

the laboratory, females stayed with their clutches until eggs hatched (N.L.S., personal observation).

D. Juvenile Habitat. Juveniles are found in the same microhabitats as adults (e.g., under rocks and logs; Myers, 1930b).

E. Adult Habitat. Black salamanders occur in areas that receive >75 cm annual precipitation (Lynch, 1974). Specific habitats include lowland forests, under rocks and logs or in wet soil along streams, under logs and rocks in grassy meadows, pastures, and burned areas, and in talus slopes (Wood, 1936; Myers and Maslin, 1948; Stebbins, 1951; Lynch, 1974, 1981; Staub, 1993). The populations in the Santa Cruz Mountains appear to prefer moister microhabitats than more northern populations. Unlike their more arboreal congeners, black salamanders are primarily ground dwellers (Myers and Maslin, 1948). Despite their ground-dwelling habits, black salamanders have a prehensile tail (Van Denburgh, 1895).

F. Home Range Size. Unknown.

G. Territories. In captivity, adults often bite one another (e.g., Myers, 1930b), and adult males and females show agonistic behavior toward conspecific intruders (Staub, 1993). Animals captured in the field are frequently scarred; males show a higher frequency of scarring than do females (Staub, 1993). This species may be territorial in the field.

H. Aestivation/Avoiding Desiccation. In southern populations that are associated with streamside habitats, black salamanders are active year-round. In habitats that are not associated with permanent water, salamanders move underground during the dry season (mid-April to mid-October; Lynch, 1974).

I. Seasonal Migrations. Not known to occur.

J. Torpor (Hibernation). Not known to occur.

K. Interspecific Associations/Exclusions. Black salamanders occur syntopically with clouded salamanders (*A. ferreus*), wandering salamanders (*A. vagrans*), arboreal salamanders (*A. lugubris*), ensatinas (*Ensatina eschscholtzii*), and California slender salamanders (*Batrachoseps attenuatus*; Wood, 1936; Myers and Maslin, 1948; Lynch, 1974, 1985). Black salamanders also occur extensively with Del Norte salamanders (*Plethodon elongatus*) in the Klamath River Valley and Trinity River drainage.

L. Age/Size at Reproductive Maturity. Reproductively mature black salamanders range in size from 60–75 mm (Lynch, 1974).

M. Longevity. In the lab, black salamanders have lived 20 yr (N.L.S., personal observation).

N. Feeding Behavior. Juveniles and adults feed on a wide variety of prey. The diet of adult salamanders consists primarily of diplopods (millipedes), coleopterans, formicans (primarily ants), and isopterans (primarily termites; Lynch, 1985). The diet

of juveniles includes these prey as well as dipterans and collembolans (Lynch, 1985). Larger individuals consume larger prey items; mean and maximum prey size is correlated with body size. This correlation suggests that larger animals are selecting larger prey items and are ignoring smaller prey items. The number of prey items decreases as body size increases (Lynch, 1985).

O. Predators. Predators include western terrestrial garter snakes (*Thamnophis elegans*; Lynch, 1981).

P. Anti-Predator Mechanisms. When startled, juveniles generally remain immobile and adults flee (Van Denburgh, 1895; Jones, 1984). Other escape or defense behaviors include jumping (Van Denburgh, 1895), the production of sticky skin secretions (Lynch, 1981), an agonistic posture, and agonistic behaviors including biting (Lynch, 1981; Staub, 1993). The agonistic posture of black salamanders is distinctive. The animal raises its body off the substrate with the legs fully extended, the back is arched, the head elevated with the snout pointed slightly downward, and the tail undulates (Jones, 1984; Staub, 1993; Stebbins, 1954a). In the laboratory, black salamanders will bite

much of their prime habitat. According to Levell (1997), black salamanders are listed as Protected in Oregon.

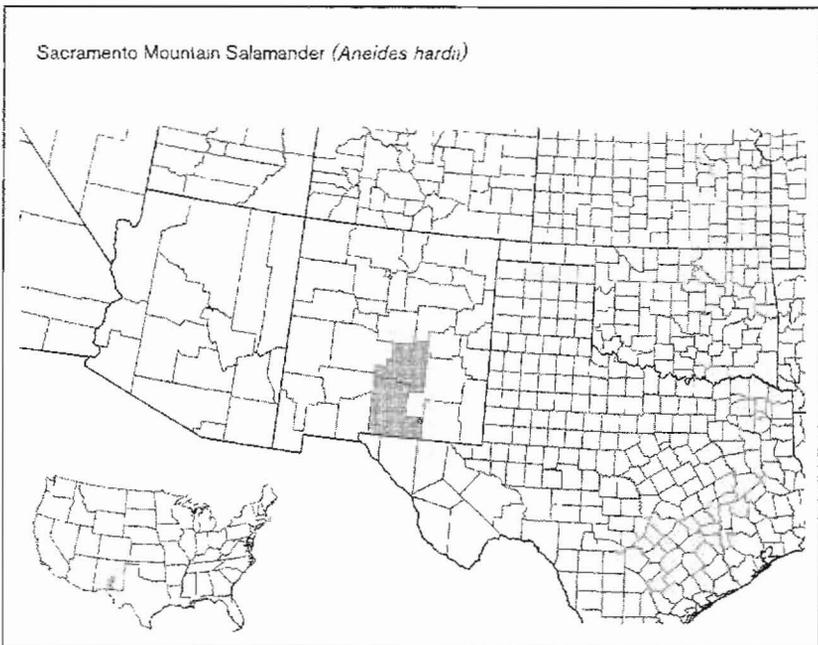
Aneides hardii (Taylor, 1941)

SACRAMENTO MOUNTAIN SALAMANDER

Cindy Ramotnik

1. Historical versus Current Distribution.

There is no evidence to support either an expansion or a contraction of the historical range of Sacramento Mountain salamanders (*Aneides hardii*) within the three disjunct areas where they occur: the Capitan, White, and Sacramento mountains of south-central New Mexico, in Lincoln and Otero counties (Ramotnik, 1997). Researchers have revisited some historical localities known from the 1950s and 1960s (these salamanders were discovered in 1940) in the Capitan and Sacramento mountains and have continued to find salamanders (Meents, 1987; Scott et al., 1987; C. Painter, personal communication). The increase in new locality records from the Sacramento Mountains in the last 10 yr most likely reflects increased survey effort and not range expansions (Ramotnik, 1997).



western terrestrial garter snakes, which can result in serious injuries to the snakes (Lynch, 1981).

Q. Diseases.

R. Parasites. Nematodes have been found in the black salamander (Lehmann, 1954; Schad, 1960).

4. Conservation. Black salamanders have become rare in recent years due in large part to the proliferation of vineyards in northern California that has destroyed

2. Historical versus Current Abundance.

Historical abundance unknown. Sacramento Mountain salamanders are abundant in appropriate habitat (above 2,800 m), but populations can be patchy within relatively uniform habitat (Ramotnik and Scott, 1988).

3. Life History Features.

A. Breeding. Reproduction is terrestrial.

i. Breeding migrations. None reported.

i. Breeding habitat. Courtship and mating take place in underground sites (Johnston and Schad, 1959).

B. Eggs.

i. Egg deposition sites. Clutches have been found from mid-July to September, usually within large, decaying Douglas fir logs or stumps, but eggs also are believed to be oviposited below ground (Johnston and Schad, 1959).

ii. Clutch size. Clutch size ranges from 1–10 eggs (mean = 5.9; Staub, 1986), the lowest of any North American plethodontid salamander.

C. Direct Development. As previously noted (see "Egg deposition sites" above), clutches have been found from mid-July to September, usually within large, decaying Douglas fir logs or stumps, but eggs also are believed to be oviposited below ground (Johnston and Schad, 1959). Newly emerged salamanders from a clutch hatched in captivity measured 11–13 mm (SVL) and had color patterns similar to adults (Weigmann et al., 1980).

D. Juvenile Habitat. Presumably the same as adult habitat.

E. Adult Habitat. Within mesic mixed-habitat forest above 2,400 m, salamanders can be found within and under logs and moist litter and under rockslides and surface objects such as bark, rocks, and small woody debris. Above timberline they are associated with rocks and mats of mosses and lichens (Moir and Smith, 1970). Salamanders are often found within coniferous logs (primarily Douglas fir) that are in advanced stages of decay. They can be found under bark or in small cracks and chambers near the inner bark surface in less decayed logs (Johnston and Schad, 1959). Sacramento Mountain salamanders are more frequently associated with an understory of Rocky Mountain maple, less frequently with a sparse understory, and rarely with Gambel oak (Weigmann et al., 1980). However, Johnston and Schad (1959) noted that small oaks (*Quercus* sp.) were present among dominant conifers at all collecting sites.

F. Home Range Size. Unknown. Fifteen marked salamanders moved an average of 22.7 m (range = 0–50 m) between July and September (Staub, 1986).

G. Territories. Unknown.

H. Aestivation/Avoiding Desiccation. During periods of drought, salamanders retreat beneath surface objects (e.g., large decayed logs) or to subterranean retreats; they respond to decreased temperature and precipitation in September by reducing surface activity (Ramotnik, 1997).

I. Seasonal Migrations. None reported.

J. Torpor (Hibernation). Believed to be inactive below ground from October–May (Johnston and Schad, 1959; Scott and Ramotnik, 1992).

K. Interspecific Associations/Exclusions. Interspecific competition is unlikely within their range because the only salamanders

that occur sympatrically are tiger salamanders (*Ambystoma tigrinum*), which have distinctly different microhabitat preferences (Ramotnik, 1997).

L. Age/Size at Reproductive Maturity. Sexual maturity is reached at 43 mm SVL when females are 4 yr of age (based on growth-rate estimates by Staub, 1986). Williams (1976) reports that females reach sexual maturity from 2–3 yr of age but do not oviposit for another year in order to allow ova to reach sufficient size.

M. Longevity. At least 10 yr of age (based on a growth rate of 3.2 mm/yr; Staub, 1986).

N. Feeding Behavior. Salamanders feed on ground-dwelling invertebrates, primarily arthropods, especially spiders and insects, some mollusks (Johnston and Schad, 1959; Staub, 1986), and earthworms (Scott, 1990). In a sample of 83 stomachs of Sacramento Mountain salamanders, ants (Formicidae) occurred most frequently and were found in 55% of the stomachs, followed in frequency by rove beetles (Staphylinidae: 20%) and springtails (Sminthuridae: 18%; unpublished data). Males and females exhibit little difference in the sizes of prey taken (Staub, 1989). Captive salamanders initially foraged during daylight hours but after acclimation actively foraged at night or under low-light conditions (Johnston and Schad, 1959).

O. Predators. Western terrestrial garter snakes (*Thamnophis elegans*) are the only known predators (Painter et al., 1999).

P. Anti-Predator Mechanisms. Immobile when initially exposed; body coiled and body flipped (*sensu* Brodie, 1983); will spin and writhe in a continuous motion when held by hand (Ramotnik, 1997).

Q. Diseases. None reported.

R. Parasites. A sample of 30 adult salamanders collected in July showed a high infection rate, 83% and 90%, by two species of nematodes, *Oswaldocruzia* sp. and *Theladros* sp., respectively (Johnston and Schad, 1959).

4. Conservation.

Sacramento Mountain salamanders are listed as Threatened in New Mexico (Levell, 1997; New Mexico Department of Game and Fish, 2000) and are potentially vulnerable to actions such as logging and fire that dry the habitat and reduce the amount of moisture available to them for respiration. However, salamanders have endured bouts of logging activities (sometimes intense) in the Sacramento Mountains over the past 60–90 yr, and there is no evidence that populations have been eliminated. Numbers of salamanders decreased the first year following logging in 1986 and 1987 in the Sacramento Mountains, but their numbers approached or exceeded pre-logging values after 5–7 yr (unpublished data). Salamanders apparently survived the frequent, low-intensity fires that occurred

historically in the Sacramento Mountains, but fire suppression has created opportunities for large, catastrophic, "stand-reducing" fires. The intensity of these fires compared to historical fires makes it difficult to predict how salamanders will respond. An opportunity to study a recent large-scale fire occurred in May 2000, when the Scott Able Fire burned over 16,000 ac within the habitat of Sacramento Mountain salamanders. Second year results from the five-year study indicate that salamanders minimize moisture loss on burned sites by aggregating in large numbers beneath logs, and that arthropod prey diversity is greatest on low-burned sites (unpublished data).

Aneides lugubris Hallowell, 1949

ARBOREAL SALAMANDER

Nancy L. Staub, David B. Wake

1. Historical versus Current Distribution.

Arboreal salamanders (*Aneides lugubris*) occur in coastal oak woodlands from northern California (Humboldt County) to approximately Valle Santo Tomás, Baja California del Norte, Mexico. Their range includes South Farallon, Santa Catalina, Los Coronados, and Año Nuevo Islands (Lynch and Wake, 1974; McPeak, 2000). In the foothills of the Sierra Nevada, a geographically isolated cluster of populations occurs in black oak and yellow pine forests (Lynch and Wake, 1974). This group of populations is genetically distinct from coastal populations (Jackman, 1993). The range of arboreal salamanders is similar to the range of the oaks (*Quercus agrifolia* and *Q. wislizenii*), presumably a consequence of shared moisture and soil characteristics (Rosenthal, 1957). However, in southern California, arboreal salamanders are frequently associated with sycamores (*Platanus racemosa*) bordering seasonal streams.

Populations have certainly been eliminated as coastal California habitats have been developed, but the species survives in many urbanized regions where adequate cover is present.

2. Historical versus Current Abundance.

Although arboreal salamanders remain common in many areas, in some areas populations have declined in the past 20 yr (D.B.W., personal observations). Petranka (1998) suggests that large oaks used for nesting and aestivation should be preserved. The current decline of live oaks in California will have negative effects on arboreal salamander populations.

3. Life History Features.

Reproduction is terrestrial.

A. Breeding.

i. Breeding migrations. Breeding migrations do not occur, but seasonal or daily vertical migrations into and out of trees are possible.

AMPHIBIAN DECLINES

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