

## Catalogue of American Amphibians and Reptiles.

Boundy, J. 2000. *Batrachoseps attenuatus*.

***Batrachoseps attenuatus* (Eschscholtz)**  
California Slender Salamander

*Salamandrina attenuata*: Eschscholtz 1833:1. Type locality, "in der Umgebung der Bai St. Francisco auf Californien." Holotype, sex unknown, unlocated according to Frost (1985), collected by crew of the Russian ship *Predpriatië*, October or November 1824 (not examined by author).

*Batrachoseps attenuatus*: Bonaparte 1839:fasc. 26, fol. 131.

*Batrachoseps attenuata*: Baird and Girard 1852:302.

*Batrachoseps caudatus* Cope 1889:126. Type locality, "Hassler Harbor, Alaska," probably on Anette Island (per Stejneger and Barbour 1917, in error; see Comments). Holotype, USNM 13561, adult female, collected by H.E. Nichols, December 1881 (not examined by author).

*Batrachoseps attenuatus attenuatus*: Dunn 1926:224.

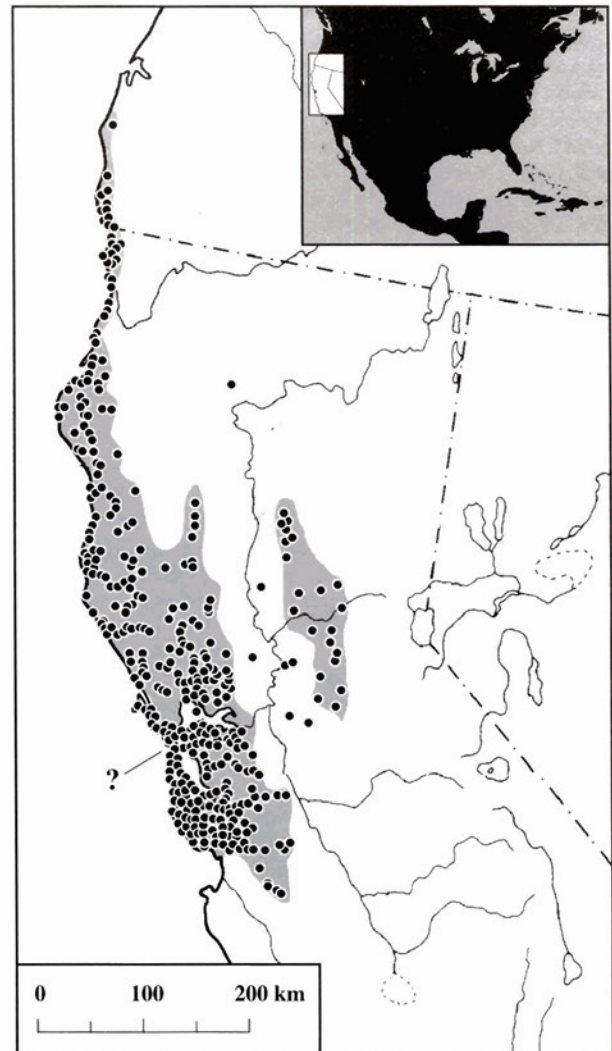
*Batrachoseps attenuatus caudatus*: Dunn 1926:232.

• **CONTENT.** No subspecies are recognized (see **Comments**).

• **DEFINITION.** *Batrachoseps attenuatus* is an elongate, lungless salamander, with diminutive legs and pes. The maximum TL is 172 mm, although 140 mm is rarely exceeded. Snout-vent length of adults is usually 37–47 mm, with a maximum of 65 mm. Tail length ranges from about 50–60% of TL. Head width ranges from about 9–13% of SVL. Toes are 4-4 and arranged from 1-4-2-3 in increasing order of length. Costal grooves usually number 19 or 20, but may be 18 or 21. The body and tail are subcylindrical and highly fusiform. The snout is very blunt and the eyes are protuberant, moderate in size for small bolitoglossine salamanders. The limbs are miniaturized, and separated by 10–12.5 costal grooves when adpressed. The costal grooves extend towards the vertebral line where they curve forward to produce a herringbone pattern. Caudal grooves nearly encircle the tail. The mouth contains two short patches of vomerine teeth arranged in 2–3 rows. Parasphenoid teeth are grouped in an oblong patch, which is slightly narrowed anteriorly, and may be separated by a narrow space at midline.

The dorsum usually is bicolor, with a middorsal gray, brown, tan, or red band separated or not from the lateral color by a dorsolateral black line. The middorsal band bears pale, thin outer margins within the dorsolateral line, and often contains dark spots or streaks, especially on the tail. The black dorsolateral line extends from around the snout and canthi, to the distal portion of the tail, and may be broken into a series of elongate markings. The sides and venter are dark gray, heavily stippled with white guanophores that decrease in density on midventer.

• **DIAGNOSIS.** *Batrachoseps* is one of three genera of non-perennibranch salamanders with four toes on each foot and oc-



**MAP.** Range of *Batrachoseps attenuatus*; the question mark (?) indicates the approximate site of the type locality; dots represent other localities from which specimens are known.

curing north of Mexico. It differs from *Hemidactylum* in lacking a constriction at the tail base, and in having 16 or more costal grooves. It differs from *Eurycea quadridigitata* in having a subcylindrical, rather than laterally compressed tail. Diagnosis of *B. attenuatus* is based on numerous fixed allelic differences from congeners. *Batrachoseps attenuatus* tends to have shorter limbs and narrower feet and head relative to other species in the genus, although quantified data remain unpublished.

• **DESCRIPTIONS.** Descriptions of external features were provided by Bishop (1943), Cope (1889), Dunn (1926), Emmel



**FIGURE.** Adult *Batrachoseps attenuatus* from the east slope of Hall's Valley, Diablo Range, Santa Clara County, California.

(1924), Eschscholtz (1833), Hendrickson (1954), Nussbaum et al. (1983), Petranka (1998), Slevin (1928), Stebbins (1951), and Storer (1925). Descriptions of internal features are in Cope (1889), Eschscholtz (1833), Hilton (1945b, 1947, 1948, 1953), Jockusch (1997b), Linke and Roth (1989), Linke and Rottluff (1986), Lombard and Wake (1977, 1986), Monath (1965), Noble (1921), Piatt (1935), Roth (1987), Roth et al. (1988, 1990, 1994, 1995), Roth and Schmidt (1993), Roth and Wake (1985), Sever et al. (1990), Thireau (1975a), Uzzell (1961), Wake (1966), Wake and Dresner (1967), Wake et al. (1988, 1983), Wever (1985), and Wiggers and Roth (1991).

• **ILLUSTRATIONS.** Illustrations are listed by type or subject: **color** (Behler and King 1979, Leonard et al. 1993, Petranka 1998, Stebbins 1959, 1972, 1985), **black-and-white** (Bishop 1943, holotype of *B. caudatus*; Cope 1889, holotype of *B. caudatus*; Eschscholtz 1833, holotype of *Salamandrina attenuata*; Hilton 1945a, Klingelhoffer 1956, Nussbaum et al. 1983, Petranka 1998, Pickwell 1947, Stebbins 1951, 1954b, 1985, Stebbins and Lowe 1949, Storer 1925, Szarski 1960), **brain and spinal cord** (Roth 1987, Roth et al. 1995, Roth, Rottluff et al. 1990, Thireau 1975a, Wake et al. 1988), **chromosomes** (Leon and Kezer 1978), **defensive behavior** (Arnold 1982), **eggs** (Stebbins 1951), **erythrocytes** (Eisen 1897, Villolobos et al. 1988), **eye** (Roth 1987), **feet** (Cope 1889, Hilton 1945a, Peabody 1959), **hatchling** (Roth, Rottluff et al. 1988), **head** (Cope 1889), **histology** (Elkan 1958, Hilton 1948, Linke and Roth 1989, Linke and Rottluff 1986, Sever 1994), **hyolingual apparatus** (Lombard and Wake 1977, Piatt 1935, Roth, Nishikawa et al. 1990, Roth and Wake 1985, Wake et al. 1983), **inner ear** (Wever 1985), **innervation** (Roth 1987, Roth, Nishikawa et al. 1988, 1990, Roth and Wake 1985, Wake et al. 1983), **oral cavity** (Cope 1889, Lombard and Wake 1977), **skeleton** (Eschscholtz 1833, Hilton 1945a,b, Wake 1966), **teeth** (Cope 1889), and **viscera** (Eschscholtz 1833).

• **DISTRIBUTION.** *Batrachoseps attenuatus* occurs in upland areas and intermontane valleys of northern California and southwestern Oregon. In Oregon it is confined to the outer coast of Curry County, and remains on the coastal slope of the Coast Ranges until the Russian River Valley, where it extends into the interior of Mendocino County, California. The species occurs throughout the Coast Ranges and valleys within from Lake County south to the northern margin of the Monterey Bay lowlands and the vicinity of Tres Pinos Creek in Santa Cruz and San Benito counties, where it is replaced by an undescribed species. In the inner Coast Ranges it occurs from the San Luis Reservoir watershed in Merced County, north to just north of Newville in Tehama County. Several isolated localities are within the Sacramento Valley at Sutter Buttes, Sutter County, and in riparian zones near the lower Sacramento River. In the Sierra Nevada foothills it occurs from near Paradise, Butte County, south to Fiddletown, Amador County. A single record is known from near Shasta Reservoir, Shasta County.

• **FOSSIL RECORD.** Late Miocene fossils of *Batrachoseps* sp. are reported from Contra Costa Co., California, where *B. attenuatus* is the only recent species (Clark 1985).

• **PERTINENT LITERATURE.** Literature is listed by topic: **abundance** (Anderson 1960, Burke 1911, Cope 1883, Hubbard 1903, Slevin 1928, Storer 1925, Welsh and Lind 1989), **activity** (Adams 1968, Banta and Morafka 1966, Basey 1976, Brame 1959, Brodie et al. 1974, Burke 1911, Burt and Burt 1929, Gordon 1939, Hendrickson 1954, Maiorana 1976b, 1977a, Myers 1930, Nussbaum et al. 1983, Pickwell 1947, Reaser 1997, Snyder 1923, Stebbins 1951, 1954a, 1959, 1985, Storer 1925), **anatomy**

(Cope 1889, Duellman and Trueb 1986, Elkan 1958, Emmel 1924, Eschscholtz 1833, Highton 1957, Hilton 1945b, 1947, 1948, 1953, Jockusch 1997b, Linke and Roth 1989, Linke and Rottluff 1986, Lombard and Wake 1977, 1986, Marlow et al. 1979, Monath 1965, Noble 1921, Piatt 1935, Roth 1987, Roth et al. 1994, 1995, Roth, Nishikawa et al. 1990, Roth, Naujoks-Manteuffel et al. 1990, Roth, Rottluff et al. 1988, 1990, Roth and Schmidt 1993, Roth and Wake 1985, Sever 1994, Sever et al. 1990, Slevin 1928, Snyder 1904, Stebbins 1951, Storer 1925, Thireau 1975a,b, Uzzell 1961, Wake 1966, Wake and Dresner 1967, Wake et al. 1988, 1983, Wever 1985, Wiggers and Roth 1991, Wiggers et al. 1995), **behavior** (Basey 1976, Brodie 1977, Brodie et al. 1974, Duellman and Trueb 1986, Hubbard 1903, Leonard et al. 1993, Maiorana 1977b, 1978a, Myers 1930, Nussbaum 1985, Nussbaum et al. 1983, Petranka 1998, Schonberger 1944, Stebbins 1951, Storer 1925), **biogeography** (Anderson 1960, Brame and Murray 1968, Cope 1896, Morafka and Banta 1972, Peabody and Savage 1958, Yanev 1980), **blood** (Cohen 1982, Eisen 1897, Emmel 1921, 1924, Villolobos et al. 1988), **captive care** (Klingelhoffer 1956), **checklists** (Borland 1857, Collins 1997, Cope 1875, Hallowell 1860, Jennings 1987, Yarrow 1882), **conservation** (Banta and Morafka 1966, Bury 1983, Jennings 1987, Petranka 1998), **cytology** (Campbell 1969, Seto et al. 1969), **development** (Burke 1911, Duellman and Trueb 1986, Jockusch 1997a,b, Noble 1931, Snyder 1923, Stebbins 1951, 1954b, Storer 1925, Wake and Hanken 1996), **distribution** (Basey 1976; Behler and King 1979, Bishop 1943, Bury 1983, Dunn 1926, Frost 1985, Gordon 1939, Grinnell and Camp 1917, Hendrickson 1954, Hilton 1945a, Jockusch 1997b, Leonard et al. 1993, Nussbaum et al. 1983, Peabody and Savage 1958, Petranka 1998, Pickwell 1947, Slevin 1928, Stebbins 1951, 1954b, 1959, 1972, 1985, Storer 1925, Wake et al. 1998, Yanev 1980), **eggs** (Burke 1911, Houck 1977, Maiorana 1976b, Maslin 1939, Myers 1930, Pickwell 1947, Snyder 1923), **food** (Adams 1968, Bury and Martin 1973, Jaeger 1981, Lynch 1985, Maiorana 1978a,b, Nussbaum et al. 1983, Petranka 1998, Schonberger 1944, Stebbins 1951, 1954a, 1959, Storer 1925), **genetics** (Alegria Coto and Leon 1991, Eisen 1897, Janssens and Dumez 1903, Jockusch 1997a, Larson 1984, 1991, Larson et al. 1984, Larson and Wilson 1988, Leon and Kezer 1978, Sessions and Kezer 1991, Seto et al. 1969, Wake 1981), **growth** (Hendrickson 1954, Nussbaum et al. 1983, Petranka 1998, Storer 1925, Wake and Castanet 1995), **habitat** (Anderson 1960, Banta and Morafka 1966, Basey 1976, Bishop 1943, Block et al. 1988, Brame 1959, Burt and Burt 1929, Bury 1983, Bury and Martin 1973, Gordon 1939, Grinnell and Camp 1917, Hall and Grinnell 1919, Hendrickson 1954, Hubbard 1903, Jennings 1982, Kessell 1954, Leonard et al. 1993, Maiorana 1976a,b, 1978a,b, Myers 1930, Nussbaum et al. 1983, Petranka 1998, Pickwell 1947, Reaser 1997, Schonberger 1944, Slevin 1928, Stebbins 1951, 1954a,b, 1959, 1985, Welsh and Lind 1989), **localities** (Adams 1968, Anderson 1958, 1960, Baird and Girard 1852, Banta and Morafka 1966, Bishop 1943, Block et al. 1989, Brame 1959, Brame and Murray 1968, Brodie et al. 1974, Burke 1911, Burt and Burt 1929, Bury 1983, Bury and Martin 1973, Campbell 1931, Cook 1949, Cope 1883, 1889, Dunn 1918, 1926, Fisher 1953, Fowler and Dunn 1917, Hendrickson 1954, Jennings 1982, Kessell 1954, Lynch 1985, Maiorana 1976b, 1977a, 1978a,b, Myers 1930, Reaser 1997, Slevin 1928, Snyder 1923, Stebbins 1951, Storer 1925, Tanner 1948, Wake and Castanet 1995, Wake et al. 1998), **morphology** (Anderson 1960, Bennett and Licht 1973, 1974, Bishop 1943, Boulenger 1882, Burke 1911, Cope 1869, 1889, Czopek 1961, Dunn 1926, Eschscholtz 1833, Feder 1976a, 1977, 1978b, Fisher 1953, Fowler and Dunn 1917, Gordon 1939, Hendrickson 1954, Hilton 1945a, Houck 1977, Jockusch 1997b, Leonard et al. 1993, Linke and Rottluff 1986, Lynch 1985, Maiorana 1976b, 1978b, Maslin 1939, Nussbaum



et al. 1983, Peabody 1959, Petranka 1998, Ray 1958, Slevin 1928, Stebbins 1951, 1954a,b, 1972, 1985, Stebbins and Lowe 1949, Storer 1925, Wake and Castanet 1995), **movements** (Anderson 1960, Hendrickson 1954, Stebbins 1954a), **nests** (Burke 1911, Maslin 1939, Myers 1930, Snyder 1923), **parasites** (Douglas 1958, Helfer 1948), **physiology** (Anderson 1958, 1960, Bennett and Licht 1973, 1974, Borgens et al. 1984, Christensen 1965, Cook 1949, Czopek 1961, Duellman and Trueb 1986, Evans and Brodie 1994, Feder 1976a,b, 1977, 1978a,b, 1983, Feder and Olsen 1978, Hillman et al. 1979, Jones and Hillman 1978, Licht and Lowcock 1991, Licht et al. 1975, Maiorana 1976b, 1977b, Mushinsky and Brodie 1975, Ray 1958, Roth 1987, Roth, Rottluff et al. 1988, Roth and Schmidt 1993, Schmidt et al. 1989), **populations** (Anderson 1960, Bury 1983, Duellman and Trueb 1986, Hendrickson 1954, Maiorana 1976a,b, 1977a, 1978b, Nussbaum et al. 1983, Petranka 1998, Stebbins 1954a, Storer 1925, Wake and Castanet 1995), **predation** (Anderson 1960, Fox 1952, Harvey 1962, Hubbard 1903, Petranka 1998, Reaser 1997, Stebbins 1954a, Storer 1925), **reproduction** (Anderson 1958, 1960, Burke 1911, Christensen 1965, Duellman and Trueb 1986, Gordon 1939, Houck 1977, Jockusch and Mahoney 1997, Maiorana 1976a,b, Maslin 1939, Myers 1930, Nussbaum 1985, Nussbaum et al. 1983, Petranka 1998, Snyder 1923, Stebbins 1951, 1959, 1985, Storer 1925, Wake and Castanet 1995), **systematics** (Brame and Murray 1968, Campbell 1931, Cochran 1961, Dunn 1926, Fitzinger 1843, Frost 1985, Hendrickson 1954, Hilton 1945a, Jockusch 1997b, Jockusch et al. 1998, Larson 1984, Petranka 1998, Sever et al. 1990, Slevin 1928, Stebbins and Lowe 1949, Storer 1925, Yanev 1980), **thermal ecology** (Brattstrom 1963, Brodie et al. 1977, Feder et al. 1982, Maiorana 1977a), and **variation** (Anderson 1960, Brame and Murray 1968, Dunn 1926, Fowler and Dunn 1917, Hendrickson 1954, Jockusch 1997b).

• **ETYMOLOGY.** The specific epithet is derived from the Latin *attenuare* (to make thin), certainly in reference to the elongate form of this species.

• **COMMENTS.** The existence of *Batrachoseps* in Alaska has remained unverified since the purported collection of the type series of *B. caudatus* there in 1881 (Wake et al. 1998). Stebbins and Lowe (1949) synonymized *Batrachoseps caudatus* with *B. attenuatus*. The name *Batrachoseps attenuatus* has been associated with populations throughout much of the Coast Ranges and Sierra Nevada of California, southwestern Oregon, and northern Baja California (Hendrickson 1954). The current concept of *B. attenuatus* (*sensu stricto*), limited to the northern one-third of this range, is derived from Yanev (1980) and Jockusch et al. (1998). This species is the sole member of the *Batrachoseps attenuatus* group of the subgenus *Batrachoseps*.

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#### LITERATURE CITED

NOTE: citations preceded by an asterisk discuss "*Batrachoseps attenuatus*," but may not refer to *Batrachoseps attenuatus, sensu stricto*.

Adams, D.R. 1968. Stomach contents of the salamander *Batrachoseps attenuatus* in California. *Herpetologica* 24:170–172.  
Alegria Coto, J. and P. Leon. 1991. Repetitive DNA sequences and the ecology of Neotropical plethodontid salamanders, p. 157–173. *In*

D.M. Green and S.K. Sessions (eds.), *Amphibian Cytology and Evolution*. Acad. Press, Inc., San Diego.  
Anderson, P.K. 1958. Induced [*sic*] oviposition in *Batrachoseps attenuatus*, and incubation of eggs. *Copeia* 1958:221–222.  
—. 1960. Ecology and evolution in island populations of salamanders in the San Francisco Bay region. *Ecol. Monogr.* 30:359–385.  
Arnold, S.J. 1982. A quantitative approach to antipredator performance: salamander defense against snake attack. *Copeia* 1982:247–253.  
Baird, S.F. and C. Girard. 1852 (1853). List of reptiles collected in California by Dr. John L. LeConte, with description of new species. *Proc. Acad. Nat. Sci. Philadelphia* 6:300–302.  
Banta, B.H. and D.J. Morafka. 1966. An annotated check list of the recent amphibians and reptiles inhabiting the city and county of San Francisco, California. *Wasmann J. Biol.* 24:223–238.  
\*Basey, H. 1976. *Discovering Sierra reptiles and amphibians*. Yosemite Nat. Hist. Assoc., California.  
Behler, J.A. and F.W. King. 1979. *The Audubon Society Field Guide to North American Reptiles and Amphibians*. A. Knopf, New York.  
Bennett, A.F. and P. Licht. 1973. Relative contributions of anaerobic and aerobic energy production during activity in Amphibia. *J. Comp. Physiol.* 87:351–360.  
— and —. 1974. Anaerobic metabolism during activity in amphibians. *Comp. Biochem. Physiol.* A 48:319–327.  
Bishop, S.C. 1943. *Handbook of Salamanders: The Salamanders of the United States, of Canada, and of Lower California*. Cornell Publ. Co., Inc., Ithaca, New York.  
Block, W.M., M.L. Morrison, J.C. Slaymaker, and G. Jongejan. 1988. Design considerations for the study of amphibians, reptiles, and small mammals in California's oak woodlands: temporal and spatial patterns, p. 247–253. *In* R. Szaro et al. (eds.), *Management of Amphibians, Reptiles, and Small Mammals in North America*. USDA For. Serv. Gen. Tech. Rept. RM-166. Fort Collins, Colorado.  
Bonaparte, C.L. 1839 [1832–1841]. *Iconographia della fauna Italica per le quattro classi degli animali vertebrati*. Fasc. 26. Salviucci, Roma.  
\*Borgens, R.B., M.E. McGinnis, J.W. Vanable, Jr., and E.S. Miles. 1984. Stump currents in regenerating salamanders and newts. *J. Exper. Zool.* 231:249–256.  
\*Borland, J.N. 1857. [List of reptiles collected in California by Mr. E. Samuels]. *Proc. Boston Soc. Nat. Hist.* 6:192–194.  
Boulenger, G.A. 1882. *Catalogue of the Batrachia Gradiata s. Caudata and Batrachia Apoda in the Collection of the British Museum*. 2nd ed. The Trustees, British Museum, London.  
Brame, A.H., Jr. 1959. Summer surface activity in certain California salamanders. *Bull. Philadelphia Herpetol. Soc.* 7:1–3.  
— and K.F. Murray. 1968. Three new Slender Salamanders (*Batrachoseps*) with a discussion of relationships and speciation within the genus. *Bull. Los Angeles Co. Mus. Nat. Hist.* (4):3 + 35 p. +1 pl.  
\*Brattstrom, B.H. 1963. A preliminary review of the thermal requirements of amphibians. *Ecology* 44:238–255.  
\*Brodie, E.D., Jr. 1977. Salamander antipredator postures. *Copeia* 1977: 523–535.  
—, J.A. Johnson, and C.K. Dodd, Jr. 1974. Immobility as a defensive behavior in salamanders. *Herpetologica* 30:79–85.  
Burke, C.V. 1911. Notes on *Batrachoseps attenuatus* Esch. *Amer. Nat.* 45:413–414.  
Burt, C.E. and M.D. Burt. 1929. Field notes and locality records on a collection of amphibians and reptiles chiefly from the western half of the United States. I. Amphibians. *J. Washington Acad. Sci.* 19:428–434.  
Bury, R.B. 1983. Differences in amphibian populations in logged and old growth redwood forest. *Northwest Sci.* 57:167–178.  
— and M. Martin. 1973. Comparative studies on the distribution of foods of plethodontid salamanders in the redwood region of northern California. *J. Herpetol.* 7:331–335.  
Campbell, B. 1931. Notes on *Batrachoseps*. *Copeia* 1931:131–134.  
\*Campbell, F.R. 1969. Electron microscope studies on granulocytopenias in the Slender Salamander. *Anat. Rec.* 163:427–441.  
\*Christensen, A.K. 1965. Testicular fine structure in the California Slender Salamander during the postnuptial regression of the testis (abstract). *Amer. Zool.* 5:678–679.  
Clark, J.M. 1985. Fossil plethodontid salamanders from the latest Miocene of California. *J. Herpetol.* 19:41–47.  
Cochran, D.M. 1961. Type specimens of reptiles and amphibians in the United States National Museum. *Bull. U.S. Natl. Mus.* (220):xv + 291 p.

- Cohen, W. 1982. The cytomorphic system of anucleate non-mammalian erythrocytes. *Protoplasma* 113:23–32.
- Collins, J.T. 1997. Standard common and current scientific names for North American amphibians and reptiles. 4th ed. SSAR Herpetol. Circ. (25):iii + 40 p.
- Cook, S.F. 1949. Respiratory metabolism of certain reptiles and amphibians. Univ. California Publ. Zool. 53:367–376.
- Cope, E.D. 1869. A review of the species of the Plethodontidae and Desmognathidae. Proc. Acad. Nat. Sci. Philadelphia 21:93–118.
- . 1875. Check-list of North American Batrachia and Reptilia; with a systematic list of the higher groups, and an essay on geographical distribution. Based on the Specimens contained in the U.S. National Museum. Bull. U.S. Natl. Mus. (1):1–104.
- . 1883. Notes on the geographical distribution of Batrachia and Reptilia in western North America. Proc. Acad. Nat. Sci. Philadelphia 35:10–35.
- . 1889. The Batrachia of North America. Bull. U.S. Natl. Mus. (34):3–525 + 81 pl.
- . 1896. The geographical distribution of Batrachia and Reptilia in North America. Amer. Nat. 30:886–902, 1003–1026.
- \*Czopek, J. 1961. Vascularization of respiratory surfaces in some Plethodontidae. Zool. Polon. 11:131–148 + 2 pl.
- Douglas, L. 1958. The taxonomy of nematode cestodes. J. Parasitol. 44:261–273.
- Duellman, W.E. and L. Trueb. 1986. Biology of Amphibians. McGraw-Hill Book Co., New York.
- Dunn, E. 1918. The collection of Amphibia Caudata of the Museum of Comparative Zoology. Bull. Mus. Comp. Zool. 62:445–471.
- . 1926. The salamanders of the family Plethodontidae. Smith Coll. Fiftieth Anniv. Publ., Northampton, Mass.
- Eisen, G. 1897. Plasmocytes; the survival of the centrosomes and archoplasm of the nucleated erythrocytes, as free and independent elements in the blood of *Batrachoseps attenuatus* Eschscholtz. Proc. California Acad. Sci. Series 3, 1:3–72.
- \*Elkan, E. 1958. Further contributions on the buccal and pharyngeal mucous membrane in urodeles. Proc. Zool. Soc. London 131:335–355.
- Emmel, V.E. 1921. Hematological and respiratory conditions in the larval stages of the lungless amphibians, *Batrachoseps attenuatus* and *Aneides lugubris*. Anat. Rec. 21:56.
- . 1924. Studies on non-nucleated elements of blood. II. The occurrence and genesis of non-nucleated erythrocytes in vertebrates other than mammals. Amer. J. Anat. 33:347–465.
- Eschscholtz, F. 1833. Zoologischer Atlas [Herpetological sections]. Part V.G. Rieme, Berlin. Facsimile Reprint, Ohio Herpetological Society, Athens.
- \*Evans, C.M. and E.D. Brodie, Jr. 1994. Adhesive strength of amphibian skin secretions. J. Herpetol. 28:499–502.
- \*Feder, M.E. 1976a. Oxygen consumption and body temperature in Neotropical and temperate zone lungless salamanders (Amphibia: Plethodontidae). J. Comp. Physiol. 110:197–208.
- \*—. 1976b. Lunglessness, body size, and metabolic rate in salamanders. Physiol. Zool. 49:398–406.
- \*—. 1977. Oxygen consumption and activity in salamanders: effect of body size and lunglessness. J. Exp. Zool. 202:403–413.
- \*—. 1978a. Environmental variability and thermal acclimation in Neotropical and temperate zone salamanders. Physiol. Zool. 51:7–16.
- \*—. 1978b. Effect of temperature on post-activity oxygen consumption of lunged and lungless salamanders. J. Exp. Zool. 206:179–190.
- . 1983. Integrating the ecology and physiology of plethodontid salamanders. Herpetologica 39:291–310.
- , J.F. Lynch, F.B. Shaffer, and D.B. Wake. 1982. Field body temperatures of tropical and temperate zone salamanders. Smithsonian Herpetol. Info. Serv. (52):1–23.
- and L.E. Olsen. 1978. Behavioral and physiological correlates of recovery from exhaustion in the lungless salamander *Batrachoseps attenuatus* (Amphibia: Plethodontidae). J. Comp. Physiol. B 128:101–107.
- Fisher, E.M. 1953. A size record for the salamander *Batrachoseps attenuatus attenuatus*. Copeia 1953:62.
- Fitzinger, L. 1843. Systema Reptilium. Fasc. I. Amblyglossae. Braumüller Seidel et Biblioplas, Vindobonae.
- Frost, D. 1985. Amphibian Species of the World: A Taxonomic and Geographical Reference. Allen Press Inc., Lawrence.
- Fowler, H. and E. Dunn. 1917. Notes on salamanders. Proc. Acad. Nat. Sci. Philadelphia 69:7–28.
- Fox, W. 1952. Notes on feeding habits of Pacific Coast garter snakes. Herpetologica 8:4–8.
- Gordon, K. 1939. The Amphibia and Reptilia of Oregon. Oregon St. Monogr. Stud. Zool. (1):1–82.
- Grinnell, J. and C.L. Camp. 1917. A distributional list of the amphibians and reptiles of California. Univ. California Publ. Zool. 17:127–208.
- \*Hall, H.M. and J. Grinnell. 1919. Life-zone indicators in California. Proc. California Acad. Sci. Ser. 4, 9:37–67.
- \*Hallowell, E. 1860. Report upon the Reptilia of the North Pacific Exploring Expedition, under command of Capt. John Rodgers, U.S.N. Proc. Acad. Nat. Sci. Philadelphia 12:480–510.
- Harvey, J.E. 1962. Note on feeding the Western Ringneck Snake (*Diadophis amabilis*). Turtox News 40:120.
- Helfer, J.R. 1948. Two new cestodes from salamanders. Trans. Amer. Microsc. Soc. 67:359–364.
- Hendrickson, J.R. 1954. Ecology and systematics of salamanders of the genus *Batrachoseps*. Univ. California Publ. Zool. 54:1–46.
- \*Highton, R. 1957. Correlating costal grooves with trunk vertebrae in salamanders. Copeia 1957:107–109.
- Hillman, S.S., V.H. Shoemaker, R. Putnam, and P.C. Withers. 1979. Reassessment of aerobic metabolism in amphibians during activity. J. Comp. Physiol. 129:309–313.
- Hilton, W.A. 1945a. Distribution of the genus *Batrachoseps*, especially on the costal [*sic*] islands of southern California. Bull. S. California Acad. Sci. 44:101–129.
- \*—. 1945b. The skeleton of *Batrachoseps*. J. Entomol. Zool. 37:8–17.
- \*—. 1947. Lateral line sense organs in salamanders. Bull. S. California Acad. Sci. 46:97–110.
- \*—. 1948. The skin of salamanders. J. Entomol. Zool. 40:29–42.
- \*—. 1953. The choroid plexus of the lateral and third ventricles of tailed Amphibia. J. Comp. Neurol. 99:545–559.
- Houck, L.D. 1977. Life history patterns and reproductive biology of Neotropical salamanders, p. 43–72. In D.H. Taylor and S.I. Guttman (eds.), The Reproductive Biology of Amphibians. Plenum Publ. Corp., New York.
- Hubbard, M.E. 1903. Correlated protective devices in some California salamanders. Univ. California Publ. Zool. 1:157–170 + 16 pl.
- Jaeger, R. 1981. Diet diversity and clutch size of aquatic and terrestrial salamanders. Oecologia 48:190–193.
- Janssens, F. and R. Dumez. 1903. L'Élément nucléinien pendant les cinèses de maturation des spermatoctes chez *Batrachoseps attenuatus* et *Plethodon cinereus* [*sic*]. Le Cellule 20:421–460 + pl. 1–5.
- Jennings, M.R. 1982. Geographic distribution. *Batrachoseps attenuatus*. Herpetol. Rev. 13:130.
- . 1987. Annotated check list of the amphibians and reptiles of California. 2<sup>nd</sup>, rev. ed. Spec. Publ. Southw. Herpetol. Soc. (3):2 + 1–48.
- Jockusch, E.L. 1997a. An evolutionary correlate of genome size change in plethodontid salamanders. Proc. Royal Soc. London B 264:597–604.
- . 1997b. Geographic variation and phenotypic plasticity of number of trunk vertebrae in Slender Salamanders, *Batrachoseps* (Caudata: Plethodontidae). Evolution 51:1966–1982.
- and M.J. Mahoney. 1997. Communal oviposition and lack of parental care in *Batrachoseps nigriventris* (Caudata: Plethodontidae) with a discussion of the evolution of breeding behavior in plethodontid salamanders. Copeia 1997:697–705.
- , D.B. Wake, and K.P. Yanev. 1998. New species of Slender Salamanders, *Batrachoseps* (Amphibia: Plethodontidae), from the Sierra Nevada of California. Contrib. Sci. Los Angeles Co. Mus. (472):1–17.
- Jones, R.M. and S.S. Hillman. 1978. Salinity adaptation in the salamander *Batrachoseps*. J. Exp. Biol. 76:1–10.
- Kessell, E.L. 1954. Transportation of an egg cluster by a female of *Ensatina eschscholtzi* Gray (Caudata: Plethodontidae). Wasmann J. Biol. 12:133–134.
- \*Klingelhoff, W. 1956. Lurche. Terrarienkunde 2:1–236 + 5 pl.
- Larson, A. 1984. Neontological influences of evolutionary pattern and process in the salamander family Plethodontidae. Evol. Biol. 17:119–217.
- . 1991. A molecular perspective on the evolutionary relationships of the salamander families. Evol. Biol. 25:211–277.
- , D.B. Wake, and K.P. Yanev. 1984. Measuring gene flow among populations having high levels of genetic fragmentation. Genetics 106:293–308.

- and A.C. Wilson. 1988. Patterns of ribosomal RNA evolution in salamanders. *Mol. Biol. Evol.* 6:131–154.
- León, P. and J. Kezer. 1978. Localization of 5S RNA genes on chromosomes of plethodontid salamanders. *Chromosoma* 65:213–230.
- Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. *Amphibians of Washington and Oregon*. Seattle Audubon Soc., Seattle.
- \*Licht, L.E. and L.A. Lowcock. 1991. Genome size and metabolic rate in salamanders. *Comp. Biochem. Physiol. B* 100:83–92.
- Licht, P., M.E. Feder, and S. Bledsoe. 1975. Salinity tolerance and osmoregulation in the salamander *Batrachoseps*. *J. Comp. Physiol.* 102:123–134.
- Linke, R. and G. Roth. 1989. Morphology of retinal ganglion cells in lungless salamanders (Fam. Plethodontidae): an HRP and Golgi study. *J. Comp. Neurol.* 289:361–374.
- , —, and B. Rottluff. 1986. Comparative studies of the eye morphology of lungless salamanders, family Plethodontidae, and the effect of miniaturization. *J. Morphol.* 189:131–143.
- \*Lombard, E.R. and D.B. Wake. 1977. Tongue evolution in the lungless salamanders, family Plethodontidae. II. Function and evolutionary diversity. *J. Morphol.* 153:39–79.
- and —. 1986. Tongue evolution in the lungless salamanders, family Plethodontidae. IV. Phylogeny of plethodontid salamanders and the evolution of feeding dynamics. *Syst. Zool.* 35:532–551.
- Lynch, J.F. 1985. The feeding ecology of *Aneides flavipunctatus* and sympatric plethodontid salamanders in northwestern California. *J. Herpetol.* 19:328–352.
- Maiorana, V.C. 1976a. Predation, submergent behavior, and tropical diversity. *Evol. Theory* 1:157–177.
- . 1976b. Size and environmental predictability for salamanders. *Evolution* 30:599–613.
- . 1977a. Observations of salamanders (Amphibia, Urodela, Plethodontidae) dying in the field. *J. Herpet.* 11:1–5.
- . 1977b. Tail autotomy, function conflicts and their resolution by a salamander. *Nature* 265:533–535.
- . 1978a. Behavior of an unobservable species: diet selection by a salamander. *Copeia* 1978:664–672.
- . 1978b. Difference in diet as an epiphenomenon: space regulates salamanders. *Can. J. Zool.* 56:1017–1025.
- Marlow, R.W., J.M. Brode, and D.B. Wake. 1979. A new salamander, genus *Batrachoseps*, from the Inyo Mountains of California, with a discussion of relationships in the genus. *Contrib. Sci. Los Angeles Co. Mus.* 308:1–17.
- Maslin, T.P., Jr. 1939. Egg-laying of the Slender Salamander (*Batrachoseps attenuatus*). *Copeia* 1939:209–212.
- \*Monath, T. 1965. The opercular apparatus of salamanders. *J. Morphol.* 116:149–170.
- Morafka, D.J. and B.H. Banta. 1972. The herpetozoogeography of the Gabilan Range, San Benito and Monterey counties, California. *Wasmann J. Biol.* 30:197–240.
- Mushinsky, H.R. and E.D. Brodie, Jr. 1975. Selection of substrate pH by salamanders. *Amer. Midl. Nat.* 93:440–443.
- Myers, G.S. 1930. Notes on some amphibians in western North America. *Proc. Biol. Soc. Washington* 43:55–64.
- \*Noble, G.K. 1921. The anterior cranial elements of *Oedipus* and certain other salamanders. *Bull. Amer. Mus. Nat. Hist.* 44:1–6 + 2 pl.
- \*—. 1931. *The Biology of the Amphibia*. McGraw-Hill Book Co., Inc., New York.
- Nussbaum, R.A. 1985. The evolution of parental care in salamanders. *Misc. Publ. Mus. Zool. Univ. Michigan* (169):4 + 50 p.
- , E.D. Brodie, Jr., and R.M. Storm. 1983. *Amphibians and Reptiles of the Pacific Northwest*. Univ. Press Idaho, Moscow.
- Peabody, F.E. 1959. Trackways of living and fossil salamanders. *Univ. California Publ. Zool.* 63:3 + 48 p.
- and J.M. Savage. 1958. Evolution of a coast range corridor in California and its effects on the origin and dispersal of living amphibians and reptiles, p. 159–185. *In* C.L. Hubbs (ed.), *Zoogeography: A Symposium*. Amer. Assoc. Adv. Sci. Publ. (51). Washington, D.C.
- Petranka, J.W. 1998. *Salamanders of the United States and Canada*. Smithsonian Inst. Press, Washington.
- \*Piatt, J. 1935. A comparative study of the hyobranchial apparatus and throat musculature in the Plethodontidae. *J. Morphol.* 57:213–251.
- Pickwell, G. 1947. *Amphibians and Reptiles of the Pacific States*. Stanford Univ. Press, Stanford.
- \*Ray, G.C. 1958. Vital limits and rates of desiccation in salamanders. *Ecology* 39:75–83.
- Reaser, J.K. 1997. *Batrachoseps attenuatus*. Predation. *Herpetol. Rev.* 28:81.
- Roth, G. 1987. *Visual Behavior in Salamanders*. Springer, Berlin.
- , J. Blanke, and M. Ohle. 1995. Brain size and morphology in miniaturized plethodontid salamanders. *Brain Behav. Evol.* 45:84–95.
- , —, and D.B. Wake. 1994. Cell size predicts morphological complexity in the brains of frogs and salamanders. *Proc. Natl. Acad. Sci.* 91:4796–4800.
- , K.C. Nishikawa, D.B. Wake, U. Dicke, and T. Matsushima. 1990. Mechanics and neuromorphology of feeding in amphibians. *Netherlands J. Zool.* 40:115–135.
- , —, U. Dicke, and D.B. Wake. 1988. Topography and cytoarchitecture of the motor nuclei in the brainstem of salamanders. *J. Comp. Neurol.* 278:181–194.
- , C. Naujoks-Manteuffel, and W. Grunwald. 1990. Cytoarchitecture of the tectum mesencephali in salamanders: a Golgi and HRP study. *J. Comp. Neurol.* 291:27–42.
- , B. Rottluff, W. Grunwald, J. Hanken, and R. Linke. 1990. Miniaturization in plethodontid salamanders (Caudata: Plethodontidae) and its consequences for the brain and visual system. *Biol. J. Linn. Soc.* 40:165–190.
- , —, and R. Linke. 1988. Miniaturization, genome size and the origin of functional constraints in the visual system of salamanders. *Naturwissenschaften* 75:297–304.
- and A. Schmidt. 1993. The nervous system of plethodontid salamanders: insight into the interplay between genome, organism, behavior, and ecology. *Herpetologica* 49:185–194.
- and D.B. Wake. 1985. The structure of the brainstem and cervical spinal cord in lungless salamanders (Family Plethodontidae) and its relation to feeding. *J. Comp. Neurol.* 241:99–110.
- Schmidt, A., G. Roth, and M. Ernst. 1989. Distribution of substance p-like, leucine-enkephalin-like, and bombesin-like immunoreactivity and acetylcholinesterase activity in the visual system of salamanders. *J. Comp. Neurol.* 288:123–135.
- Schonberger, C. 1944. Food of salamanders in the northwestern United States. *Copeia* 1944:257.
- Sessions, S.K. and J. Kezer. 1991. Evolutionary cytogenetics of bolitoglossine salamanders (Family Plethodontidae), p. 89–130. *In* D.M. Green and S.K. Sessions (eds.), *Amphibian Cytology and Evolution*. Acad. Press, Inc., San Diego.
- Seto, T., J. Kezer, and C.M. Pomerat. 1969. A cinematographic study of meiosis in salamander spermatocytes *in vitro*. *Zeitschr. Zellforsch. Mikrosk. Anat.* 94:407–424.
- Sever, D.M. 1994. Comparative anatomy and phylogeny of the cloacae of salamanders (Amphibia: Caudata). VII. Plethodontidae. *Herpetol. Monogr.* 8:276–337.
- , E.A. Heinz, P.A. Lempert, and M.S. Taghon. 1990. Phylogenetic significance of the cloacal anatomy of female bolitoglossine salamanders (Plethodontidae: tribe Bolitoglossini). *Herpetologica* 46: 431–446.
- Slevin, J.R. 1928. The amphibians of western North America. *Occ. Pap. California Acad. Sci.* (16):1–152 + 23 pl.
- Snyder, C.D. 1904. Locomotion in *Batrachoseps* with severed nerve-cord. *Biol. Bull.* 7:280–288.
- Snyder, J. 1923. Eggs of *Batrachoseps attenuatus*. *Copeia* (121):86–88.
- Stebbins, R.C. 1951. *Amphibians of Western North America*. Univ. California Press, Berkeley.
- . 1954a. Natural history of the salamanders of the plethodontid genus *Ensatina*. *Univ. California Publ. Zool.* 54:47–123.
- . 1954b. *Amphibians and Reptiles of Western North America*. McGraw-Hill Book Co., New York.
- . 1959. *Reptiles and Amphibians of the San Francisco Bay Region*. Univ. California Press, Berkeley.
- . 1972. *Amphibians and Reptiles of California*. Univ. California Press, Berkeley.
- . 1985. *A Field Guide to Western Reptiles and Amphibians*. 2nd ed. Houghton Mifflin Co., Boston.
- and C.H. Lowe, Jr. 1949. The systematic status of *Plethopsis* with a discussion of speciation in the genus *Batrachoseps*. *Copeia* 1949:116–129.
- Stejneger, L. and T. Barbour. 1917. *A Check List of North American Amphibians and Reptiles*. Harvard Univ. Press, Cambridge.
- Storer, T.I. 1925. A synopsis of the Amphibia of California. *Univ. Cali-*

- fornia Publ. Zool. 27:1-343 + 18 pl.
- Szarski, H. 1960. Plazy i gady Ameryki Północnej. *Przegl. Zool.* 4:170-179.
- Tanner, V.M. 1948. Amphibians and reptiles contributed to Brigham Young University by Owen Bryant. *Great Basin Nat.* 9:47-49.
- Thireau, M. 1975a. L'allométrie pondérale encéphalo-somatique chez les Urodèles. I. Relations intraspécifiques. *Bull. Mus. Natl. Hist. Nat. Paris* 3(4):467-482.
- . 1975b. L'allométrie pondérale encéphalo-somatique chez les Urodèles. I. Relations interspécifiques. *Bull. Mus. Natl. Hist. Nat. Paris* 3(4):483-501.
- \*Uzzell, T.M., Jr. 1961. Calcified hyoid and mesopodial elements of plethodontid salamanders. *Copeia* 1961:78-86.
- Villolobos, M., P. Leon, S.K. Sessions, and J. Kezer. 1988. Eucleated erythrocytes in plethodontid salamanders. *Herpetologica* 44:243-250.
- \*Wake, D. 1966. Comparative osteology and evolution of the lungless salamanders, family Plethodontidae. *Mem. S. California Acad. Sci.* (4):1-111.
- . 1981. The application of allozyme evidence to problems in the evolution of morphology, p. 257-270. *In* G.E. Scudder and J.L. Reveal (eds.), *Evolution Today*. Proc. 2<sup>nd</sup> Internatl. Congr. Syst. Evol. Biol., Carnegie-Mellon Univ., Pittsburgh, Pennsylvania.
- and J. Castanet. 1995. A skeletochronological study of growth and age in relation to adult size in *Batrachoseps attenuatus*. *J. Herpetol.* 29:60-65.
- and I. Dresner. 1967. Functional morphology and evolution of tail autotomy in salamanders. *J. Morphol.* 122:265-306.
- and J. Hanken. 1996. Direct development in lungless salamanders: what are the consequences for developmental biology, evolution and phylogenesis? *Internatl. J. Dev. Biol.* 40:859-869.
- , E.L. Jockusch, and T.J. Papenfuss. 1998. Does *Batrachoseps* occur in Alaska? *Herpetol. Rev.* 29:12-14.
- , K.C. Nishikawa, U. Dicke, and G. Roth. 1988. Organization of the motor nuclei in the cervical spinal cord of salamanders. *J. Comp. Neurol.* 278:195-208.
- , G. Roth, and M.H. Wake. 1983. Tongue evolution in lungless salamanders, family Plethodontidae. III. Patterns of peripheral innervation. *J. Morphol.* 178:207-224.
- Welsh, H. and A. Lind. 1989. Old growth forests and the distribution of the terrestrial herpetofauna, p. 439-455. *In* R.C. Szaro et al. (eds.), *Management of Amphibians, Reptiles, and Small Mammals in North America*. USDA For. Serv. Gen. Tech. Rept. RM-166, Fort Collins, Colorado.
- \*Wever, E.G. 1985. *The Amphibian Ear*. Princeton Univ. Press, Princeton, New Jersey.
- Wiggers, W. and G. Roth. 1991. Anatomy, neurophysiology and functional aspects of the nucleus isthmi in salamanders of the family Plethodontidae. *J. Comp. Physiol. A* 169:165-176.
- , G. Roth, C. Eurich, and A. Straub. 1995. Binocular depth perception mechanics in tongue-projecting salamanders. *J. Comp. Physiol. A* 176:365-377.
- Yanev, K.P. 1980. Biogeography and distribution of three parapatric salamander species in coastal and borderland California, p. 531-550. *In* D.M. Power (ed.), *The California Islands: Proceedings of a Multidisciplinary Symposium*. Santa Barbara Mus. Nat. Hist., Santa Barbara, California.
- Yarrow, H.C. 1882. Check list of North American Reptilia and Batrachia, with catalogue of specimens in the U.S. National Museum. *Bull. U.S. Natl. Mus.* (24):v + 249 p.

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