Body-coiling Behavior in the Three-toed Amphiuma (*Amphiuma tridactylum*)

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Salamanders coil their bodies for a variety of reasons, but primarily as a response to predators. For the aquatic salamander *Amphiuma*, all reports on coiling are associated with nest attendance, although another notion has made it into the literature, that *Amphiuma* coils its body to reduce evaporative water loss of the adult. We inadvertently tested this notion via another study on temperature preference in an aquatic thermal gradient. Because nearly half of our observations were of tightly coiled individuals underwater, we conclude that this behavior is not for reducing evaporative water loss, but more likely a defensive posture.

Body-coiling behavior has been reported in salamanders, primarily in plethodontids. However, the "tightness" of these coils is presumably limited by their skeletal morphology and relatively short body length. Coiling in plethodontids is generally 1–2 loosely coiled body loops, or as an "S" shape. A variety of explanations for coiling behavior have been suggested for plethodontids, including removal of cover, springing or leaping (Wake 1996), rolling downhill (García-París and Deban 1995), exposure to toxins (Brodie 1977), and reduction of evaporative water loss (Hillman et al. 2009).

Body-coiling also has been reported for species in the family Amphiumidae, and has always been associated with reproduction. All reports describe a presumed female discovered in mud under a previously submerged log, coiled in a single loop around eggs in both *A. means* (Davison 1895, Weber 1944, Seyle 1985) and *A. tridactylum* (Hay 1888,


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Fig. 1. Non-nesting body-coiling behavior in *Amphiuma tridactylum.* This tight coiling occurs underwater, is presumed defensive, and differs from the loose coiling associated with nesting.

Baker 1937, Baker 1945, Tinkle 1959). Conversely, Hillman et al. (2009) and Duellman and Trueb (1994), citing Ray (1958), indicated that *Amphiuma* tightly coils its body and tail to reduce evaporative surface area and thus water loss. However, the word "*Amphiuma*" does not occur in the Ray (1958) reference, and thus we believe this reference and/or concept to be in error. Here, we describe the nature of body-coiling in *Amphiuma*, and test the notion of an evaporative-water-loss reducing function.

Materials and Methods

During the course of another study on temperature preference in a laboratory thermal gradient, we inadvertently tested whether body coiling is a mechanism to reduce evaporative water loss. We collected *A. tridactylum* (n = 15) by hand at night from East Baton Rouge Parish, Louisiana from April through May 1990. For determining temperature preference, an aquatic thermal gradient was created by dividing an aquarium into five water-filled sections at temperatures of 22, 26, 28, 31, and 35 °C. Prior to each experimental trial, the aquatic thermal gradient was drained and rinsed with well water to remove any olfactory cues left by other animals. The aquatic gradient consisted of an aquarium (125 x 38 x 34 cm) with five sections (25 x 38 x 9 cm) formed by four glass dividers (9 cm high). Each pool was aerated to provide circulation of oxygenated water and to maintain a more uniform temperature within each pool. The gradient was kept in a dark room to eliminate possible light cues, because these salamanders utilize mostly underwater burrows in turbid water. Each individual was placed randomly in one of the five pools at the beginning of each trial. Each experimental trial consisted of observing one individual for behavior, and recording the selected water temperature and body position every 30 min for 6 h (1100–1700 h).

Results

In 95 of the 205 observations (46%) of thermal selection within the gradient, individuals were positioned in a tightly coiled posture of 3–4 body loops with the head positioned at the bottom of the spring-shaped coil (Fig. 1). We noted some variations, including a knot-like configuration (figure on p. 134), but the head was always underneath. In the other 110 observations, the individuals were lying across the bottom in a more natural sprawled position, typical of that observed in the field (Figs. 2 & 3).

Discussion

All of our laboratory and field observations were of animals in water, suggesting that the body-coiling behavior observed here was not being used to reduce evaporative water loss. The body-coiling behavior we observed in *A. tridactylum* instead was probably attributable to an inability to find concealment. Accordingly, this behavior might be a defensive posture, as it reduces exposed surface area from an otherwise very elongate body position. The senior author has observed this behavior hundreds of times over many years with individual *A. tridactylum* and *A. means* being transported to the lab in a bucket or other container with water, as well as in an aquarium without cover. Anecdotal observations suggest that if a cover item is provided, the animals uncoil and use the provided cover — and we have not observed tight body-coiling behavior when cover is available, nor in the field under any condition. Virtually all individuals, males, females, and juveniles, found under cover in the field were typically in a mud depression with a single loose body loop, and generally remained that way unless disturbed (CLF, pers. obs.). On the other hand, the concept that tight body coiling could be used to reduce evaporative water loss is plausible. Given that *Amphiuma*

Fig. 2. *Amphiuma tridactylum* in natural mud/muck habitat in Baton Rouge, Louisiana. This individual was placed on the surface for photographic purposes because these salamanders normally are aquatic/fossorial and nocturnal, and it indeed burrowed into the mud and disappeared. Note the bite marks from another *Amphiuma* visible on the skin, as well as an old tail injury.

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Fig. 3. *Amphiuma* live in crayfish burrows, and often hunt with their head at the entrance to take passing prey. This individual was coaxed out of the burrow by twiddling a stick at the water's surface to mimic an insect.

often live in ditches, ponds, and lakes that are susceptible to drying (Aresco and Gunzburger 2004, Gunzburger 2003), it is easy to imagine the benefit of such a behavior in a drying burrow during aestivation. However, no currently available evidence supports that contention. The very different coiling behavior associated with *Amphiuma* reproduction, with one loose coil around an egg mass on land, probably does reduce evaporative water loss of the eggs. In that case, the eggs are held together in a pile surrounded by the adult, thereby reducing the surface/volume ratio of the egg mass (Hayes and Lahanas 1987). Because our observations were incidental via another study, we did not specifically test the effect of cover availability on body-coiling behavior, and we suggest this as a future study.

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Spotted Salamander (*Ambystoma maculatum*) larvae metamorphosed and began exhibiting characteristics consistent with the chytrid-induced symptoms observed in Ozark Zigzag Salamanders (*Plethodon angusticlavius*).