunk is cylindrical, flattened below. There are 14 costal grooves, counting 1 in the axilla and 2 that run together in the groin, and the toes of the appressed limbs may meet or be separated by 1 or 2 costal interspaces. The tail is broadly oval in section at the base, compressed and sharp-edged above; distally, slender and pointed. In the fully adult male the tail may comprise 62 per cent of the total length. Legs and feet well developed, the hind noticeably larger and stouter than the fore. Toes 5–4, those of the hind feet 1–5–2–(3–4) in order of length from the shortest, slightly webbed at base; toes of the fore feet 1–4–2–3. Tongue broadly oval in outline, the margins thin and free, the pedicel attached near the center. The vomerine teeth in rather long series of 12–16 which arise behind the middle or inner margin of the inner naris, curve inward and forward, then sharply backward, separated by about the width of a naris. Parasphenoid teeth in 2 separate elongate patches, widely separated from the vomerine.

COLOR. This species is marked above with a broad dorsal band much lighter than the adjacent sides. The ground color of the dorsal band varies from dull brownish-yellow in old individuals, through shades of greenish-yellow, to bright yellow in the juveniles. The band originates on the snout, passes between the eyes, back of which it widens to the full width of the head, then, narrowing in the neck region, continues the length of the trunk and on the tail sometimes to the tip. Within the dorsal band are many small, irregular, dark brown or black spots. The spots are few and scattered on the snout, more abundant on the head back of the eyes, and rather uniformly distributed along the trunk. In some individuals the spots from a fairly regular median series, in others a double row either side of the middorsal line; in most, however, there is no particular arrangement apparent. On the basal half of the tail above, the spots may be few and scattered, but in others continued to

the tip. The upper sides bordering the dorsal band are dark, varying from grayish in the young to deep reddish-brown in mature individuals. The dark sides are marked with light gray or yellow flecks and spots, which are generally absent next the dorsal band and most abundant on the lower sides. On the tail the dark ground color of the sides may be mottled and blotched, or the sides may be almost uniformly reddish-brown with only the lighter yellow of the dorsal stripe showing as a narrow line along the top. The venter is usually free from dark spots, but occasionally an individual will be lightly blotched with brown. The throat is flesh color, the belly dull white, and the ventral surface of the tail yellowish. Rarely the yellow of the ventral surface of the tail extends forward some distance on the belly. The male may usually be recognized by the swollen snout and greater development of blunt cirri.

BREEDING. Direct observations are lacking. Females collected at Ravenden, Arkansas, in November, and sent me by B. C. Marshall, had well developed ovarian eggs. On the evening of Nov. 18, I confined males and females together and the following morning a spermatophore was found attached to a bit of damp moss (text fig. 12e.).

LARVAE. A series of small larvae sent from Imboden, Arkansas, by B. C. Marshall, was collected Feb. 10, 1928. These varied in length from 17 to 31 mm. and were uniformly pigmented on the dorsal and lateral surfaces except for a dorsolateral series of small, round, light spots. Chin and anterior part of throat pigmented. Larvae attain a length of at least 1 13/16″ (46 mm.).

CAVE SALAMANDER. SPOTTED TAIL SALAMANDER. *Eurycea lucifuga* (Rafinesque). Fig. 129. Map 50.

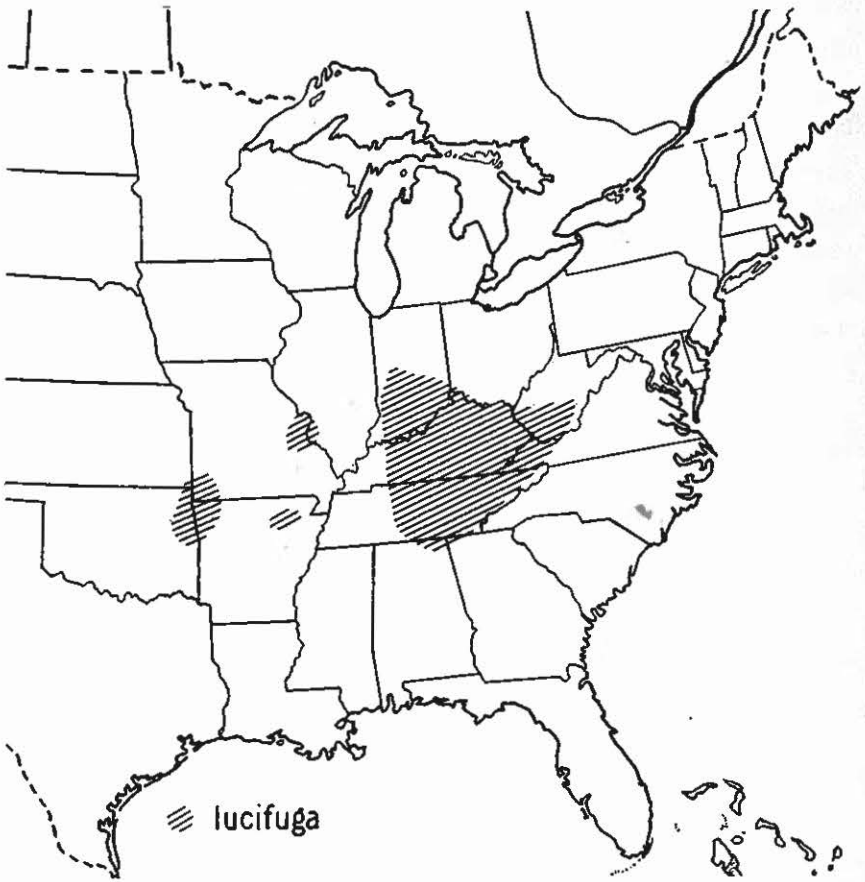
TYPE LOCALITY. Caves near Lexington, Kentucky.

RANGE. Illinois, Indiana, Ohio, West Virginia, Kentucky, and possibly Alabama east of the Mississippi River, and Arkansas, Oklahoma, and Missouri west of the river.

HABITAT. Most abundant in the twilight regions of caves, where they climb about over the walls and ledges. Frequently found under logs,

stones, and rubbish, in damp situations outside of caves. The adults are essentially terrestrial.

SIZE. The average length of 30 individuals of both sexes is $4\frac{25}{32}''$



MAP 50.—Distribution of *Eurycea lucifuga*.

(122.2 mm.), with extremes of $2\frac{3}{4}''$ (70 mm.) and $6\frac{13}{32}''$ (161 mm.). In my collection the 19 males average $5\frac{3}{16}''$ (132.3 mm.), the 11 females $4\frac{1}{8}''$ (104.7 mm.). Individual females, however, exceed in length the largest males, Dunn (1926, p. 340) recording one individual $6\frac{19}{32}''$ (167 mm.) in total length, and largest male $6\frac{15}{32}''$ (164 mm.). The proportions of a male from Mammoth Cave, Kentucky, are as follows:

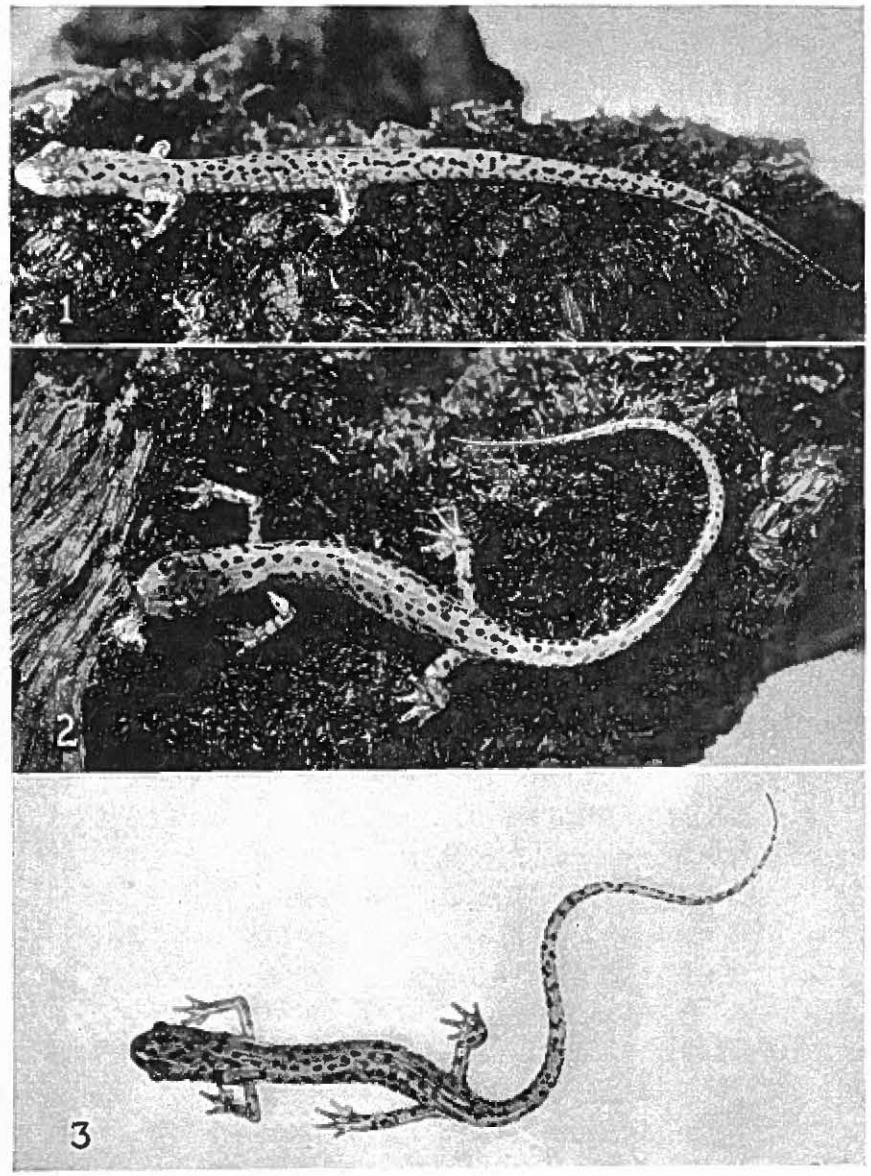


FIG. 129. *Eurycea lucifuga* Rafinesque. (1) Adult male, lateral view; actual length 6″ (153 mm.). (2) Same, dorsal view. [Photograph by E. J. Stein.] (3) Adult female, actual length $5\frac{1}{8}''$ (131 mm.). Imboden, Arkansas.

total length 6 7/32″ (157 mm.), tail 3 25/32″ (95 mm.); head length 5/8″ (16 mm.), width 13/16″ (10 mm.). A female from near Lexington, Kentucky, has the following proportions: total length 6 1/8″ (155 mm.), tail 3 19/32″ (92 mm.); head length 5/8″ (16 mm.); width 3/8″ (9.5 mm.).

DESCRIPTION. A slender species with reddish-orange ground color and many black spots. The head is widest immediately back of the eyes, the sides behind the eyes gently converging to the lateral extensions of the gular fold and in front rather abruptly to the bluntly truncated snout. The males have the snout more strongly swollen in the region of the nasolabial grooves, and the short, blunt cirri developed to a greater extent than in the females. An impressed line extending from the posterior angle of the eye to the lateral extension of the gular fold is usually present, and a short vertical groove from the posterior angle of the eye to the angle of the mouth. The eyes are large, the horizontal diameter about equal to the length of the snout. The trunk is subcylindrical, flattened below. There are 14 costal grooves, counting 1 each in the axilla and groin, and the toes of the appressed limbs may just meet or overlap 2 intercostal spaces. Tail subquadrate in section at the base, becoming compressed into a flat oval at about the mid-length, and more strongly flattened and sharp pointed distally. The legs are well developed and moderately long. Toes 5–4, those of the hind feet short and webbed at base, 1–5–2–(3–4) in order of length from the shortest; toes of the fore feet 1–4–2–3. The boletoid tongue is broadly oval in outline and fills the floor of the mouth; vomerine teeth in long, sharply angled series of 11–20. The series arise behind the middle or inner margin of the inner nares, slant forward and inward, then strongly backward toward the center line, where they are separated by about the diameter of a naris. The parasphenoid teeth in 2 long club-shaped patches, separated from each other by about the diameter of a naris, and twice that distance from the vomerine. In this species the cirri are usually longer in the females than in the males, and longer in adults than in the recently transformed individuals.

COLOR. Ground color variable, dull yellow through orange to bright

orange-red. The younger individuals usually yellowish, the orange-red developing with age. Scattered generally over the dorsal and lateral surfaces are many irregular, or rounded, or elongate black spots of variable size, usually 1–3 mm. in diameter. These spots sometimes form a dorsolateral series on either side of the trunk, enclosing a broad dorsal band within which there may be a single median series or many irregularly scattered spots. The lower surfaces are generally light yellow and without spots. In old and large individuals the spots of the lower sides may become enlarged and somewhat fused. The sexes may be distinguished by the form of the vent, which, in the male, has the margins raised and finely papillose, and by the greater development of cirri.

BREEDING. The mating habits have not been reported, nor have the eggs been described. Small larvae 17.5 mm. long have been found early in February and as late as March 20 in Mayfield's Cave, near Bloomington, Indiana, and have been described and figured by McAtee (1906, p. 74). The young larvae are nearly uniformly pigmented above and on the sides, except for 3 longitudinal series of small rounded or elongate spots on each side. The upper series of spots is near the middorsal line, the 2nd near the middle of the sides, and the 3rd between the limbs. As the larvae increase in size, the pigment tends to become concentrated in the characteristic black spots of the adult. Larvae attain a length of about 2 1/4″ (58 mm.). Larvae have a broad tail fin which arises above the insertion of the hind legs and continues to the broadly pointed tip and ventrally to the vent.

MANY-RIBBED SALAMANDER. *Eurycea multiplicata* (Cope). Fig. 130. Map 51.

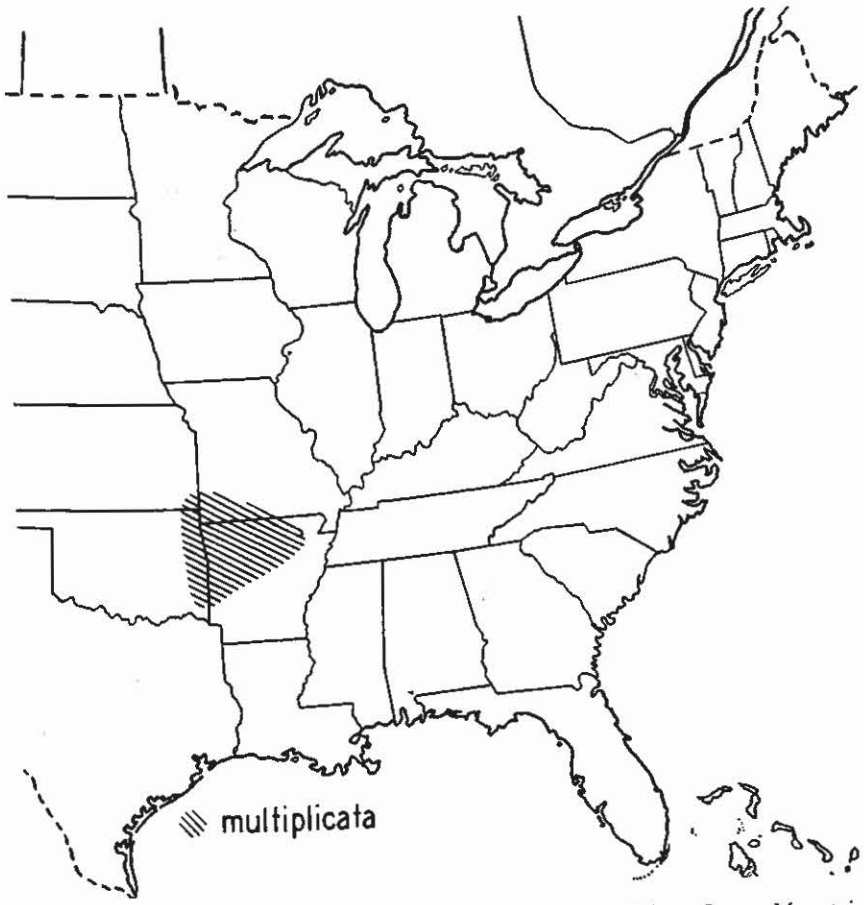
TYPE LOCALITY. Red River, eastern Oklahoma.

RANGE. Stone County, Missouri, to Pulaski County, Arkansas, and Kansas; also reported from the Jemez Mountains, New Mexico, but probably erroneously.

HABITAT. Found under stones, logs, and other debris, in streams and springs, both in the open and in caves. Essentially an aquatic species but

occasionally on land. In Arkansas found by Strecker (1908, p. 88) to be associated with *Desmognathus f. brimleyorum*, and in Missouri with *Typhlotriton* (Noble, 1927, p. 418).

SIZE. The largest specimen measured by Dunn (1926, p. 315) was a



MAP 51.—Distribution of *Eurycea multiplicata*. (Also recorded from Jemez Mountains, New Mexico, but doubtless in error.)

male having a total length of $3\frac{17}{32}''$ (90 mm.). My largest specimen is a female from near Bono, Arkansas, which measures: total length $3\frac{15}{32}''$ (87 mm.), tail $1\frac{11}{16}''$ (43 mm.); head length $\frac{13}{32}''$ (10 mm.), width $\frac{7}{32}''$ (6 mm.). The average length of 6 adults from Arkansas and Mis-

souri is $3\frac{1}{4}''$ (82.7 mm.), with extremes of $2\frac{29}{32}''$ (74 mm.) and $3\frac{15}{32}''$ (87 mm.). Dunn (*ibid.*) records a transformed specimen only $1\frac{19}{32}''$ (41 mm.) in total length.

DESCRIPTION. The head is slender, with the sides back of the eyes nearly parallel and in front tapering abruptly to the pointed snout. There is an impressed line extending from the posterior angle of the eye to the lateral extension of the gular fold, and a short vertical groove from this

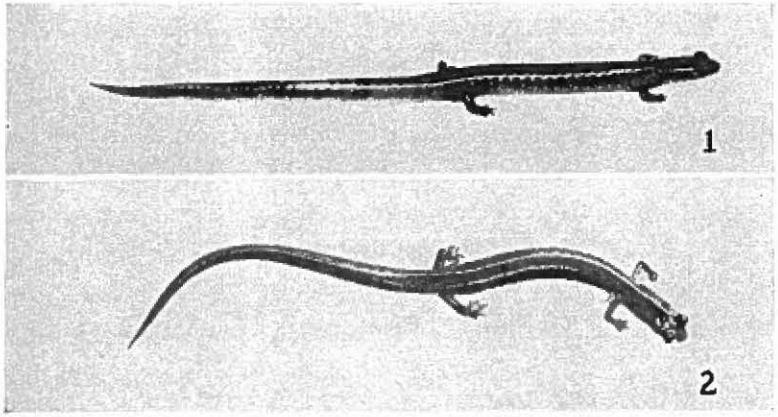


FIG. 130. *Eurycea multiplicata* (Cope). (1) Adult male, actual length $3\frac{9}{32}''$ (84 mm.). (2) Same, dorsal view. Rich Mountain, Polk County, Arkansas.

passing behind the angle of the jaw. The eyes are of moderate size and bordered behind by a vertical fold; the iris is brassy mixed with reddish-brown. The trunk is subcylindrical and provided above with a slight impressed median line. Costal grooves usually 19, counting 1 each in the axilla and groin, occasionally 20, and 8–10 intercostal spaces between the toes of the appressed limbs. The tail is subquadrate in section at the base, rounded below, sharp-edged above, and becoming strongly compressed and slightly keeled above, distally. Legs rather small, toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest, the inner rudimentary, all rather short and blunt; toes of the fore feet 1–4–2–3, the inner very short. Tongue small, oval in outline, rather thick, and provided with a central pedicel. Vomerine teeth in short irregular

series of 6–10, the series arising behind the inner margin of the inner naris and curving inward and backward toward the mid-line, where it is separated from its fellow of the opposite side by about ½ the diameter of an inner naris. The parasphenoid teeth in 2 elongate patches, separated from one another by nearly the width of a patch and from the vomerine by about 3 times that distance.

COLOR. The general ground color is yellow, resembling *Manculus,* but without the darker longitudinal stripes. The entire dorsal surface is usually evenly pigmented with dilute chocolate-brown, over which are scattered small, stellate, pigment-free spots, through which the ground color strikes and imparts a yellowish tinge. There is in some individuals an indication of a broad, middorsal, light stripe, limited on either side by an interrupted line of small dark spots. In some a series of small dark flecks follows the median impressed line to the base of the tail. The entire ventral surface is a bright lemon-yellow except the throat and lower surface of the limbs, which are flesh. The yellow of the venter extends on the sides of the tail and trunk to the level of the lower sides of the limbs. In some individuals the sides of the head and trunk are finely flecked with white pigment dots, and a few are often present on the dorsal surface of the head and trunk and on the sides of the tail. In alcohol, specimens may be dull yellow above, grayish on the sides, and with an indication of larval spots in a line below the edges of the dorsal band.

BREEDING. Little is known of the breeding habits, and the eggs have not been reported.

LARVAE. I have measured larvae from Scott County, Arkansas, collected April 30, 1934, by A. A. Heinze, which were only 23 mm. long, and others from Reed Spring, Missouri, sent me by B. C. Marshall, which had attained a total length of 85 mm. The small larvae are yellowish above and on the sides, finely flecked with brown pigment, and with a dorsolateral series of rounded pigment-free spots; a second series is sometimes developed near the lower edge of the pigmentation of the sides. The tail is keeled above to a point above the hind legs and below

to the vent. The large larvae are colored essentially as the adults, but perhaps somewhat lighter. The dorsal fin of the tail is broad and lightly mottled, and extends to a point above the vent; the ventral tail fin is mainly confined to the distal half.

DWARF EURYCEA. *Eurycea nana* Bishop. Fig. 131. Map 48.

TYPE LOCALITY. Lake at head of San Marcos River, at San Marcos, Hays County, Texas.

RANGE. Known only from the type locality.

HABITAT. Collected among aquatic plants close to the surface of the water by C. E. Mohr.

SIZE. Smallest among the species of *Eurycea,* 6 adults average only 1 13/16″ (46 mm.), the extremes 1 5/8″ (41 mm.) and 1 31/32″ (50 mm.). The proportions of an adult male are as follows: total length 1 15/16″ (49.5 mm.), tail 7/8″ (22 mm.); head length 3/16″ (4.5 mm.), width 5/32″ (3.5 mm.). An adult female measures: total length 1 31/32″ (50 mm.), tail 25/32″ (20 mm.); head length 7/32″ (5 mm.), width 3/16″ (4.5 mm.).

DESCRIPTION. The known specimens are neotenic. The head is narrow, with the sides back of the eyes parallel, in front converging to the bluntly rounded snout. The eyes are of moderate size, partly or completely surrounded by a dark ring, the horizontal diameter about 1¼ in the snout; the iris is dark, with only a few light flecks evident in preserved specimens. Gills well developed and highly pigmented, the rachises flattened and increasing in length posteriorly, the filaments slender and pigmented nearly to the tips. Trunk slender, somewhat compressed, flattened above, and with a slightly impressed median line. There are 16–17 costal grooves and 6–7 intercostal folds between the toes of the appressed limbs. The tail is subquadrate in section at base, slender and compressed a short distance behind the vent, and with a dorsal keel that arises behind the posterior end of vent; ventral tail keel limited to the distal third. The legs are small and slender; toes 5–4, long and slender, those of the hind feet 1–5–2–4–3 in order of length

from the shortest; toes of the fore feet 1–4–2–3. Tongue and teeth larval in character. The teeth on the premaxilla usually 10–13 and average about 11. On a single sexually mature female these teeth are enlarged and reduced in number to 7; vomerine teeth 9–14, average 11.7; pterygoid teeth 4–6, average 4.8. In two adult males, the pterygoid teeth are reduced to 2 on each side, suggesting incipient metamorphosis which

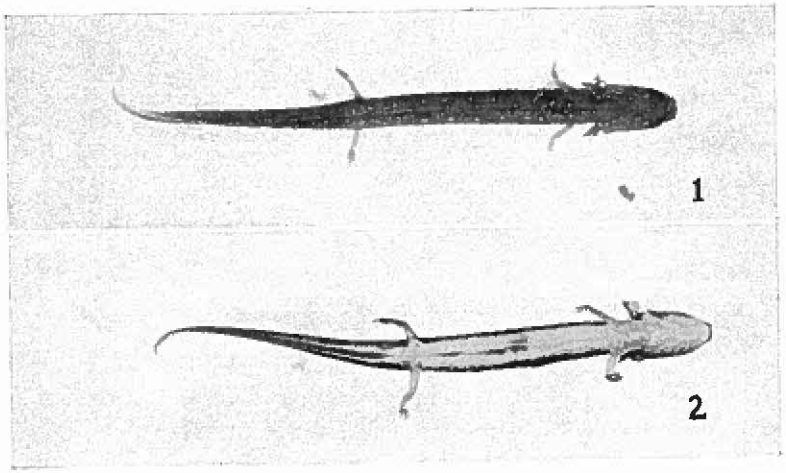


FIG. 131. *Eurycea nana* Bishop. (1) Adult male, actual length 1 17/32″ (39 mm.). (2) Same, ventral view. San Marcos, Hays County, Texas. [Photographs from a preserved specimen.]

may or may not be completed. Both sexes may be mature at a length of only 41 mm.

COLOR. The general ground color above is uniform light brown, relieved by a dorsolateral series of small, separate, yellowish flecks of irregular size and shape on each side of the mid-line. The chromatophores giving the general color above are in little clusters separated by inconspicuous, very narrow, light lines. The pigment extends on the side of the head to the level of the base of the first gills and involves the upper jaw and posterior part of the lower jaw, on the sides of the trunk to involve the upper half of the legs, and on the tail nearly to the ventral keel. The ventral surfaces are white, tinged with yellowish on the tail.

The dorsolateral series of light spots vary in number from 7 to 9, and there is sometimes a second incomplete line on the sides above the insertion of the legs. A few small light spots also invade the middorsal region in most specimens.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent, which is larger in the male and has the opening lined with short papillae. In the female, the vent is a simple slit, with the side anteriorly thrown into narrow folds. The testes are strongly pigmented with black, and the peritoneum of both sexes is specked with scattered black chromatophores.

BREEDING. Nothing is known of the breeding habits in nature, but a female 50 mm. long had well developed eggs when collected June 22, 1938.

LARVAE. A series of 12 larvae, which have not attained sexual maturity, vary in length from 20 to 41 mm. These differ in no essential respect from the sexually adult individuals.

TEXAS NEOTENIC SALAMANDER. *Eurycea neotenes* Bishop and Wright. Fig. 132. Map 48.

TYPE LOCALITY. A small stream 5 miles north of Helotes, Texas.

RANGE. Known from the type locality, a small stream 5 miles north of Helotes; from Helotes Creek, and from a cave near Boerne, all in Texas.

HABITAT. The type specimens were found among dead leaves in pools varying from 12″ to 18″ in depth. C. E. Mohr, collecting at Cascade Cave, 3 miles east of Boerne, found several in a shallow pool deep within the recesses of the cave. Wright and Wright (1938, p. 31) report having seen specimens in the leafy mats along the edges of Helotes Creek.

SIZE. Measurements of the largest specimen in the type series, a male, are as follows: total length 2 27/32″ (72 mm.), tail 1 5/16″ (33 mm.); head length 5/16″ (8 mm.), width 1/4″ (6 mm.). Female: total length 2 3/4″ (69 mm.), tail 1 7/32″ (31 mm.); head length 5/16″ (8 mm.), width 1/4″

(6 mm.). The largest among the specimens from Cascade Cave has a total length of 3 11/16″ (94 mm.).

DESCRIPTION. The head is only moderately broad, widest immediately in front of the gills, the sides gently converging to the eyes, then more

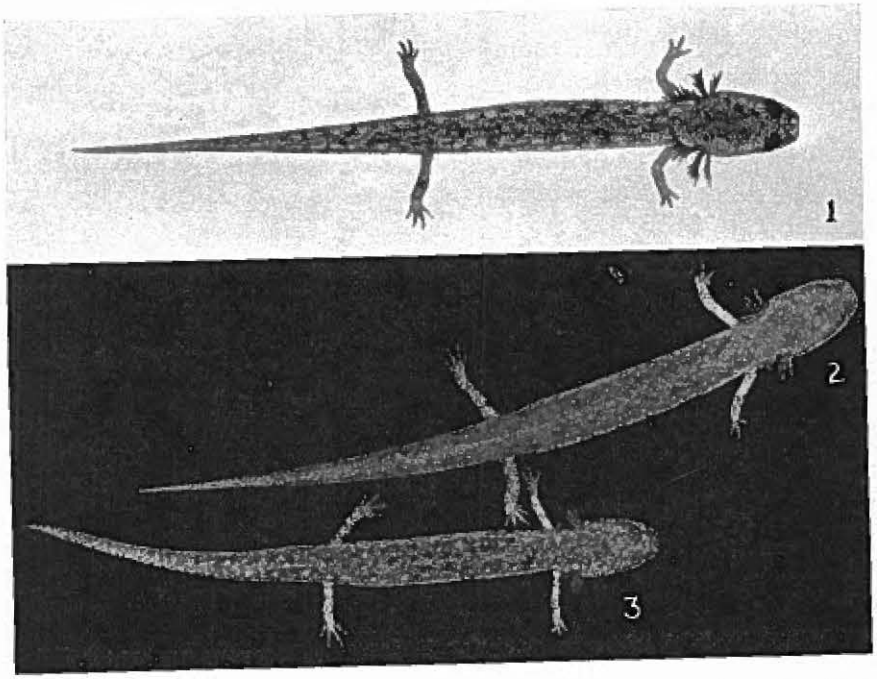


FIG. 132. *Eurycea neotenes* Bishop and Wright. (1) Adult, dorsal view. West Fork of Cibola Creek, near Bracken, Bexar County, Texas. [A. H. Wright and A. A. Wright, collectors.] (2) Same, another individual. (3) Same, another individual. [Photographs by Arthur L. Smith.]

abruptly to the bluntly pointed snout. Eyes moderate, nearly circular in outline, and without lids, apparently normal in individuals found living in open streams but considerably reduced in the cave specimens from near Boerne. The gill filaments are long, slender, and bright red in life. The trunk is slightly compressed, the tail oval in section near the base, somewhat flattened below, compressed toward the tip. Dorsal tail fin narrow, and extending from a point above the posterior end of vent to the tip, where it ends in a sharp point; ventral tail fin narrow

and extending anteriorly about ½ the tail length and continued a short distance as a low ridge. Costal grooves 15–17, the usual number 16 when 1 each is counted in the axilla and groin; 5–7 intercostal spaces between toes of appressed limbs. Legs small and slender. Toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; fore feet, 1–4–2–3. Tongue larval in character, moderately large, fleshy. Teeth larval, the vomero-pterygoid series following the lines of the upper jaw and extending posteriorly to a point about opposite the hind angle of the eye.

COLOR. The general ground color above in life is quite uniformly light yellowish, with light brown chromatophores aggregated on the back and sides to give a mottled appearance. The light dorsal band characteristic of *Eurycea b. bislineata* is here poorly developed, and the dorsolateral series of small light spots are but faintly defined. The secondary row of light larval areas on the sides is evident only on the smaller specimens. The sides of the head and chin are lightly pigmented, and there is a fairly prominent dark bar extending from the eye to the nostril. The lower sides and belly are normally without pigment, light yellow.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent, which in the female is a simple slit with a few low tubercles along the margin; in the male the margins of the vent are thrown into low folds.

BREEDING. In the original lot of specimens taken April 1, 1936, were several females having unpigmented ovarian eggs about 2 mm. in diameter and apparently nearly ready to be deposited. On August 16–17, 1938, Dr. Leo Murray collected at the type locality and secured a fine series of 47 larvae varying in length from 14 to 33.5 mm., the smallest specimens quite recently hatched, the others apparently the young of the year but at least some weeks older. The variation in size of these small larvae suggests that the egg-laying season may extend over several weeks, perhaps from April to July.

LARVAE. The recently hatched larvae have the dorsal surfaces light

brown, with the dorsolateral series of small, circular, light spots 10–12 in number, extending from the back of the head onto the basal half of the tail. A secondary row of light larval spots is inconspicuously developed on the sides of some individuals between the hind and fore legs. Small, irregular, pigment-free spots and lines are scattered generally over the back and sides to give a reticulated effect. The dorsal surfaces of the legs are colored like the back. The larval tail fins are much more strongly developed than in the sexually mature individuals, the dorsal fin arising above the insertion of the hind legs and continuing to the bluntly pointed tip, the ventral fin extending to the vent. Sexual maturity may be reached in the males at a length of about 50 mm.; in the females the smallest mature individual collected was 69 mm. in total length.

OKLAHOMA NEOTENIC SALAMANDER. *Eurycea tynerensis* Moore and Hughes. Fig. 133. Map 48.

TYPE LOCALITY. Tyner Creek near Proctor, Adair County, Oklahoma.

RANGE. Known only from the vicinity of the type locality.

HABITAT. Sexually mature individuals and larvae were raked out of loose gravel shallowly covered by the cold swift waters of Tyner Creek and Marvin's spring; associated, in this area, with *Eurycea l. melanopleura.*

SIZE. Thirteen specimens measured by Moore and Hughes (1939, p. 697) averaged 2 1/36″ (55.5 mm.) in total length and varied from 1 23/32″ (44 mm.) to 2 13/32″ (61 mm.). In this same series the tail averaged 7/8″ (22.4 mm.) and varied from 19/32″ (16 mm.) to 1 3/32″ (28 mm.).

DESCRIPTION. This is a small, neotenic species apparently related to *Eurycea neotenes,* but generally darker and with a higher costal-groove count. The head is somewhat depressed, the sides back of the eyes nearly parallel, the snout broadly rounded. Eye rather small, its horizontal diameter about twice in snout; no eyelids. Gills progressively longer from in front, the filaments well pigmented. Gular fold well

developed. Trunk subcylindrical. Costal grooves 19–20, usually 20 counting 1 each in the axilla and groin, and about 10 intercostal spaces between the toes of the appressed limbs. Tail subcylindrical at base, broadly oval in section at mid-length, and becoming compressed distally. The tail fin arises as a low ridge at a point above the vent and becomes thin-

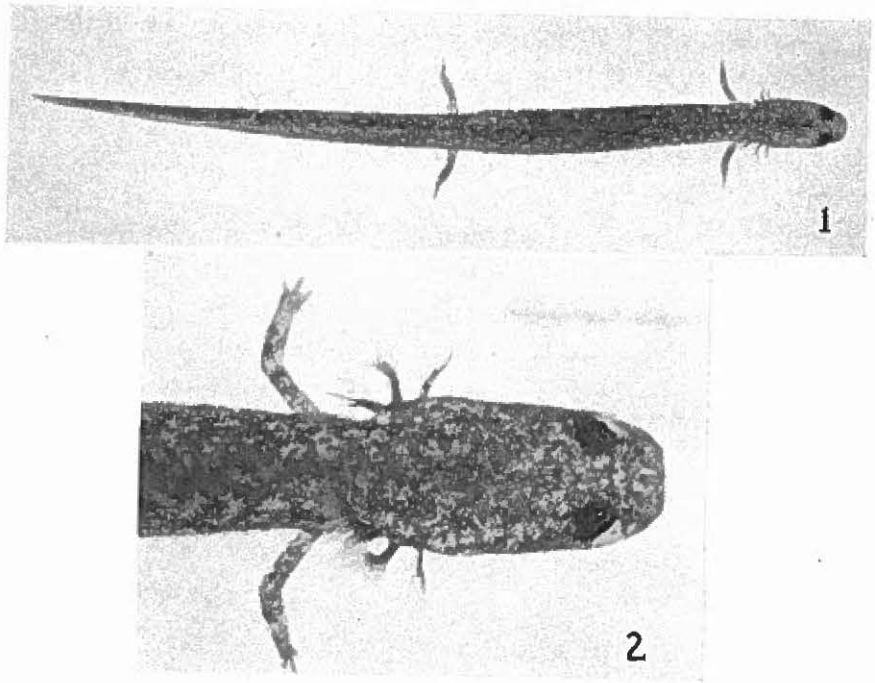


FIG. 133. *Eurycea tynerensis* Moore and Hughes. (1) Adult, actual length about 2″ (51 mm.). (2) Enlarged view of dorsum of head. Tyner Creek, Adair County, Oklahoma. [Photographs by Arthur L. Smith.]

ner and wider toward the tip; on the ventral side confined to the distal half. Legs slender, toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; toes of the fore feet, 1–4–2–3.

COLOR. I have not seen living animals, but in the specimens kindly sent me by the describers the pattern is essentially as follows: The general ground color above is dull yellow (cream in the original description), which is concentrated to form a middorsal band, and within

which brown pigment is aggregated in the form of irregular lines and blotches. The dark pigment is concentrated in a narrow band along the upper sides, extending from the back of the head onto the basal third of the tail. The lower sides have the dark pigment more diffuse and surrounding a series of rounded pigment-free spots extending between the legs and on the basal part of the tail. The legs are mottled and blotched above with yellow and brown. The dorsal surface of the tail lighter than adjacent trunk, and with a row of small light spots on either side of the middorsal line. Ventral surfaces dull white, without pigment except on chin and sides of throat in front of gular fold.

BREEDING. Nothing is known of the breeding habits or egg-laying. Some females taken in April 1939 had ovarian eggs 1.8 x 1.5 mm. in diameter (Moore and Hughes, *ibid.*, p. 697). Larvae resemble the adults in general form and color. Six specimens varied in length from 17.5 to 31 mm. in total length and averaged 23.5 mm. (*ibid.*, p. 698). A larva 27.5 mm. long has the dorsal light band sharply cut off from the darker sides at a line which extends from the side of the head onto the basal third of the tail. The dorsal tail fin arises above the vent, reaches its greatest width at mid-length, and tapers to a blunt point. The narrow ventral fin extends to the vent.

GENUS MANCULUS

DWARF FOUR-TOED SALAMANDER. *Manculus quadridigitatus* (Holbrook). Fig. 134. Map 52.

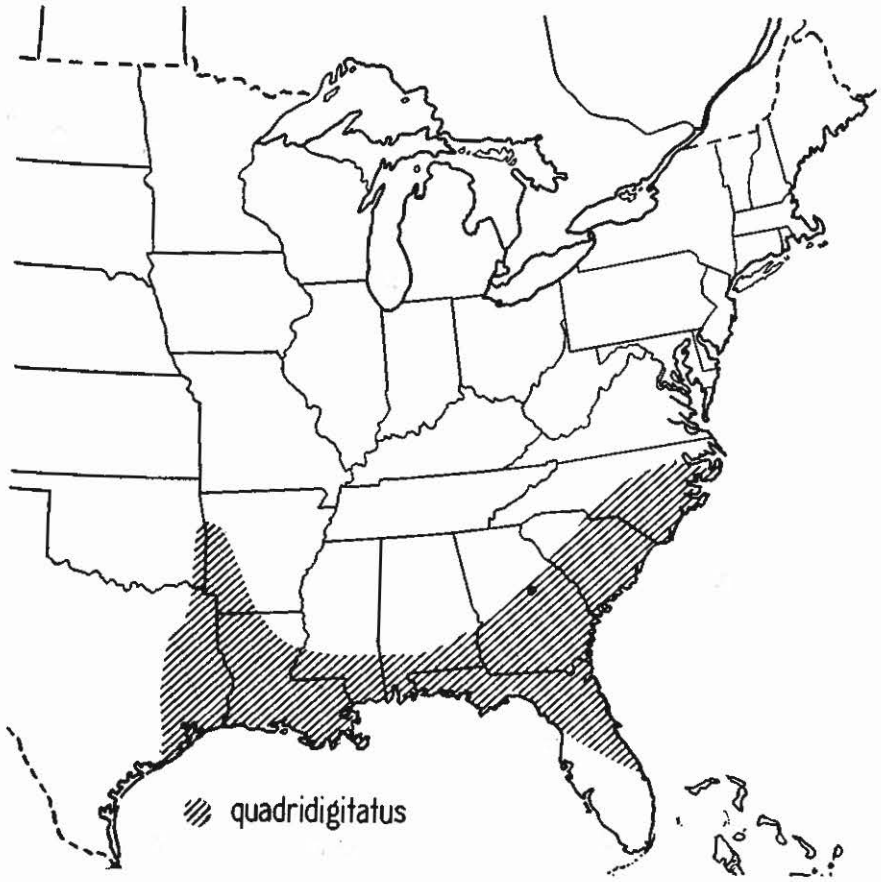
TYPE LOCALITY. Georgia, South Carolina, and Florida.

RANGE. North Carolina south to middle Florida, west through Gulf States to Texas east of the Trinity River, northward to Arkansas and Oklahoma.

HABITAT. I have found it most abundant in low, swampy places, beneath logs, bark, and other surface rubbish, in leaf-filled trickles from springs, and in the debris along the margins of pools in river swamps and marshes in the Coastal Plain. Mainly terrestrial in summer and

fall, but enters the water for the egg-laying season, usually in December.

SIZE. Attains an extreme length of 3 5/16″ (84 mm.), but this is exceptional. A series of 10 adult females from Raleigh, North Carolina, taken June 12, 1924, and sent me by Mr. C. S. Brimley, varied from 2 1/8″



MAP 52.—Distribution of *Manculus quadridigitatus*.

(53 mm.) to 3 5/16″ (84 mm.) and averaged 2 11/16″ (67.5 mm.). The males average a little shorter. The proportions of a male from near Spanish Creek, 3 miles west of Folkston, Georgia, are as follows: total length 3 1/16″ (74 mm.), tail 1 3/4″ (44 mm.); head length 5/16″ (7 mm.), width 3/16″ (4 mm.).

DESCRIPTION. The Dwarf salamander is a small, slender, four-toed species which superficially resembles the Two-lined salamander, *Eurycea b. bislineata*. The head is long and slender, widest at a point about midway between the eyes and the lateral extensions of the gular fold; the sides in front of the eye converging rather abruptly to the very short and bluntly rounded snout. The snout of the male is more strongly truncated than that of the female, slightly swollen in the region of the nasolabial grooves, and the upper lip at the lower end of the grooves is produced into short cirri. Commissure of mouth slanting upward toward and extending back to posterior angle of the eye. The eyes are large and strongly protuberant, the pupil horizontally elliptic, the iris golden flecked with black. There is an impressed line extending from the posterior angle of the eye to the lateral extension of the gular fold, but no well defined vertical groove extending from this back of the jaw. The trunk is slender, well rounded above and on the sides, slightly flattened below. In some specimens there is a slightly impressed median dorsal line which splits at the back of the head and sends a branch to each eye. There are usually 16 costal grooves, counting 1 each in the axilla and groin, but occasionally the number is 15, and about 5 intercostal spaces between the toes of the appressed limbs. Legs small, toes 4–4, those of the hind feet 1–4–2–3 or 1–2–4–3 in order of length from the shortest, the 1st rudimentary, the 2nd and 4th about equal; toes of the fore feet 1–4–2–3, both inner and outer short. The tail is long and slender, subquadrate in section at the base, and becoming compressed and oval in section distally and slightly keeled above. The tongue is of moderate size, nearly circular in outline, and with a central pedicel. Vomerine teeth in short series of 4–8, the series beginning behind the inner margin of the inner naris and extending inward and backward to the center line, where they are scarcely separated. Parasphenoid teeth in narrowly separated elongate patches and widely separated from the vomerine.

COLOR. (Light form.) Marked above with a broad, bronzy band, with irregular edges, extending from the tip of the snout to the end of the

tail. Near the base of the tail the band is usually brighter and with tinges of gold. Many individuals have a median dorsal line of small, irregular, dark brown spots; in others the spots may be lacking or may

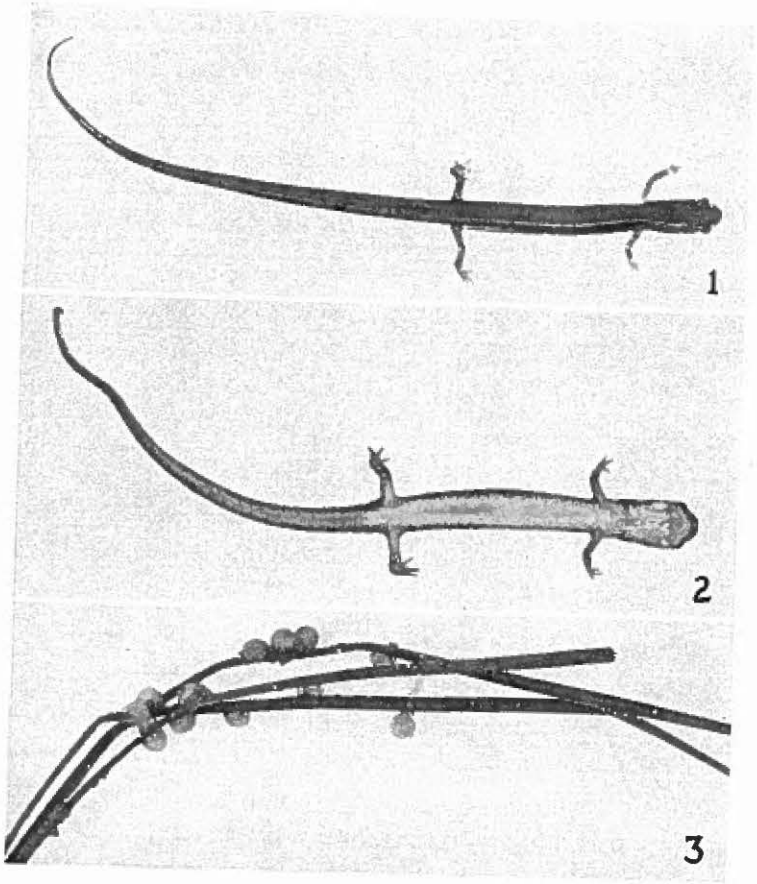


FIG. 134. *Manculus quadridigitatus* (Holbrook). (1) Adult female, actual length 2¾″ (70 mm.). Florida. (2) Adult male, actual length 2½″ (63 mm.). Amite, Louisiana. (3) Eggs, slightly enlarged. Raleigh, North Carolina, Jan. 30.

appear only at the base of the tail or back of the head. The dorsal band is limited on either side by a narrow brown stripe which originates on the side of the snout and continues along the trunk onto the basal half of the tail. The upper sides below the dark stripe are of lighter brown,

gradually fading on the lower sides to permit the golden-yellow ground color to strike through. The venter is bright yellow except on the distal third of the tail, which is dusky yellow, and on the throat and lower sides of the legs and feet, which are flesh color.

(Dark form.) Many individuals exhibit a much darker pigmentation and somewhat different pattern. In these the sides are very dark brown, with narrow longitudinal or oblique lines of yellow or white. The light lateral lines are best developed at the level of the legs, and often with additional imperfect lines above and below. The ventral surfaces are quite uniformly pigmented, with small dark brown flecks and a few scattered light spots.

BREEDING. The egg-laying season at Raleigh, North Carolina, extends from late December to early February (Brimley, 1923, p. 81). When the eggs are laid in leafy trickles, they are usually attached, singly or in small clusters of 3–6, to the leaves and debris. In a pond at Gainesville, Florida, Carr (1940, p. 48) found three sets Jan. 15, 1935, each containing about 20 eggs attached to the lower surface of a log in shallow water. A female collected Jan. 12, 1924, and sent me by Mr. C. S. Brimley, deposited 48 eggs on the night of Jan. 30. The container was provided with damp leaves and the eggs were attached to the lower surfaces in small groups of 5–8. The eggs are creamy white, without pigment, and are provided with 2 envelopes. The egg itself is about 2 mm. in diameter and, with the outer envelopes, about 3 mm. They are attached by a short and thin tubular extension of the outer envelope, which, at the point of attachment, flares out to form a flange.

LARVAE. At Raleigh larvae are found mainly in March, and transform 2 or 3 months later. Dunn records a transformed individual only 32 mm. long, but the larvae frequently attain a much larger size before transformation.

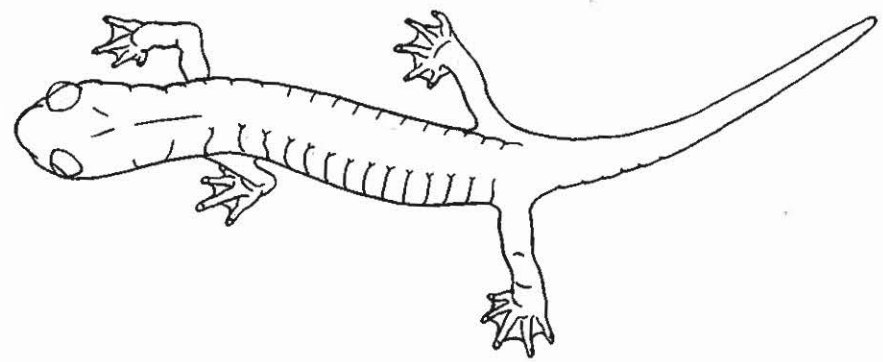


FIG. 135. Outline of *Hydromantes platycephalus* to show the form of the body and the character of the legs and feet. [H.P.C. *del.*]

GENUS HYDROMANTES

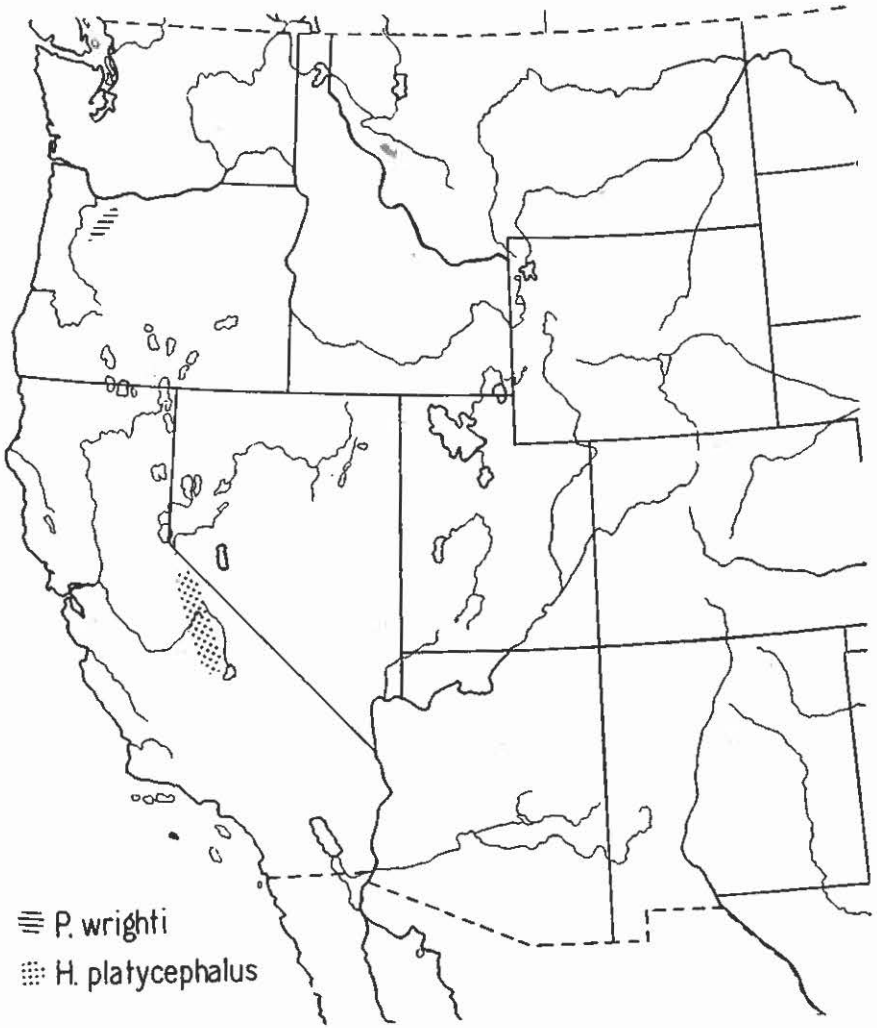
MOUNT LYELL SALAMANDER. *Hydromantes platycephalus* (Camp). Figs. 135–136. Map 53.

TYPE LOCALITY. Head of Lyell Canyon, Yosemite National Park, California.

RANGE. The high Sierras from Alpine County south to northern Tulare County, California.

HABITAT. This is an Alpine species, known only from high elevations in the Sierras, where it has been found beneath stones and rock slabs and, infrequently, crawling in the open. The first specimens discovered were taken at an elevation of 10,800′ at the head of Lyell Canyon, Yosemite National Park. The 2 specimens then found were caught in a mousetrap set in a patch of heather in front of a small hole running into moist soil beneath some rocks. A fine series of 13 specimens was taken August 1, 1940, by Miss Catherine Hemphill and Miss Orlie Anderson, at Triple Divide Peak, Alpine County, California, at an elevation of 10,700′. The specimens, all collected in the course of about one hour, were found in slightly damp situations under rocks in a meadow about 15–20 yards below a snowslide, but neither in nor very near trickling streams of melting snow water. Two specimens exposed

by the turning of a rock were occupying a small burrow some 10″ in length and ½″–⅝″ in diameter.



MAP 53.—Distribution of *Plethopsis wrighti* and *Hydromantes platycephalus*.

SIZE. The 29 individuals I have measured varied in length from 1 11/32″ (34 mm.) to 4⅛″ (104 mm.). The proportions of an adult male are: total length 3 11/16″ (94 mm.), tail 1 11/32″ (34 mm.); head length 9/16″

(14.5 mm.), width 7/16″ (11 mm.). An adult female has the following measurements: total length 4⅛″ (104 mm.); tail 1 15/32″ (37 mm.); head length 9/16″ (14.5 mm.), width 7/16″ (11 mm.).

DESCRIPTION. This salamander has a deep brown or blackish ground color, thickly overlaid with many irregular, light gray, lichen-like patches. The head and trunk are strongly depressed, perhaps an adaptation to the mode of life in crevices or beneath flakes of rock. The broad head is widest just back of the eyes, the sides tapering to the bluntly rounded snout, and behind gently to the lateral extensions of the gular fold. The snout in side view is obliquely truncate. The eyes are large and protuberant, the iris flecked with tan and brassy. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold, and from this a vertical groove on the side of the head behind the angle of the jaw which is continued across the throat to connect with its fellow of the opposite side. The dorsally flattened trunk has the sides rounded and the belly flat. There are 13 costal grooves, counting 1 each in the axilla and groin and 1–2 intercostal spaces between the toes of the appressed limbs. The tail is flattened above at the base, broadly oval in section distally in the adults, and slightly compressed in the young. Legs short and stout; toes 5–4, those of the hind feet 1–5–2–3–4 in order of length from the shortest, the 2nd, 3rd, and 4th nearly equal in length and all strongly webbed; soles of feet very broad; tips of toes swollen ventrally; toes of the fore feet 1–2–4–3, webbed at base. The tongue is small, oval in outline, thin at the margins, and with a central area finely papillose. It is freely protrusible, the pedicel rather broadly attached at the anterior third. Vomerine teeth 8–13 in each series. In an adult male, there are 12 and 13 teeth respectively in the vomerine series, which arise behind and outside the inner nares and curve inward and backward toward the mid-line, where they are separated by about the diameter of an inner naris, and from the parasphenoid patches by about 3 times the diameter. The parasphenoid teeth in 2 elongate club-shaped patches narrowly separated anteriorly, divergent posteriorly. In the female the maxillary teeth are small, short,

and mainly limited to the anterior part of the jaw; in the adult male these teeth are fewer in number, slender, longer, and directed obliquely backward and continued to the angle of the jaw.

COLOR. The general ground color is deep brown to black, marked above and on the sides with many light spots and speckings, which in

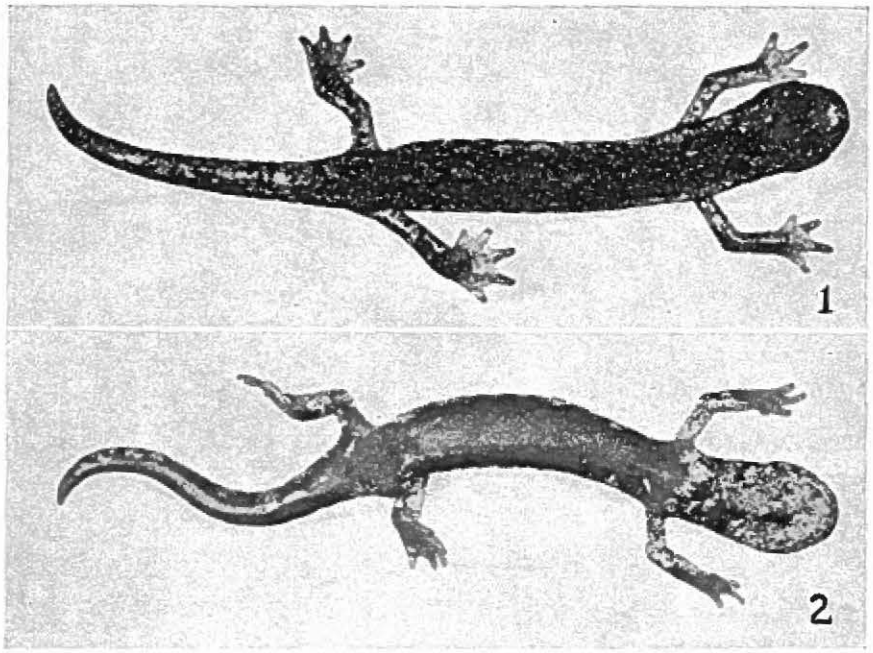


FIG. 136. *Hydromantes platycephalus* (Camp). (1) Adult male, actual length 3¼" (82 mm.). (2) Same, ventral view. Sonora Pass, California, elevation 9000'. [Laura Henry, collector.]

some individuals run together to form lichen-like blotches of considerable extent. The light markings vary from light buff or gray, tinged with greenish yellow in the smaller individuals, to clay color in the adults. In the large specimens the light markings are so extensive that much of the ground color is obscured. In most small specimens the light markings are brighter on the dorsal surface of the tail than elsewhere, and extend on the sides to below the level of the legs. Legs and toes strongly mottled and blotched. The lower surface of the head is

blotched and a few light spots encroach on the belly. The belly is light slate, the lower surface of the feet and tail a little lighter, dilute chocolate. In some individuals the light markings are more or less concentrated in a band along each side of the back.

BREEDING. Nothing is known of the breeding habits of this species. Females taken August 1 had well developed ovarian eggs which showed as elongate light patches on either side of the belly.

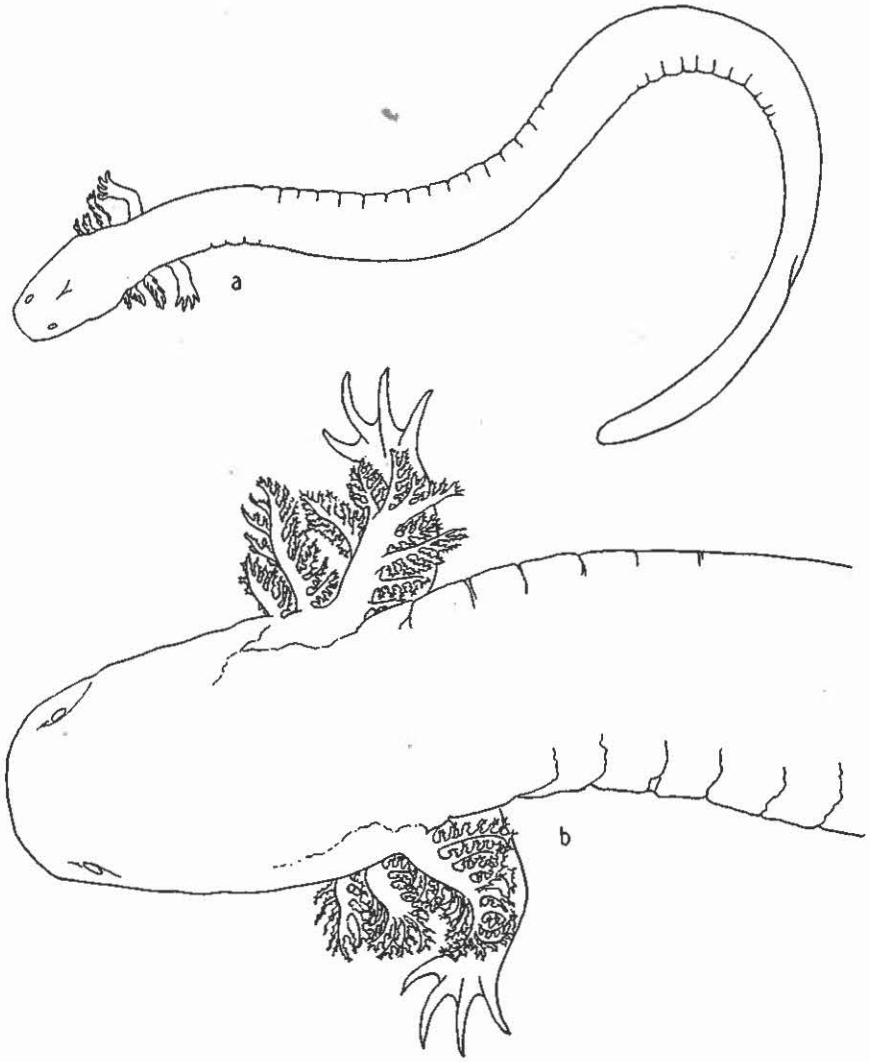


FIG. 137. (a) Outline of *Siren intermedia nettingi* to show the form of the body, the gills, and the anterior limbs. (b) Head and fore part of trunk of *Siren lacertina* to show the character of gills and legs. [H.P.C. *del.*]

Family SIRENIDAE

Aquatic; body elongate, eel-like; size small, 8¼″ (210 mm.) in *Pseudobranchus,* to large, 36″ (915 mm.) in *Siren;* anterior legs, only, present; 3 pairs of gills; eyelids, maxillae, and cloacal glands absent; margins of jaws with horny sheaths; dentition larval; fertilization probably external. Two genera in the family.

KEY TO THE GENERA OF SIRENIDAE

With 4 toes; 3 pairs of gill slits; body without longitudinal light lines or stripes; size to 36″ (915 mm.). Southeastern Atlantic states, northward in the Mississippi Valley to Illinois and Indiana ..... SIREN p. 457

With 3 toes; a single pair of gill slits; body with longitudinal light lines or stripes; size to 8¼″ (210 mm.). Vicinity of Charleston, South Carolina, southward to Dade County, Florida ..... PSEUDOBRANCHUS p. 468

GENUS SIREN

KEY TO THE SPECIES AND SUBSPECIES OF SIREN

1. Size large, to 36″ (915 mm.); costal grooves 36–39, the usual number 37; color in life light gray, the sides lighter than the back; venter bluish, with many small, dull yellow flecks (in preservatives, slate color above, dull gray below). District of Columbia south to southern Florida, west into Leon County, Florida ..... *lacertina* p. 464

   Size small, from 15 9/16″ (396 mm.) to 26″ (660 mm.) in southeasern Texas; costal grooves 31–36, rarely to 38 2

2. With 31–34 costal grooves, the usual number 33; venter usually without light spots; length to about 13⅝″ (347 mm.). Virginia to Pasco County, Florida, west to the Florida Parishes of Louisiana .... *intermedia intermedia* p. 458

   With 34–36 costal grooves, the usual number 35 (rarely to 37 or 38

in southern Texas and northern Tamaulipas); length to 15 9/16″ (396 mm.); sides and venter often with small light spots. Southern Louisiana northward to southern Illinois and Indiana, west and south to Maverick County, Texas, and northern Tamaulipas, Mexico .... *intermedia nettingi* p. 461

EASTERN DWARF SIREN. *Siren intermedia intermedia* Le Conte. Fig. 138. Map 54.

TYPE LOCALITY. Restricted type locality, Riceborough, Liberty County, Georgia (Harper, 1935, p. 279).

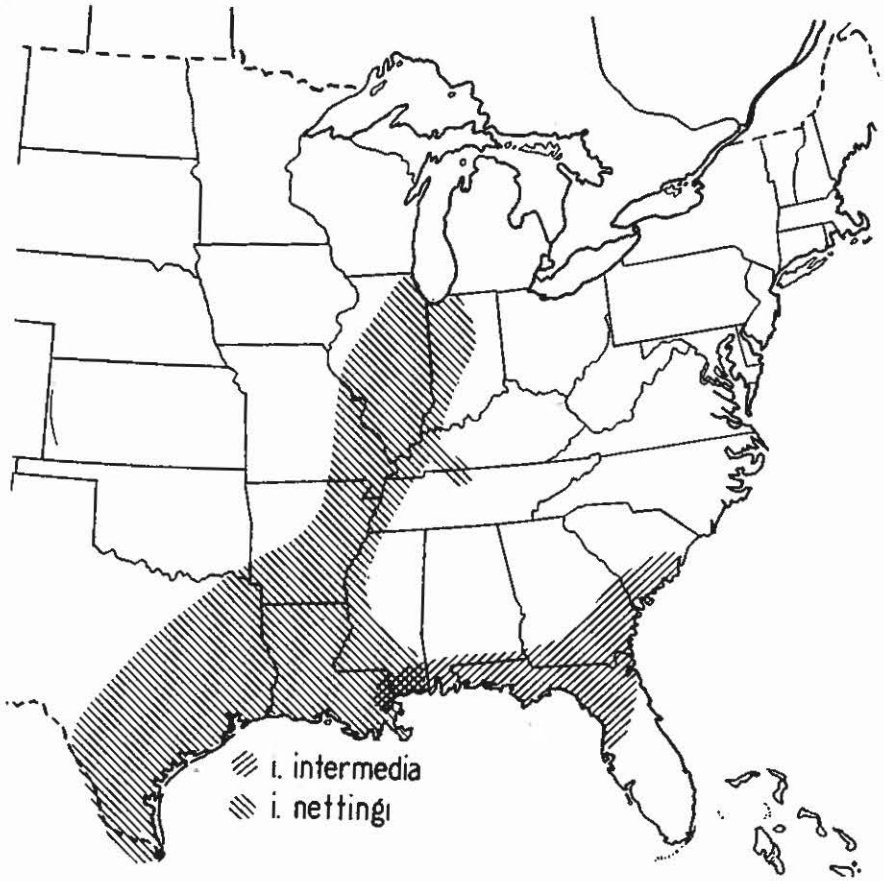
RANGE. From Georgetown County, South Carolina, south to Pasco County, Florida, westward to the Florida Parishes of Louisiana. Also reported from Guiney Station, Virginia.

HABITAT. Common in cypress and pinewoods ponds and ditches, where they hide by day beneath bottom vegetation and stranded logs and bark.

SIZE. The average of 12 adults of both sexes from South Carolina, Georgia, and Florida is 8 5/8″ (219 mm.), the extremes 5 9/32″ (135 mm.) and 13 5/8″ (347 mm.). The proportions of an adult male from Gainesville, Florida, are: total length 9 1/16″ (230 mm.), tail 3 1/16″ (78 mm.); head length 1 1/32″ (26 mm.), width 17/32″ (13 mm.). An adult female from the same locality measures: total length 7 1/2″ (190 mm.), tail 2 9/32″ (58 mm.); head length 26/32″ (21 mm.), width 15/32″ (12 mm.).

DESCRIPTION. The body is long, slender, and eel-like. In life it is slightly flattened below and above and provided with a weak middorsal impressed line and a more strongly impressed midventral line. The head is long, widest at a point 1/3 the distance from the base of the anterior gills to the end of the snout, the sides behind this point converging very slightly to the gills and in front gently to the broadly rounded snout. The eyes are small and without lids, the interorbital distance about 3 times in the length of the head from the end of the snout to the base of the first gills. Mouth small, crescentic, subterminal, and slightly overhung by the upper jaw. Nostrils small and slit-like and placed at the ventrolateral angles of the snout. Gills variable, with rachises and fila-

ments short and knobby to comparatively long and brushy. Costal grooves 31–34, the usual number 33. The tail is broadly oval in section at the base, becoming more strongly compressed progressively toward



MAP 54.—Distribution of the subspecies of *Siren intermedia*. (*S. i. intermedia* also reported from Guiney Station, Virginia.)

the tip. The dorsal tail fin arises as a low ridge above the vent, but immediately thins and continues to the tip. The ventral fin is narrow and confined to the distal 1/2 or 1/3, continuing to the vent as a low ridge. The fore legs, only, present. Toes 4, in order of length from the shortest 4–3–1–2 or 4–1–3–2, the tips sharp-pointed, horny, often black beneath.

Tongue moderate, bluntly rounded, and free anteriorly. Palatine teeth in a broad V-shaped series slightly separated in front, the apex directed

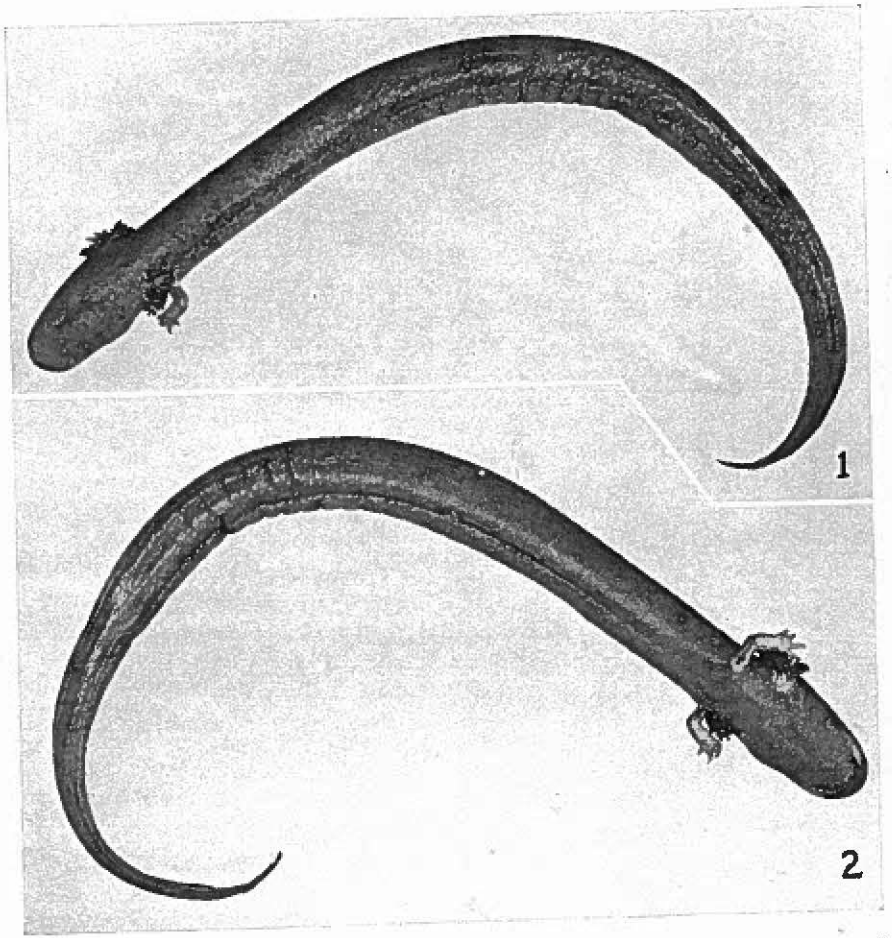


FIG. 138. *Siren intermedia intermedia* Le Conte. (1) Adult male, actual length 9″ (228 mm.). (2) Same, ventrolateral view. Dedge Pond, two miles east of Chesser's Island, Okefinokee Swamp, Georgia. [Photographs of a preserved specimen.]

forward, each lateral group in 2 patches slightly separated, the posterior patch small. A short, thin, black, horny sheath covering the premaxillary, a longer, sharp-edged sheath covering the tip of lower jaw; behind

this sheath, mandibular teeth in 2 short patches forming divergent series.

COLOR. The color in life of several specimens taken in Dedge Pond near Chesser's Island, Okefinokee Swamp, Georgia, is as follows: above, varying from deep brown to olive-green. Scattered irregularly over the back and sides of the head, trunk, and tail are many small, rounded black spots, decreasing in size on the lower sides and fading out toward the tip of the tail in some specimens. The ventral surface is dull slate color, slightly lighter than the back. Lower surface of the legs and snout lighter. The ventral surfaces lack the light spots frequently well developed in *nettingi*. Some juvenile specimens are olive-green with minute brown spots.

In a series of preserved specimens taken in the vicinity of Gainesville, Florida, and sent me by Mr. Coleman J. Goin, the general color above and on the sides is uniformly bluish-black, the ventral surfaces slightly lighter.

The typical subspecies differs from *nettingi* in its smaller size, in having fewer costal grooves, and usually in its generally darker color.

BREEDING. Nothing has been reported concerning the breeding habits of this race, and the eggs and larvae have not been described.

TEXAS DWARF SIREN. *Siren intermedia nettingi* Goin. Figs. 137a, 139. Map 54.

TYPE LOCALITY. Imboden, Lawrence County, Arkansas.

RANGE. Southern Louisiana northward to southern Illinois and Indiana, west and south to Maverick County, Texas, and northern Tamaulipas, Mexico (Goin, 1942, p. 217).

HABITAT. Found in mucky and muddy ditches, sloughs, and flatlands ponds.

SIZE. Attains a maximum length of 15 9/16″ (396 mm.). The average length of 10 adults of both sexes from Mississippi and Arkansas is 9 1/8″ (232 mm.). The proportions of an adult female from Imboden,

Arkansas, are as follows: total length 8 7/32″ (209 mm.), tail 2 7/32″ (57 mm.); head length 27/32″ (22 mm.), width 13/32″ (11 mm.). An adult male from the same locality measures: total length 7 3/32″ (180 mm.), tail 2 3/16″ (56 mm.); head length 23/32″ (19 mm.), width 3/8″ (10 mm.).

DESCRIPTION. Body slender, slightly compressed; a lightly impressed middorsal line and a stronger midventral line. Head elongate, widest immediately in front of the gills, from this point gently rounding to the angle of the jaws, then tapering to the bluntly rounded snout. Eyes small, without lids, the interorbital distance 2½–2¾ in the length of the head from tip of snout to base of first gills. Mouth small, crescentic, partly overhung by tip of snout. Nostrils small, slit-like, ventral in position at the lateral angles of the snout. Gill slits normally 3. Gills variable, perhaps depending on environmental conditions; they may be short and stubby or fairly long and with bushy filaments. Costal grooves 33–37, the usual number 35. Tail broadly oval in section at base, becoming compressed distally. The dorsal tail fin arises above the vent and continues to the tip; ventral tail fin scarcely developed in juveniles, in adults narrow and mainly confined to distal ⅔, sometimes reduced to a low ridge. Fore feet only present. Toes 4–4, in order of length from the shortest usually 4–1–3–2, occasionally 4–3–1–2 or 4–1–2–3; toes flattened, wide at base, tapering to the black-pointed horny tips. Tongue small, pointed in front, the anterior third free. Premaxillary with a short, flat, black, horny sheath; a long, narrow, curved, black sheath at tip of lower jaw in front of mandibular teeth, which are in 2 short, strongly divergent patches. Palatine teeth in strongly divergent patches narrowly separated at the mid-line in front, each lateral patch consisting of 2 groups of teeth, the posterior smaller.

COLOR. In some living specimens from the type locality, the color in life is uniform deep seal-brown. Scattered irregularly over the dorsal surface of head and trunk, and to a lesser extent on the tail, are many small, round, black spots. The ground color of the ventral surface is dull slate color, with here and there a scattering of small light markings

most abundant on the throat and on the area between and immediately behind the legs. The lower surface of the legs is lighter than the belly, and there is a light area on the side of the neck between the gills and the legs. Gills pale bluish. On some individuals, the lateral-line sense

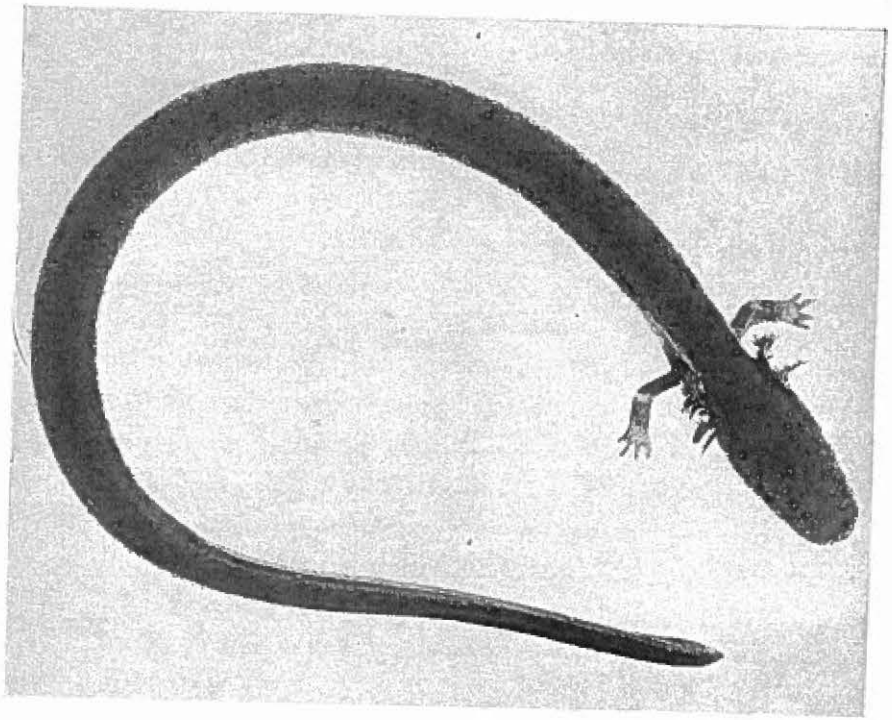


FIG. 139. *Siren intermedia nettingi* Goin. Adult female, actual length 8¼″ (210 mm.). Imboden, Arkansas (type locality).

organs are well developed as short white dashes in 2 well separated longitudinal lines extending along the sides from the gills to the base of the tail. Preserved specimens may be light olive to dark gray above and lighter below.

BREEDING. Eggs far advanced in development were found April 8 and April 10, 1931, in the vicinity of Imboden, Arkansas, and reported by Noble and Marshall (1932, p. 9). Eggs to the number of 555 were found in one lot disposed in a mass in a hollow in the mud at the

bottom of a shallow pond. The individual egg averages about 3 mm. in diameter and is provided with 3 envelopes, the innermost thin, about 4 mm. in diameter, the middle one 4.2 mm., and the outer 4.4 mm. and slightly opaque.

LARVAE. Larvae soon after hatching are about 13 mm. in length, the tail comprising only 2.5 mm., or 19.2 per cent. The gills are well developed, the 3rd about as long as the head. A well developed dorsal fin extends from the back of the head to the tip of the tail, and a ventral fin from the tip to the vent. The legs are represented by short buds. The larvae are marked as follows: A dark bar through the eye to the base of the 3rd gills; a bar on the snout between the eyes widens on the dorsum of the head and sends a narrow branch to join the bar from the eye. On the trunk a dark stripe on either side of the dorsal keel extends to the tip of the tail; below this a narrow light line from the base of the 3rd gills to a point above the vent; below the light line, a dark stripe from the side of the head to the base of the tail, below which the sides are usually yellow, with small, scattered, round, brown spots. In larger larvae the dorsal fin is restricted to the tail, and the light markings are lost except on the snout, a narrow transverse bar on the dorsum of the head, a bar from the angle of the mouth to the base of the third gills, and a broken line of small dashes on the side from the gills to the base of the tail. The size at which sexual maturity is attained has not been determined.

GREAT SIREN. *Siren lacertina* Linné. Figs. 137b, 140. Map 55.

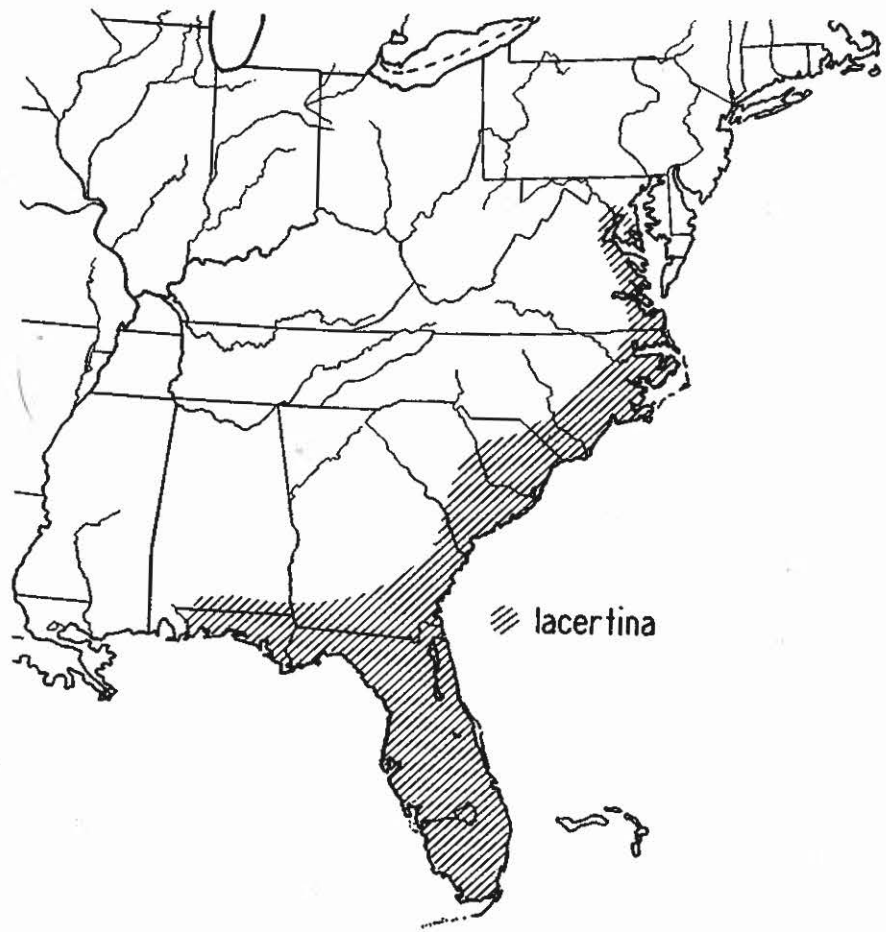
TYPE LOCALITY. "Habitat in Carolinae paludosis."

RANGE. District of Columbia south to southern Florida, westward to Leon County, Florida, and lower Alabama, all in the Coastal Plain.

HABITAT. We have collected this species in shallow roadside ditches, from beneath rocks in the bed of a swift-running stream, from weedy ponds and pools and muddy swamps. It is particularly abundant in Lake Miccosukee, Florida. The lake is weed-choked and mud-bottomed, its outlet crossed by a low dam, perhaps 18″ high, which offered little

obstruction to large Siren which were observed to surmount it with ease.

SIZE. Attains an extreme length of about 36″ (915 mm.). A fine adult



Map 55.—Distribution of *Siren lacertina*.

31⅜″ (798 mm.) from the outlet of Lake Miccosukee, Florida, is proportioned as follows: total length 31⅜″ (798 mm.), tail 9 7/16″ (240 mm.); head length (snout to posterior margin of third gills) 2 13/16″ (72 mm.), width 1¾″ (45 mm.); girth 6 15/16″ (170 mm.).

DESCRIPTION. The body is stout, considerably deeper than wide, and

with a slightly impressed median dorsal line. The head is widest a short distance in front of the gills, the sides in front of this point somewhat convex and converging to the broadly rounded snout. Eyes small, with-

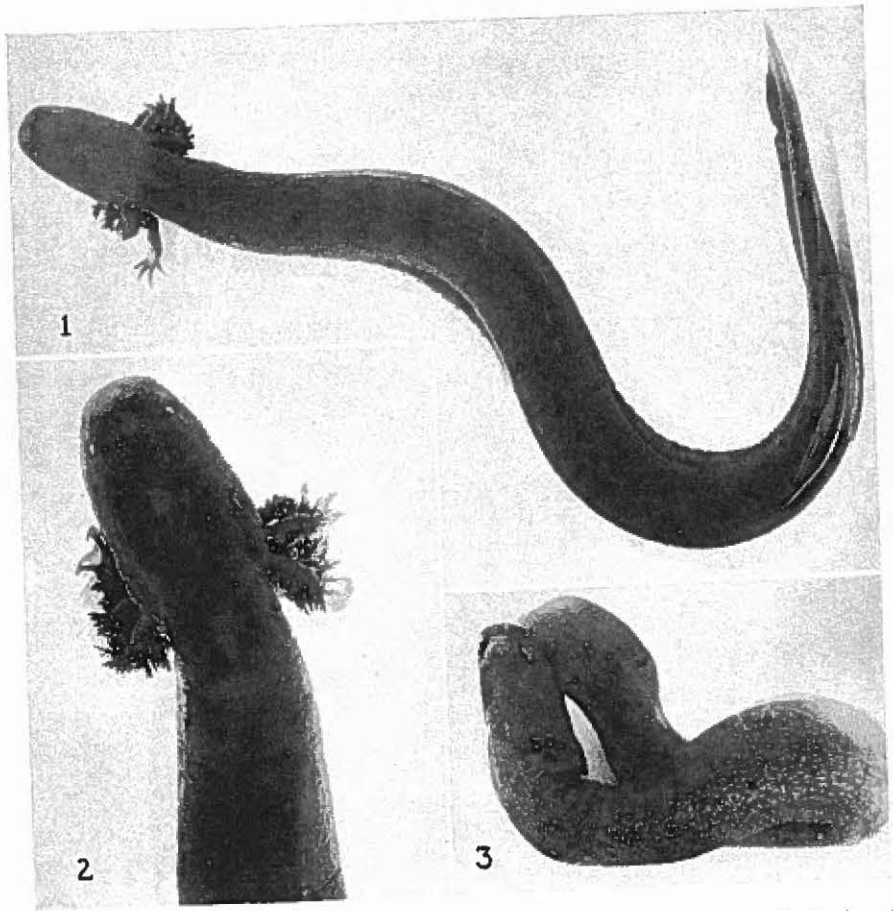


FIG. 140. *Siren lacertina* Linné. (1) Adult, actual length 31⅜″ (915 mm.). Outlet of Lake Miscosukee, Florida. (2) Same, head somewhat enlarged. (3) Adult, actual length 19″ (482 mm.). Near St. Augustine, Florida.

out lids, the interorbital distance about twice in the distance from the nostril to the base of the anterior gills. Mouth small, crescentic, subterminal. Nostrils small, round or oval in outline, and overhung by the

anteriolateral angles of the snout. Gills in adults with compressed rami which are often branched or provided with a secondary series bearing slender filaments. Gills frequently reduced and sometimes nonfunctional. Gill slits, 3. The muscular trunk is rather strongly compressed, slightly flattened below. Costal grooves 36–39, the usual number 37. The tail is broadly oval in section at base, becoming strongly compressed beyond. The dorsal tail fin may arise above the vent or a short distance before it. The ventral tail fin narrower, and extends ½–⅔ the distance from the tail tip to the vent. Fore legs only developed. Toes 4, variable, usually 4–1–3–2 in order of length from the shortest, sometimes 4–3–1–2. Toe tips blunt, horny. Tongue large, filling the floor of the mouth, and free anteriorly and slightly at the sides. Palatine teeth in 2 contiguous patches on either side, the anterior patch longer and wider than the posterior, the teeth in oblique rows extending from the outer to the inner side of the patch. The 2 groups of teeth form a V-shaped patch with the apex directed forward. A short, black, horny sheath over the premaxillary, and a longer, sharp-edged sheath covering the dentary.

COLOR. The adult in life is light gray, the sides lighter than the back, and with inconspicuous yellow dashes and blotches. The venter has the ground color bluish, marked with many small, dirty, yellow chromatophores. The gills have a decided greenish cast; toes yellowish, tipped with black. The snout is mottled with yellow and light brown. In preservative, the general color becomes slate above and dull gray below. Young usually darker than the adults.

BREEDING. Nothing is known of the breeding habits of Siren in nature, and the very young have not been described. Eggs of *Siren lacertina* deposited by specimens in captivity have been reported by Noble and Richards (1932, p. 15, Fig. 5B). As in *Pseudobranchus striatus,* the egg is surrounded by 3 definite envelopes, the innermost filled with thin fluid. The upper ⅓ or ⅖ of the egg is heavily pigmented with brown. The average diameter of the fixed egg is 4 mm., of the inner envelope

5.3 mm., of the middle envelope 6.2 mm., and of the outermost 9 mm. (Noble and Marshall, 1932, p. 12). The captive specimens deposited the eggs singly or in small clusters.

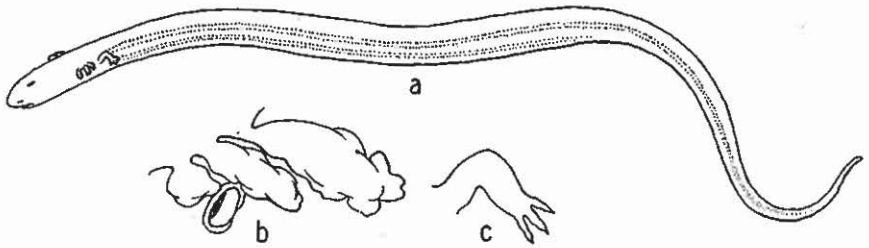


FIG. 141. (a) Outline of *Pseudobranchus striatus axanthus* to show the eel-like body, the anterior limbs, and the gills. (b) Gills and spiracle enlarged. (c) Fore leg enlarged. [H.P.C. *del.*]

GENUS PSEUDOBRANCHUS

KEY TO THE SUBSPECIES OF PSEUDOBRANCHUS STRIATUS

Ground color brownish; lateral light stripes broad, yellowish; head stripes distinct; venter with some yellow markings; length at least to 5 27/32" (150 mm.), probably larger. Atlantic Coastal Plain from near Charleston, South Carolina, south to the Okefinokee Swamp, Georgia .... *striatus striatus* p. 468

Ground color grayish; lateral light stripes narrow and often incomplete; head stripes indistinct; venter uniformly gray without yellow spots; length to 8¼" (210 mm.). Peninsular Florida from region of intergradation with typical *striatus* in the Okefinokee Swamp, Georgia, south to Dade County ..... *striatus axanthus* p. 471

BROAD-STRIPED MUD-SIREN. *Pseudobranchus striatus striatus* (Le Conte). Fig. 142. Map 56.

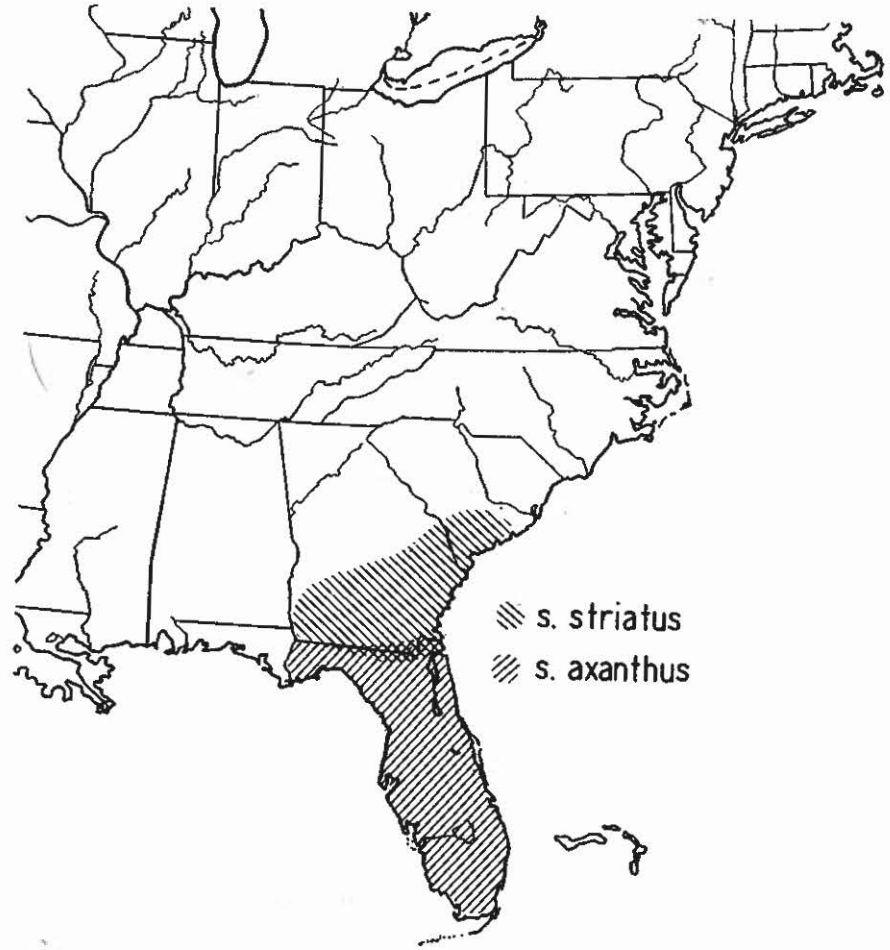
TYPE LOCALITY. Riceborough, Liberty County, Georgia.

RANGE. Vicinity of Charleston, South Carolina, southward in the Coastal Plain to the Okefinokee Swamp, Georgia, where it intergrades with *P. s. axanthus*.

HABITAT. Common in cypress ponds, hiding among plants or burrowing in the mud or muck of the bottom.

SIZE. Apparently a smaller race than *P. striatus axanthus,* the few

specimens I have measured varying in total length from 5¼" (134 mm.) to 5 27/32" (150 mm.). The proportions of an adult female from Georgia



MAP 56.—Distribution of the subspecies of *Pseudobranchus striatus.*

are as follows: total length 5 27/32" (150 mm.), tail 2 7/16" (62 mm.); head length 1 7/32" (13 mm.), width 7/32" (6 mm.).

DESCRIPTION. The head is widest immediately in front of the gills, the sides in front of this point gently converging to the eyes, then rather abruptly to the pointed snout. Head in side view wedge-shaped, the

upper slope the greater. Eyes small, without lids, the interorbital distance 2¼–2¾ in the length of the head from the nostril to the base of the first gills. Nostrils small, slit-like, located in a ventrolateral position near the tip of the snout. Mouth subterminal, small, crescentic. Gills usually shorter and stubbier than in *P. s. axanthus,* sometimes com-

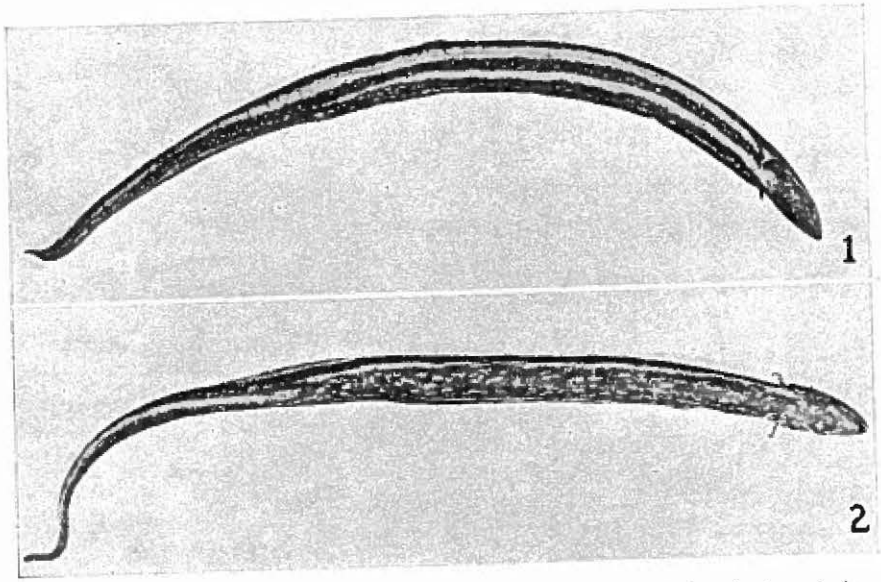


FIG. 142. *Pseudobranchus striatus striatus* (Le Conte). (1) Adult female, lateral view; actual length 5 27/32″ (150 mm.). (2) Same, ventrolateral view. Georgia. [Photographs of a preserved specimen. U.S.N. Mus. No. 5051 a.]

pletely covered by the skin, through which the rachises and filaments may be faintly seen. Usually a single open gill slit behind the first gill, but when gills are covered the slit not open to the outside. The trunk is rather short and stout, thicker in proportion to its length than in *axanthus.* There are usually 34 costal grooves, but the number may vary from 33 to 36. The tail is nearly circular in cross section at the base, becoming compressed and sharp-edged above and below at about the distal half. Fore legs only developed. Toes 3, usually 3–1–2 in order of length from the shortest; slender, pointed, often with sharp, brown or blackish, horny tips. Tongue small, pointed, free at the tip and sides.

Palatine teeth small, comparatively slender, in 2 slightly divergent single or double lines. Horny sheath at tip of upper jaw scarcely developed in the specimens examined, that of lower jaw narrow, and brownish rather than black as in *axanthus.*

COLOR. The general ground color is brownish in preserved specimens. Of the two lateral light stripes, the upper is broad, yellow or buff in color, and extends from the gills along the trunk and basal half of the tail without much decrease in width. On the distal half of the tail it tapers to the tip. Lower light stripe narrower and extending only from the legs to the vent. Sides between the lateral light stripes brown or grayish-green, with many small, light yellow or buff flecks. Venter lighter than back, the ground color grayish-green, with many small, irregular, light yellow flecks somewhat concentrated at the sides and imparting a mottled appearance. Mid-line of tail beneath, sometimes with a narrow, light line. Head sometimes with a light stripe through the eye to the base of the gills. In some specimens there is a narrow light vertebral line.

BREEDING. Nothing has been recorded of the mating habits. Eggs apparently of this subspecies were described by Noble (1930, p. 52). A female collected at Lakeland, Georgia, Feb. 23, 1930, and confined in a crystalizing dish with two apparent males and a clump of water hyacinth, deposited a total of 11 eggs over a period of several weeks. The eggs were deposited singly or in pairs and attached to the sides of the dish or to the hyacinth roots. The individual egg had a diameter of 3 mm. and was surrounded by envelopes as follows: in addition to the vitelline membrane, which had a diameter of 3.8 mm., there were two envelopes, the inner with a diameter of 4.5 mm., the outer 5.5 mm.

NARROW-STRIPED MUD-SIREN. *Pseudobranchus striatus axanthus* Netting and Goin. Figs. 141, 143–144. Map 56.

TYPE LOCALITY. Payne's Prairie, 5 miles southeast of Gainesville, Alachua County, Florida.

RANGE. Peninsular Florida from the area of intergradation with typi-

cal *striatus* in the Okefinokee Swamp region, Georgia, southward to Dade County.

HABITAT. Inhabits swamps, bogs, and marshes, where it is found in submerged vegetation. Often most abundant in water-hyacinth beds, in shallow water, where it may be collected by the effective expedient of rolling up masses of the plants upon a sloping shore and catching the animals as they wriggle down toward the water.

SIZE. Attains a maximum length of approximately 8¼″ (210 mm.).

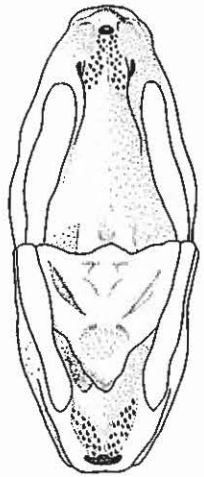


FIG. 143. Open mouth of *Pseudobranchus striatus axanthus* to show the character of the tongue, teeth, and horny sheaths at the tip of the jaws. [M.L.S. *del.*]

The average length of 8 sexually mature individuals of both sexes is 6¼″ (159 mm.) with extremes of 7 13/16″ (198 mm.) and 5″ (127 mm.). The proportions of an adult female from near Gainesville, Florida, are: total length 6 27/32″ (173 mm.), tail 2 25/32″ (71 mm.); head length 13/32″ (11 mm.), width ¼″ (6 mm.).

DESCRIPTION. The head is narrow, widest at a point about midway between the eyes and the anterior gills, the sides behind this point parallel and in front tapering rapidly to the bluntly pointed snout. Viewed from the side the head is wedge-shaped, the upper slope more pronounced than the lower. Eyes small, without lids, iris reddish-brown; the inter-

orbital distance 3–3⅔ in the head from nostril to base of the first gills. Nostrils small and slit-like and placed at the ventrolateral angles of the

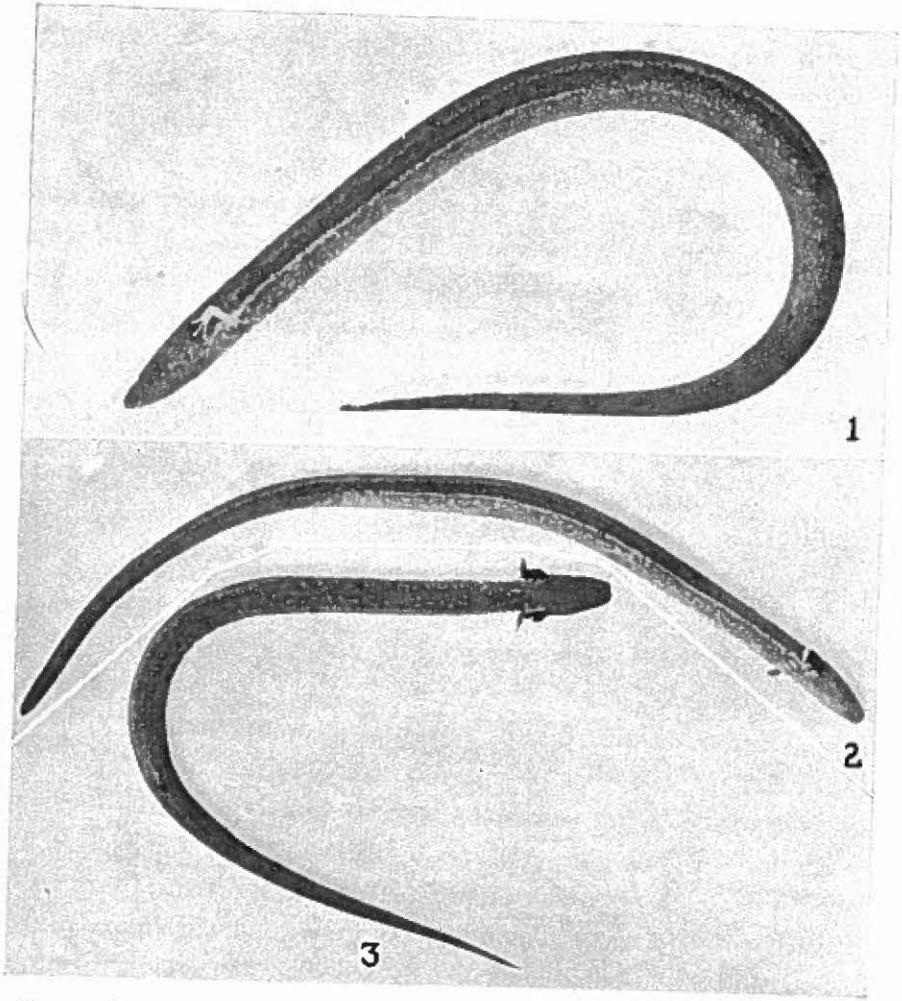


FIG. 144. *Pseudobranchus striatus axanthus* Netting and Goin. (1) Adult female, actual length 6 3/16″ (157 mm.). (2) Same, ventrolateral view. (3) Same, ventral view. Brooksville, Florida.

snout. Mouth small, crescentic, and subterminal. Gills short and stubby or moderately long and plumose, with the lateral branches basally long, apically short, and with short double fringes; gills well pigmented

above. A single open gill slit. The trunk is subcylindrical in section, flattened below. There are usually 35 grooves between the axilla and the vent, but they are not strongly developed and the number may vary in either direction by 1 or 2 grooves. The tail is broadly oval in section at base, becoming more strongly compressed distally. The tail fins are narrow, the dorsal in adults arising about at the end of the proximal third and continuing to the tip, the ventral mainly confined to the distal third and sometimes continued as a low ridge toward the vent. Fore legs only developed, slender and weak. Toes 3, usually 3–1–2 in order of length from the shortest, tips black, pointed, and horny. Tongue small, pointed, and free anteriorly and at the sides. Palatine teeth in 2 scarcely divergent V-shaped patches of 2 or 3 rows. Premaxillary with a short, black, horny sheath; a longer, narrow, black, sharp-edged sheath covering the dentary.

COLOR. The general ground color above varies from light greenish-gray to dark gray or slate. In the adults there is a poorly defined, dark-margined, light vertebral line extending from between the eyes to the end of the tail and on each side of the trunk, and 2 narrow, dark-bordered, dull yellow or buff stripes, the upper often broken, extending from the base of the 3rd gills well onto the sides of the tail, and the lower, usually narrower and frequently broken, originating at the base of the legs and extending only to the vent. The back and the sides between the lateral light stripes are dark, irregularly mottled with light greenish-gray. Belly pale slate-gray, often with a few small pigment-free spots, the throat usually somewhat darker, the ventral surface of the tail orange-yellow or with a fleshy tinge, and the tail fin above conspicuously lighter than adjoining parts, yellowish. On some individuals there is an incomplete line of light dots on either side of the vertebral line.

BREEDING. Nothing is known of the mating habits. Noble and Richards (1932, p. 14) induced egg-laying by pituitary transplants. The eggs were deposited singly or in small groups and adhered to one another and to vegetation by the adhesiveness of the outer envelopes. Eggs average

about 2.55 mm. in diameter and are provided with three envelopes in addition to the vitelline membrane, the inner having a diameter of 3 mm., the middle of 4.2 mm., and the outer of 5.6 mm. The upper ⅓ or ⅔ of the egg is heavily pigmented with brown. In Florida Carr (1940, p. 52) has found the eggs attached singly to the filamentous leaves of *Cabomba* and *Ceratophyllum* throughout the spring months. The recently hatched larvae have not been described.

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[*Please Note.*—The numbers all refer to pages. The boldface numbers refer to the Accounts of Species. Within each specific account, in a regular order, will be found the common name and the scientific name, reference to the appropriate figure and map, and the details of type locality, range, habitat, size, description, color, breeding habits, etc.]