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A KEY TO SALAMANDER LARVAE AND LARVIFORM ADULTS OF THE UNITED STATES AND CANADA

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ABSTRACT: A key is presented for the identification of free-living aquatic salamander larvae and larviform adults of the United States and Canada that are old enough to have the hind legs and toes fully differentiated.

Key words: Salamander larvae; Identification; Key; United States

SIXTY-SIX of about 109 species of salamanders in the United States and Canada have free-living aquatic larvae during development. Twenty-three species typically have larviform adults. This key allows the identification of larvae and larviform adults in which the hind legs and toes are fully differentiated, except sirenids (see Conant, 1975).

Younger specimens must be raised or identified by other means (e.g., Brandon, 1961, 1964). Some facultative neotenes are included, and the larvae of *Ambystoma laterale*, *A. tremblayi* and *A. platineum* are grouped under *A. jeffersonianum*. The systematics of *Necturus* on the Gulf Coast needs clarification, and we adopted Mount's (1975) opinion that only two species should be recognized in this area. Larvae of *Eurycea bislineata* and *E. junaluska* could not be distinguished accurately. In the area of sympatry, *E. junaluska* grows to 45 mm SVL (snout–vent length), compared with ca. 25 mm SVL for *E. bislineata*. Undescribed species may be adding confusion to the identification of this group (D. Sever, personal communication). Desmognathine larvae are the most difficult to identify because of large geographic variations, poor or no available characterizations, and small interspecific differences. The bibliography

by Altig and Lohoefener (1980) contains many references pertinent to salamander larvae.

KEY

1. Hind limbs or limb buds absent; fingers usually with keratinized tips; body eel-like, 1–76 cm TL (total length); larvae black with transparent fins and red or yellow head markings; post-larvae without transparent fins and variously patterned with dark ground color; sirenid 2
   Hind limbs and toes completely differentiated; not marked as above 4
2. Three fingers present ..... *Pseudobranchus striatus*
   Four fingers present 3
3. Thirty-one to 34 costal grooves (axilla–vent); head markings on larvae red in life; widespread in southeastern United States and north in Mississippi Embayment ..... *Siren intermedia*
   Thirty-six to 39 costal grooves; head markings in larvae yellow in life; Coastal Plain from Mobile Bay east through peninsular Florida and north to southern Maryland ..... *Siren lacertina*
4. Body elongate and cylindrical; 1–3 toes; legs appear disproportionately small for body; uniformly dark dorsally; one gill slit open; if gills present, thin, non-pigmented and transparent; amphiumid 5
   Body not elongate and cylindrical; 4–5 toes; legs appear normal in proportion to body; variously pigmented; 1–4 gill slits open; if gills present, as above or heavier and pigmented 6
5. One toe present; to 33 cm TL ..... *Amphiuma pholeter*
   Two toes present; to 116 cm TL ..... *Amphiuma means*
   Three toes present; to 106 cm TL ..... *Amphiuma tridactylum*
6. Body depressed and skin appears loose; lateral skin folds present, limbs with folds posteriorly; toes (5) flattened and fleshy; if gills present, unpigmented and transparent; one gill slit open; to 74 cm TL ..... *Cryptobranchus alleganiensis*
   Not as above 7
7. Collected east of the Continental Divide 8
   Collected west of the Continental Divide 12
8. Five toes on hind foot 9
   Four toes on hind foot 21
9. Grooves that delimit the labial folds on the lower jaw do not extend anteriorly to the mandibular symphysis; gills with rami and with fimbriae throughout length; 3–4 gill slits open unless partially metamorphosed; tips of toes and soles of feet not keratinized; hemidactyliine plethodontid, ambystomatid or salamandrid 10
   Grooves that delimit the labial folds on lower jaw extend to and bisect the fold adjacent to the mandibular symphysis; gills without rami, short and branched from base, often appear silvery in life; four gill slits; toes and soles of feet often keratinized; desmognathine plethodontid 61
10. Dorsal fin extends onto body unless partially metamorphosed; lungs present; ambystomatid or salamandrid; rarely collected in lotic water 11
    Dorsal fin terminates on tail or at tail–body junction; lungs absent; hemidactyliine plethodontid; most often collected in lotic water 28
11. Four gill slits open unless partially metamorphosed; keratinized dental sheath absent; head somewhat pointed in dorsal view and not large; body slender; skin of large specimen may be granular; salamandrid 50
    Three gill slits open unless partially metamorphosed; keratinized dental sheath usually present; broadly-rounded head appears large on chunky body; skin always smooth; ambystomatid 52
12. Costal grooves distinct or not; three gill slits open; skin smooth; dorsal fin terminates on body (lentic water species) or near tail–body junction (lotic water species); keratinized dental sheath usually present; head rounded in dorsal view; to 30 cm TL, typically shorter; ambystomatid 13
    Costal grooves absent to indistinct; four gill slits open; skin granular in large specimens; dorsal fin terminates on body; keratinized dental sheath absent; head angular in dorsal view; to ca. 6 cm TL; salamandrid 18
13. Dorsal fin terminates on body; gills typ-

ically large and bushy, rami long; keratinized dental sheath present; costal grooves distinct 14

Dorsal fin terminates on tail to slightly anterior to pelvis; gills typically small, or if bushy, rami are short; keratinized dental sheath present or not; costal grooves distinct or not 16

14. More than 15 gill rakers on third arch; glandular ridge on tail and paratoid glands absent; toes flattened and pointed; Rocky Mountains northwestward to central Washington plus west-central California ..... *Ambystoma tigrinum* (part)

Fewer than 15 gill rakers on third arch; in large specimens, glandular ridge on tail and paratoid glands present or not; toes rounded; Pacific Northwest 15

15. Nine to 13 gill rakers on third arch; melanic patches on dorsum and fins absent; no paratoid gland or glandular ridge on tail; gular fold distinctly indented medially; to 8.0 cm TL; 12 costal grooves typical; Pacific Northwest, northern Rocky Mountains and west-central Washington .. .. *Ambystoma macrodactylum*

Seven to 10 gill rakers on third arch; relatively large melanic patches on dorsum and fins; gular fold moderately indented medially; large specimens with paratoid glands and glandular ridge on tail; 11 costal grooves typical; to 20 cm TL; Pacific Northwest west of Cascade Mountains .. .. *Ambystoma gracile*

16. Head flattened in lateral view; gills relatively long, usually visible above neck in lateral view; snout long and eyes small (i.e., eye diameter 0.5 or less of snout length); large specimens with definite shelf below eye; keratinized dental sheath present; dorsal fin terminates near pelvis or on tail; costal grooves indistinct; nasal bones present; lungs well developed; to 30 cm TL 17

Head rounded in lateral view; gills short, not visible above neck in lateral view; snout short and eye large (i.e., eye diameter about equal to snout length); head broadly rounded in dorsal view; keratinized dental sheath absent; dorsal fin terminates on tail; costal grooves distinct; nasal bones absent; lungs reduced; to 6.5 cm TL ..... *Rhyacotriton olympicus*

17. Costal grooves between adpressed limbs 0–2; head width 0.18–0.21 times snout–vent length; conspicuous granular glands on dorsum; 28–42 vomerine teeth; venter dark; Washington west to the Cascade crest plus Multnomah County, Oregon .... *Dicamptodon copei*

Costal grooves between adpressed limbs 0.5 to overlapping by one; head width 0.20–0.23 times snout–vent length; conspicuous granular glands absent on dorsum; 46–59 vomerine teeth; venter light; southwestern British Columbia to central California west of the Cascade crest plus west-central and northern Idaho .... *Dicamptodon ensatus*

18. Dorsum and fins uniformly pigmented 19

Dorsum marked with small dark and light markings 20

19. Skin obviously granular; dark reddish-brown dorsally, orange below; fins absent or present only as indistinct ridge on tail; partial neotene; to ca. 15 cm TL ... *Taricha granulosa* (part)

Skin smooth; dorsum and fins uniformly dark; dorsal fin does not extend to shoulder; coastal streams of Sonoma and Mendocino counties, California ..... *Taricha rivularis*

20. Dorsum brownish, fins lightly pigmented without notable markings; venter light; dorsal fin may reach as far as shoulder; dorsolateral dark stripe present on body; Coast Range and Sierra Nevada Range of California ..... *Taricha torosa*

Dorsum brownish; fins lightly pigmented uniformly; venter with some pigment; dorsal fin not to shoulder; no dorsolateral dark stripe present on body, scattered black dots present; Santa Cruz County, California north to southern Alaska plus northern Idaho ..... *Taricha granulosa* (part)

21. Dorsal fin extends onto body; snout rounded; lungless; to ca. 35 mm TL; usually collected in lentic water ... 22

Dorsal fin terminates on tail or at tail–

body junction; lunged; snout angular; to ca. 330 mm TL; usually collected in lotic water 23

22. Thirteen to 14 costal grooves; eye line present .... *Hemidactylium scutatum*
Fourteen to 17 costal grooves; eye line absent ..... *Eurycea quadridigitata*

23. Body long and slender; uniformly gray dorsally; collected in central Atlantic Coastal Plain ..... *Necturus punctatus*
Body more or less chunky; spotted, striped or mottled dorsally 24

24. Dorsal surface marked with central dark area bordered laterally by white stripes .... *Necturus maculosus* (part)
Dorsum not marked as above 25

25. Lateral body surface dark with light markings; dorsum lighter with dark markings; dark eye line present ... . *Necturus lewisi* (part)
Lateral body not marked as above; dorsum spotted 26

26. Collected in Gulf Coastal Plain of Alabama, Mississippi (north as far as Pearl River drainage), Louisiana, and Texas ..... *Necturus beyeri*
Collected elsewhere 27

27. Collected east of the Appalachian Mountains in Neuse and Tar rivers of North Carolina .... *Necturus lewisi* (part)
Collected west and north of Appalachian Mountains south to north-central Louisiana .... *Necturus maculosus* (part)

28. Collected west of the Mississippi River 29
Collected east of the Mississippi River 39

29. Collected in south-central Texas along Balcones Escarpment and Edwards Plateau (Austin to San Antonio) ... 30
Collected in Ozarks and adjacent areas 36

30. Specimen albinistic or with reduced reticulate pigmentation pattern; collected in caves; eyes absent or reduced in size; limbs often attenuate 31
Specimen not albinistic; not collected in caves, or if so, not fitting other characters; eyes not reduced; limbs not notedly attenuate 34

31. Thirteen to 14 costal grooves; 0–4 (usually two) costal folds between adpressed limbs; ca. 24 premaxillary teeth; no definite elevation of cranium at level of eyes; interorbital distance/eye diameter 5–7; collected from Valdina Farms Sinkhole, Medina County, Texas .. *Eurycea troglodytes*
Costal grooves 11–12 or 14–15; conspicuous elevation of cranium at level of eyes; otherwise not as above 32

32. Fourteen or 15 costal grooves; eyes not covered by skin; 3–5 costal grooves between adpressed limbs; snout rounded in dorsal view; collected in Kendall County, Texas .... *Eurycea latitans* (part)
Eleven or 12 costal grooves; adpressed limbs meet or overlap; eyes conspicuously small and covered with skin; snout truncate in dorsal view 33

33. Adpressed limbs overlap up to six costal grooves; collected from Hays County, Texas ..... *Typhlomolge rathbuni*
Adpressed limbs touch or overlap by up to four costal grooves; collected from Honey Creek Cave near Spring Branch, Comal County, Texas .... *Typhlomolge tridentifera*
Adpressed limbs overlap by one costal groove; head and body notedly robust; collected from Hays County, Texas ..... *Typhlomolge robusta*

34. Fourteen to 15 (usually 15) costal grooves; 3–5 costal grooves between adpressed limbs; dorsum with reticulated pigmentation with pigmentless areas; abrupt cranial elevation from snout; more than 15 premaxillary teeth; collected from Kendall County, Texas .. *Eurycea latitans* (part)
Fifteen to 17 costal grooves; 5–7 costal folds between adpressed limbs; abrupt cranial elevation at level of eyes absent; dorsum not reticulated or with pigmentless areas 35

35. Sixteen to 17 costal grooves; 6–7 costal folds between adpressed limbs; dorsum uniformly light brown with a dorsolateral row of yellowish flecks; interorbital distance/eye diameter = 1.0–1.5; 2–5 pterygoid teeth; collected from the head of the San Marcos River, Hays County, Texas .... *Eurycea nana*
Fifteen to 17 (usually 16) costal grooves; 5–7 (usually 5) costal folds between

adpressed limbs; dorsum light yellow; interorbital distance/eye diameter = 1–3; more than six pterygoid teeth ..... *Eurycea neotenes*

36. Sixteen or more costal grooves 37
Fifteen or less costal grooves 46

37. Sixteen to 19 costal grooves; 4–6 costal folds between adpressed limbs; tail fin high; eyes small; in caves or cave-associated waters ..... *Typhlotriton spelaeus*
Nineteen to 20 costal grooves; seven or more costal grooves between adpressed limbs; tail fin low; eyes large; seldom in caves but do occur in cave-associated waters; collected from adjacent areas of Arkansas, Missouri and Oklahoma 38

38. Venter not gray or yellow in life; slender body form; head not wider than neck; dorsum reticulated under low magnification; upper surface of tail with brownish stripe ..... *Eurycea tynerensis*
Venter gray to yellow in life; dorsum stippled at low magnification; head slightly wider than neck; tail without dorsal stripe; large individuals with dorsal body stripe ..... *Eurycea multiplicata*

39. Collected from caves; lightly pigmented, silvery white to pinkish in life, with or without melanic dots, spots or blotches; eyes absent to small (Note: *Gyrinophilus porphyriticus* larvae are often light colored and comparative material may be needed for eye size evaluations; check range and habitat notations) 40
Rarely collected in caves and otherwise not as above 41

40. Silvery white with few scattered melanophores in life; eyes absent or very small; 12–13 costal grooves; less than 10 cm TL; gills bright red in life; caves and artesian wells in northern Florida and adjacent Georgia ..... *Haideotriton wallacei*
Uniformly light pinkish (light brown in preservative) or light pink with darker dorsal blotches and sometimes with a dark gular stripe; caves of southeastern Tennessee, northern Alabama and adjacent Georgia ..... *Gyrinophilus palleucus*
Collected in caves in Greenbrier County, West Virginia ..... *Gyrinophilus subterraneus*

41. Costal grooves 18–19; 6–9 costal folds between adpressed limbs; patterned much like adults (Conant, 1975); head depressed; lateral line pores large and obvious; collected in swampy areas of the Carolina Coastal Plain ..... *Stereochilus marginatus*
Not as above 42

42. Seventeen to 20 costal grooves; six or more costal folds between adpressed limbs; no indication of dorsal body stripe 43
Thirteen to 16 costal grooves; seven or less costal folds between adpressed limbs; dorsal body stripe usually visible 45

43. Dorsum uniformly brownish to grayish; large individuals may have small dorsal markings; supraotic lateral line pores arranged in an ellipse; 17–19 costal grooves; northeastern states southwestwardly through Appalachia to northwestern Mississippi ..... *Gyrinophilus porphyriticus*
Dorsum with vermiculations, spots, blotches; supraotic lateral line pores arranged in a circle; 16–17 costal grooves; eye stripe often present; found in most of eastern United States 44

44. Stout body form; dorsum distinctly mottled or streaked with dark pigment; usually without spots or flecks ..... *Pseudotriton ruber*
Slender body form; dorsum uniformly brown to red-brown with small dark spots, flecks and reticulations ..... *Pseudotriton montanus*

45. Dorsum with longitudinal series of light spots 47
Dorsum without longitudinal series of light spots 46

46. Dorsolateral dark stripe present, or lateral surface of body dark 47
Dorsolateral dark stripes absent, or lateral body surface not dark ..... *Eurycea bislineata* (part)

47. Lateral body surface uniformly dark; collected from springs in north-central Alabama ..... *Eurycea aquatica*
Not as above 48

48. Gular pigment extends medially immediately in front of first gill; ventral

surface of hind feet pigmented ... *Eurycea lucifuga*
Not as above ... 49
49. Dark vertical bars on side of tail or this area uniformly dark; usually 13 costal grooves ... *Eurycea longicauda*
Dark vertical bars absent on side of tail or this area not uniformly dark; usually 14 costal grooves ... *Eurycea bislineata* (part)
50. Collected in southern Texas, south of the San Antonio River; diffuse dark midventral stripe; small light spots forming lateral or ventrolateral rows; dorsum gray-brown ... *Notophthalmus meridionalis*
Not as above ... 51
51. Collected in southern Georgia or northern Florida; greatest diameter of eye equal to the distance from eye to nostril; greatest width of head at eyes and narrower behind; scattered dusky spots on tail ... *Notophthalmus perstriatus*
Widespread; greatest diameter of eye less than distance from eye to nostril; sides of head parallel; dark spots on tail ... *Notophthalmus viridescens*
52. Chin and/or throat heavily or lightly pigmented ... 53
Chin and/or throat immaculate ... 54
53. Costal grooves 10–11; chin and ventral surface lightly pigmented; longitudinal dark stripe on ventral surface; tail and body light with dark bands except in large neotenes ... *Ambystoma talpoideum*
Costal grooves 11–13; throat evenly pigmented; ventral surface with small scattered black dots; numerous light lateral spots; body and tail not banded when in stages covered by this key ... *Ambystoma opacum*
54. Dorsum black with conspicuous light stripes; yellow-gold ventrolateral stripe from snout to mid-tail; jaw with gold spots extending to dorsal part of limbs; collected from Coastal Plain or Piedmont of South Carolina, Georgia, Alabama and northern Florida west to southern Mississippi ... *Ambystoma cingulatum*
Not as above ... 55
55. Dorsum uniformly dark with numerous small light flecks; maxillary teeth in a single row; collected from Coastal Plain of North and South Carolina ... *Ambystoma mabeei*
Not as above ... 56
56. Costal grooves 15; dorsum mottled with numerous irregular, poorly defined cream-yellow blotches that are bilaterally paired; ventrolateral dark band of pigment from limbs to vent separated from dorsal pigment by an irregular light band; collected from the Ozark Region of Oklahoma, Missouri and Arkansas ... *Ambystoma annulatum*
Not as above ... 57
57. Squarish dark dorsal blotches separated by vertical light bars; light lateral stripe; 21–35 vomerine teeth never extending beyond choanae ... *Ambystoma texanum*
Not as above ... 58
58. Paired dorsal black spots or blotches present ... 59
Paired dorsal black spots or blotches absent ... 60
59. Paired dorsal black spots separated by a middorsal black line; midlateral row of separate or partially-fused light spots; head very large; body short and stubby ... *Ambystoma jeffersonianum*, *A. laterale*, *A. platineum*, and *A. tremblayi*
Distinct dorsal black spots in individuals less than 60 mm TL; ground color highly mottled to uniformly gray; costal grooves usually more pigmented than costal folds; lateral light band and row of lateral spots on most larvae less than 60 mm TL; toes flattened ... *Ambystoma tigrinum* (part)
60. Toes rounded ... *Ambystoma maculatum*
Toes flattened ... *Ambystoma tigrinum* (part)
61. Dark occipital spot; partially metamorphosed with small eyelids; partial dorsal fin; no gular fold; no labial folds; probably never enters free water; to 15 mm TL; gills short and unpigmented; collected from seepages in southern Appalachia to central Alabama ... *Desmognathus aeneus*
Not as above ... 62
62. Collected in Ouachita Mountains of west-central Arkansas and adjacent Oklahoma ... *Desmognathus brimleyorum*
Collected elsewhere ... 63

63. Toe tips black 64
Toe tips not black 65
64. Collected in Appalachia along Tennessee-South Carolina border and adjacent areas .. *Leurognathus marmoratus*
Collected in eastern Kentucky and adjacent Virginia plus Warren County, Kentucky ..... *Desmognathus welteri*
65. Large, total length 25 mm or more .. .. *Desmognathus quadramaculatus* (part)
Small, total length less than 25 mm .. 66
66. Dorsum uniformly pigmented, or at least without well defined circles or stripes ..... *Desmognathus quadramaculatus* (part)
Dorsum marked with one or a combination of the following: middorsal stripe, dorsolateral stripes, dorsolateral series of light circular spots ... 67
67. Venter of tail diffusely blotched; angle of mouth falls within vertical lines from anterior and posterior margins of eye; ventrolateral lateral-line pores partially or entirely outside pigment margin; dorsal spots usually distinct and without dark margins; rarely on Coastal Plain ..... *Desmognathus monticola*
Not as above 68
68. Dorsolateral series of circular spots faint to absent; dorsolateral black stripes absent; ventrolateral lateral-line pores prominent and light; dorsal coloration drab and dark; gills bushy, heavily pigmented and extend past front legs; primarily Coastal Plain .. .. *Desmognathus auriculatus*
Not as above 69
69. Dorsal pattern of prominent dorsolateral stripes enclosing a central stripe that lacks prominent circular spots; collected in northeastern Ohio, New York, Pennsylvania, eastern Kentucky, West Virginia or Virginia .. ... *Desmognathus ochrophaeus* (part)
Dorsal pattern with prominent light circular spots 70
70. Collected in the Great Smoky, Unicoi or Great Balsam mountains of western North Carolina and eastern Tennessee ..... *Desmognathus imitator* (Great Smoky Mountains only), *D. ochrophaeus* (part), or *D. santeetlah*
Collected elsewhere .... *Desmognathus fuscus* or *D. ochrophaeus* (part) (see range maps in Conant, 1975)

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