

REPTILIAN PREY OF THE SONORA MUD TURTLE (*KINOSTERNON SONORIENSE*) WITH COMMENTS ON SAUROPHAGY AND OPHIOPHAGY IN NORTH AMERICAN TURTLES

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ABSTRACT—We detected evidence of predation by the Sonora mud turtle (*Kinosternon sonoriense*) on the Arizona alligator lizard (*Elgaria kingii nobilis*) and the ground snake (*Sonora semiannulata*) at Montezuma Well, Yavapai County, Arizona. Lizards have not been reported in the diet of *K. sonoriense*, and saurophagy is rare in turtles of the United States, having been reported previously in only two other species, the false map turtle (*Graptemys pseudogeographica*) and the eastern box turtle (*Terrapene carolina*). While the diet of *K. sonoriense* includes snakes, ours is the first record of *S. semiannulata* as food of this turtle. Ophiophagy also is rare in turtles of the United States with records for only five other species of turtles. Given the opportunistic diets of many North American turtles, including *K. sonoriense*, the scarcity of published records of saurophagy and ophiophagy likely represents a shortage of observations, not rarity of occurrence.

RESUMEN—Evidencia de depredación por la tortuga casquito de Sonora (*Kinosternon sonoriense*) en la lagartija lagarto de Arizona (*Elgaria kingii nobilis*) y la culebra de arena (*Sonora semiannulata*) fue observada en el Pozo Montezuma, condado de Yavapai, Arizona. Lagartijas no han sido reportadas en la dieta de *K. sonoriense*, y saurofagia es rara en tortugas en los Estados Unidos, habiendo sido reportada solamente en otras dos especies, *Graptemys pseudogeographica* y *Terrapene carolina*. Aunque la dieta de *K. sonoriense* incluye víboras, el nuestro es el primer registro de *S. semiannulata* como comida de esta tortuga. Ofiofagia es también rara en tortugas en los Estados Unidos, habiendo sido observada en sólo cinco otras especies de tortugas. Dadas las dietas oportunistas de muchas especies norteamericanas de tortugas, incluyendo *K. sonoriense*, la escasez de expedientes publicados de saurofagia y ofiofagia representa más probablemente una escasez de observaciones, y no necesariamente la rareza de la ocurrencia.

Saurophagy, or a diet that includes lizards, is unusual in North American turtles, as is ophiophagy, a diet that includes snakes. During a study of the Sonora mud turtle (*Kinosternon sonoriense*)

in Arizona, we observed evidence of predation on the Arizona alligator lizard (*Elgaria kingii nobilis*) and the ground snake (*Sonora semiannulata*), prey items not reported previously for this

turtle. We present details of our findings and a review of saurophagy and ophiophagy in North American non-marine turtles.

The study site was Montezuma Well, a large natural-spring pool in Yavapai County, Arizona, administered by the National Park Service as part of Montezuma Castle National Monument. The wetland possesses several unique limnological characteristics, including the fact that fish cannot survive in its waters due to the high concentration of dissolved calcium carbonate (CO₂; Blinn and Sanderson, 1989). We collected turtles using baited hoop traps and placed them in plastic bins for processing. On 1 May 2007, two male Sonora mud turtles were placed in a plastic bin at ca. 1000 h. Lengths of carapace were 13.2 and 12.6 cm. After ca. 4 h, the partially digested carcass of a lizard was observed floating in the container. The remains consisted of ca. 2 cm of the posterior body, with hind legs, plus 5 cm of the tail. The anterior end of the body appeared as though bitten off with a clean cut. A lump of soft, dark-gray, unidentified material partially covered the tail. We identified the remains as an Arizona alligator lizard based on the characteristic large, rectangular scales on the dorsal and ventral surfaces, a longitudinal fold of skin along the side of the body, and narrow, wavy black cross bands edged with white on the dorsum and sides. We confirmed the identification by comparison with preserved specimens at the Museum of Northern Arizona in Flagstaff. The regurgitated specimen measured 8–9 cm in snout–vent length.

On 27 July 2007, we found a regurgitated ground snake (*Sonora semiannulata*) floating in a bin with two Sonora mud turtles soon after their removal from a hoop trap in Montezuma Well. Lengths of carapace of the turtles were 11.3 and 10.8 cm (both males). We identified the snake based on a row of dark saddles on a dull-white dorsum, flat crown, and non-countersunk lower jaw. However, we could not remove this specimen from consideration as a western shovel-nosed snake (*Chionactis occipitalis*), given similarities between the species in morphology and color pattern as juveniles. Previous sequencing of the ND1 mitochondrial gene revealed substantial sequence variation between these species (ca. 12–13% sequence divergence; Wood et al., 2008; D. A. Wood, unpublished data). Based on this variation and ND1 sequence data from

this specimen, we were able to confirm identification of the species as *S. semiannulata*. The specimen was deposited into the San Diego Natural History Museum (SDNHM 72853). Total length was 11–12 cm, which is the size of a hatchling ground snake (Frost, 1983). Close examination of the specimen revealed a cut-out section in the body, 2.5 cm posterior to the snout; 3 cm of the body behind this was reduced to a flap of skin.

While the Sonora mud turtle is primarily carnivorous, it is an opportunistic forager. When benthic food organisms are uncommon in stream habitats, Sonora mud turtles tend to be more omnivorous. Hulse (1974) studied two populations in Arizona and reported that plant material comprised 18.3% of total volume of the diet in all samples. Animals comprised 81.7% of the total volume and included several groups of insects (Anisoptera, Coleoptera, Diptera, Ephemeroptera, Hemiptera, Megaloptera, Trichoptera, and Zygoptera), snails (*Physa*), fish (*Agosia chrysogaster*), frogs (*Rana pipiens*), crayfish (*Procambarus*), and ostracods. Ligon and Stone (2003) reported *K. sonoriense* feeding on the red-spotted toad *Bufo punctatus*, and Stone et al. (2005) observed a *K. sonoriense* capturing, killing, and partially eating a black-necked garter snake (*Thamnophis cyrtopsis*). Stone et al. (2005) observed a Sonora mud turtle eating a northern mockingbird (*Mimus polyglottos*), providing further evidence of the opportunistic nature of feeding in the species.

Unlike snakes, there is no previous record of lizards in the diet of the Sonora mud turtle. Our observation of a regurgitated, partially digested *E. k. nobilis* represents the first evidence of saurophagy in this turtle. Although our study site is near the northern geographic limit of both species, there is remarkable congruence in their distribution in the United States (Brennan and Holycross, 2006), providing ample opportunity for predator-prey interactions. Similarly, *S. semiannulata* occurs throughout much of the range of *K. sonoriense*. Both species of prey are relatively common in the vicinity of Montezuma Well (C. A. Schmidt et al., http://sbsc.wr.usgs.gov/files/pdfs/ofr_2006-1163.pdf).

At the time of our analysis, the most recent and complete review of diet in North American turtles was by Ernst et al. (1994). Reports of saurophagy and ophiophagy are rare in the 48 species of native non-marine turtles (Table 1).

TABLE 1—North American non-marine turtles with reptiles in their diet (Ernst et al., 1994). Nomenclature of turtles follows Fritz and Havaš (2007). Other common and scientific names of reptiles follow Crother et al. (2000).

Family	Species	Prey
Chelydridae	<i>Chelydra serpentina</i>	Other turtles including <i>Chelydra</i> , <i>Kinosternon</i> , <i>Sternotherus</i> , <i>Chrysemys</i> , <i>Pseudemys</i> , <i>Trachemys</i> , and <i>Apalone</i> . Snakes including <i>Elaphe</i> , <i>Nerodia</i> , <i>Regina</i> , <i>Thamnophis</i> , and <i>Agkistrodon</i> .
	<i>Macrochelys temminckii</i>	Other turtles including <i>Graptemys flavimaculata</i> , <i>Pseudemys</i> , <i>Trachemys</i> , <i>Sternotherus</i> , <i>Macrochelys</i> , and <i>Apalone</i> . Small alligators (<i>Alligator mississippiensis</i>) and snakes.
Trionychidae	<i>Apalone ferox</i>	Other turtles including <i>Pseudemys</i> and <i>Sternotherus</i> . Snakes including <i>Nerodia</i> and <i>Regina</i> .
Kinosternidae	<i>Sternotherus minor</i>	Other turtles including <i>Sternotherus minor</i> and <i>Trachemys scripta</i> .
Emydidae	<i>Glyptemys muhlenbergii</i>	Dead water snakes.
	<i>Glyptemys insculpta</i>	Other turtle eggs.
	<i>Graptemys pseudogeographica</i>	The lizard <i>Eumeces</i> .
	<i>Terrapene carolina</i>	The lizard <i>Phrynosoma</i> and eggs of the turtle <i>Chelydra serpentina</i> .
	<i>Trachemys scripta</i>	Turtle scutes and the snake <i>Nerodia</i> .

Although reptiles occasionally are reported in the diet of turtles, only two other species are known to be saurophagous, the eastern box turtle (*Terrapene carolina*) and false map turtle (*Graptemys pseudogeographica*). Other species of turtles that frequently are considered to be more predacious (e.g., the snapping turtle, *Chelydra serpentina*) have not been recorded eating lizards. Both *Terrapene* and *Graptemys* are omnivores like *K. sonoriense*, but no North American species of turtle consumes lizards often enough to be considered saurophagous specialists. Instead, all three species of turtles listed in the previous sentence are considered to be opportunistic omnivores, although some populations of *K. sonoriense* tend toward carnivory (Hulse, 1974). Five other species are reported to eat snakes (Table 1). Given the catholic and opportunistic diets of so many North American turtles, the paucity of published records of saurophagy and ophiophagy likely represent a shortage of observations, not necessarily rarity of occurrence.

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