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# OBSERVATIONS OF ANTIPREDATOR TACTICS OF THE SHARP-TAILED SNAKE (*CONTIA TENUIS*)

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Key words: *Contia tenuis*, sharp-tailed snake, adaptive coloration, antipredator mechanisms, mimicry

*Contia tenuis* (sharp-tailed snake) is a relatively small, secretive snake whose geographic distribution extends from southern British Columbia to central California (Stebbins 1954, 1985; Leonard and Ovaska 1998). Individuals are brown, reddish-brown, red, or gray dorsally and marked by contrasting black-and-white crossbars ventrally (Stebbins 1954, 1985; Nussbaum and others 1983). A hypothesis regarding the function of the ventral color pattern has yet to be offered. Several defensive behaviors have been attributed to *C. tenuis*, including pricking with the tail spine (Nussbaum and others 1983), smearing of offensive cloacal fluids (Leonard and others 1996), and concealing the head within tight body coils (Ovaska and Engelstoft, in press). Here we describe additional defensive behaviors by *C. tenuis* and propose a hypothesis for the function of the ventral color pattern.

On several occasions between 29 September and 12 October 1998, one of us (WPL) elicited defensive behavior from 2 hatchling *C. tenuis*. One snake (101 mm total length [TL]) was from 5 km north of Carson, Skamania County, Washington, and the other (109 mm TL) was from 2 km north of Trout Lake, Klickitat County, Washington. The behavior began after a few minutes of handling and usually after a few attempts by the snake to flee. In most instances the hatchlings remained rigid for up to several minutes, with the body of each coiled into a ball or "pretzel" shape. Once positioned in this manner, each hatchling snake was readily and inadvertently rolled or jostled into an upside-down position that exposed the ventral pattern (Fig. 1A). In a separate instance, the hatchling from Skamania County rolled onto its dorsum and lay with the entire venter exposed for 2 to 3 min. It was unclear in this instance whether the exposure of the venter had resulted from deliberate actions on the part of the snake or if it had been inadvertently jostled into this position by the author. Although defensive coiling by hatchling *C. tenuis* has been reported previously (Ovaska and Engelstoft, in press), the propensity of this behavior to result in the ex-

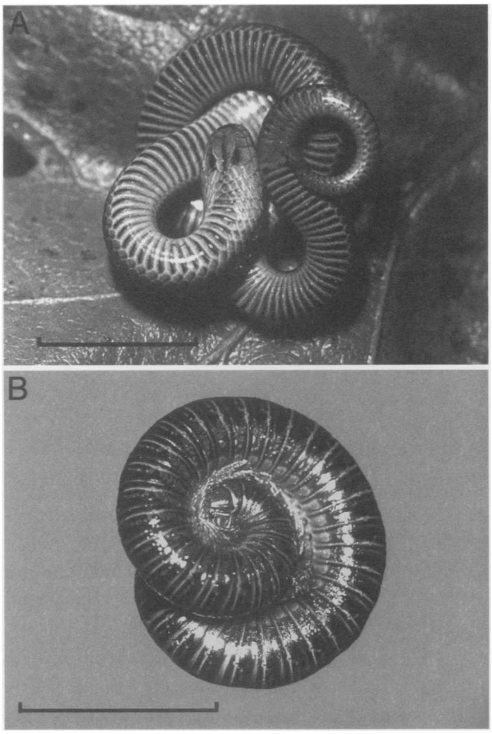

FIGURE 1. (A) After a few minutes of handling, this hatchling *Contia tenuis* coiled and immobilized the body; when returned to the ground it tumbled onto its back exposing the venter for 2 to 3 min. (B) A parajulid millipede (probably *Bollmaniulus* sp.) from Benton County, Oregon, with its body maintained in a defensive coil. Scale bars = 1 cm.

posure of the venter has not been described previously.

Balling of the body may function to facilitate locomotor escape (that is, gravity-propelled tumbling), protect vital body parts, and preclude ingestion by smaller predators (Greene 1988, 1997; Ovaska and Engelstoft, in press). In addition to these functions, we suggest that balling of the body may benefit hatchling *C. tenuis* by resulting in the exposure of the snake's ventral pattern, thereby facilitating its mimicry of sympatrically occurring millipedes. Furthermore, dark markings suggestive of eyespots on the chin scales of some hatchlings may provide the added benefit of startling some visually foraging predators (Blest 1957; Tinbergen 1974; Pough 1988a).

Most millipedes possess defensive glands capable of exuding a noxious and potentially toxic discharge (Hopkin and Read 1992; Fairhurst 1993; Ruppert and Barnes 1994; Shelley 1999; Shear 1999.). In laboratory experiments, the volatile secretions from a California millipede (*Tylobolus claremontus* [= *stebbinsi*]) were found to be sufficiently potent to kill both a San Diego alligator lizard (*Elgaria multicarinata webbii*) and a western skink (*Eumeces skiltonianus*) (Stebbins 1944).

More than 100 species of millipedes occur within the range of *C. tenuis* (Rod Crawford, Burke Museum, University of Washington, Seattle, WA [pers. comm.]; Rowland Shelley, North Carolina State Museum of Natural Sciences, Raleigh, NC [pers. comm.]). Most notable among these are members of the order Julida, whose cylindrical form and diameter most closely match that of *C. tenuis*. Julida is a highly diverse and poorly studied order, and its diversity within the geographic range of *C. tenuis* is unknown (Rowland Shelley, pers. comm.). The dorsal color patterns of julid millipedes that we have observed within the geographic distribution of *C. tenuis* include light and dark gray bands (for example, *Bollmaniulus* sp., Fig. 1B), reddish-brown and black bands (for example, *Paeromopus angustatus buttensis*), and a broad, longitudinal, yellow stripe (for example, *Californiulus chamberlini*).

We suggest that the ventral color pattern of *C. tenuis* represents the mimicry of a generalized millipede pattern. Vitt (1992, p 87) observed that the "species and color diversity of millipedes even at a single locality suggests that they would provide a general banded model as opposed to a specific color combination or model". Moreover, experimental studies have demonstrated that even a general similarity of mimic and model may be sufficient to provide measurable protection (McCorkle and Hammond 1985; Pough 1988b; Brodie and Janzen 1995). Body coiling may be a behavioral element of the mimicry as many millipedes also coil or ball the body when provoked (Hopkin and Read 1992; Ruppert and Barnes 1994; Fig. 1B).

Adult *C. tenuis* also may derive protection from the ventral pattern. On many occasions, one of us (RCS) has encountered adults both beneath and within logs. When exposed suddenly, a portion of a snake's body sometimes was found inverted and, as a result, revealed a segment of the venter that approximated the size and appearance of some millipedes (Fig.

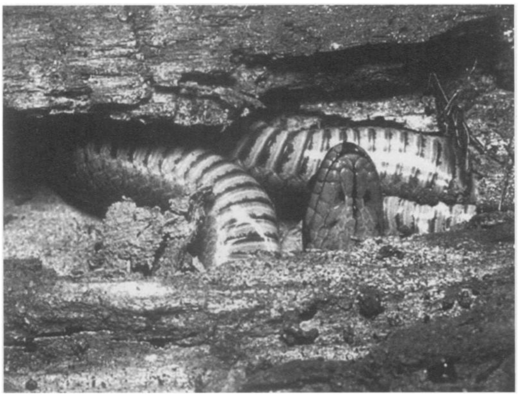

FIGURE 2. An adult *Contia tenuis* from North Pender Island, British Columbia, in decomposing wood with a segment of the venter exposed (photograph by Kristiina Ovaska).

2). These observations usually occurred during periods of cool weather when the snakes appeared lethargic and made little or no attempt to flee. The appearance of a snake positioned in this manner may provide some defense in repelling attacks by birds, such as the Steller's Jay (*Cyanocitta stelleri*), and other visually foraging animals that turn small woody debris and leaf litter while searching for small prey. Both *C. tenuis* and millipedes are commonly associated with moist conditions and areas with abundant down wood, surface debris, and rock (Stebbins 1954; Nussbaum and others 1983; Hopkin and Read 1992; Ruppert and Barnes 1994).

On 7 May 1996, one of us (WPL) observed an additional antipredator display by an adult *C. tenuis* (approximately 240 mm TL) shortly after its capture near the town of Cle Elum, Kittitas County, Washington. Upon its release the snake simultaneously flattened the mid- and lower body against the substrate and elevated the forebody in a raised S-coil, while facing and bluffing to strike its tormentor. On 22 October 1998, WPL elicited a similar response from a snake (320 mm TL) that had been collected by Richard Hoyer (Corvallis, OR) a few days earlier at Central Point, Jackson County, Oregon. At one point the second snake over-exaggerated the bluff, elevating its head so high above the ground that it lost balance and toppled over onto its head and forebody. Bluffs of this nature may provide protection to a snake by making it appear larger, more aggressive, and potentially more dangerous. Similar bluffs by other harmless snakes have proven successful at warding off predatory attacks (Greene 1988, 1997). Additionally, raising the forebody exposes the contrasting ventral pattern, which may further repel some visually oriented predators.

The sequence and functions of the above antipredator tactics are amenable to experimental testing. Both the geographic extent to which the defensive behaviors occur and the ontogeny of their expression in individuals require further testing. Additionally, the relationship of the ventral pattern to mimicry of millipedes warrants further study.

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Editor's Note: To maintain consistency with Collins (1997. Standard common and current scientific names for North American amphibians and reptiles. Herpetological Circular number 19. Society for the Study of Amphibians and Reptiles. 40 p.), the common name "sharptail snake" was used in recent notes published in this journal (for example, Leonard and others [1996]). More recently, however, Leonard and Ovaska (1998) rejected this non-hyphenated version of the common name on the grounds that it was grammatically incorrect and overly colloquial.

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# NESTS OF VAN DYKE'S SALAMANDER (*PLETHODON VANDYKEI*) FROM THE OLYMPIC PENINSULA, WASHINGTON

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Key words: Van Dyke's salamander, *Plethodon vandykei*, nest, reproduction, development, logs, microhabitat, Olympic Peninsula, Washington

Van Dyke's salamander (*Plethodon vandykei*) is an uncommon woodland salamander endemic to Washington (Leonard and others 1993). Many aspects of its ecology and life history have not been studied, and only 2 nest sites have been described. Noble (1925) reported a clutch of eggs under a moss-covered rock in "a damp situation". The clutch was in a grape-like cluster attached to the rock by a common pedicel. The locality and details of the nest were not discussed. Jones (1989) described a second nest from Mason County, Washington, on the

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