Diet composition of *Nerodia sipedon* (Serpentes: Colubridae) and its dietary overlap with, and chemical recognition of *Agkistrodon piscivorus* (Serpentes: Viperidae)

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**Abstract.** To address the potential role of the western cottonmouth (*Agkistrodon piscivorus leucostoma*) as a competitor for food and/or predator of the midland watersnake (*Nerodia sipedon pleuralis*) in drainages of the Gulf of Mexico, U.S.A., I examined the dietary compositions of these species from a series of museum collections. Small individuals of *A. piscivorus* consumed primarily lizards, fishes, and frogs, whereas large individuals consumed primarily fishes and frogs. No prey items of *A. piscivorus* were identified to be *N. sipedon*. Small individuals of *N. sipedon* consumed primarily fishes, frogs, and salamanders, whereas large individuals consumed primarily fishes. In a Y-maze experiment, a significantly higher number of individuals of *N. sipedon* selected the odorless arm of the maze over the arm containing the odor of *A. piscivorus*. However, *N. sipedon* did not exhibit a preference when presented with the odorless arm versus the arm containing the odor of a conspecific.

**Introduction**

The western cottonmouth (*Agkistrodon piscivorus leucostoma* Troost, 1836) and the midland watersnake (*Nerodia sipedon pleuralis* Cope, 1892) are common inhabitants of the Gulf of Mexico coastal plain west of the Apalachicola and Chattahoochee Rivers and east of the Mississippi River, U.S.A. (Tennant and Bartlett, 2000; pers. obs.). These species have diets consisting primarily of fishes and amphibians (Diener, 1957; Laughlin, 1959; Burkett, 1966), are primarily nocturnal during the summer and diurnal during the spring and fall (Diener, 1957; Burkett, 1966), and frequently occur in the same areas (pers. obs.). Because these species are upper-level predators that have similar habits and often occupy the same areas, they may partition food resources as a means of facilitating their
coexistence. However, *A. piscivorusr* is well-known for its snake-eating tendencies (Clark, 1949; Burkett, 1966; Kofron, 1978) and thus may be both a food competitor with, and a major predator of, *N. sipedon*. Polis et al. (1989) described such a relationship between two species as intraguild predation, although this term has not been applied to snakes.

The feeding ecologies of *A. piscivorusr* and *N. sipedon* are subject to ontogenetic changes in foraging behavior (Burkett, 1966; Mushinsky et al., 1982; Savitzky, 1989), which may result in access to different prey taxa by small (juvenile) and large (adult) snakes. This ontogenetic shift in diet may therefore affect potential predator-prey or competitive relationships between *A. piscivorusr* and *N. sipedon*. In addition, the status of heterospecific snakes as potential predators is frequently mediated through olfactory cues. Even naive (e.g., neonatal or captive-bred) snakes will respond to the odors of potential predatory snakes by moving away from areas containing such odors (Burger, 1989, 1990; Burger et al., 1991). Because *A. piscivorusr* occasionally consumes species of *Nerodiar* (Clark, 1949; Burkett, 1966; Kofron, 1978), neonates and adults of *N. sipedon* may perceive *A. piscivorusr* as a predator through detection of its odor and thus avoid areas that contain such odors.

My objective was to elucidate the potential role of *A. piscivorusr* as a competitor for food and/or predator of *N. sipedon* by 1) describing the diets of both species from areas of sympatry, 2) determining whether food habits of either species were subject to ontogenetic changes, and 3) testing for potential antipredatory behavior by *N. sipedon* in response to olfactory cues of *A. piscivorusr*. To my knowledge, a comparison of trophic and behavioral ecology has not been made between these species in areas where they occur in sympatry along the Gulf of Mexico coastal plain. Therefore, my study provides novel information on these important aspects of the life history of *A. piscivorusr* and *N. sipedon*.

**Materials and methods**

I examined the dietary compositions of *A. piscivorusr* and *N. sipedon* from preserved museum specimens. I dissected *A. piscivorusr* (*n* = 359 snakes) and *N. sipedon* (*n* = 661 snakes) that had been collected in drainages of the Gulf of Mexico located west of the Apalachicola and Chattahoochee Rivers and east of the Mississippi River, where these species are sympatric (Tennant and Bartlett, 2000) and may therefore potentially interact. Food items were removed from the esophagus and stomach, identified to the most lowest possible taxon, and grouped according to the species and size class of snake (small: <50 cm SVL; large: ≥50 cm SVL).

I measured the response of neonates and adults of *N. sipedon* to olfactory cues of *A. piscivorusr* in the laboratory. I collected non-gravid and gravid adults of *N. sipedon* from two sites (each site 1 km in straight-line distance) along Gordon’s Creek (Forrest County, Mississippi) that were respectively occupied and unoccupied by *A. piscivorusr* (no individuals of *A. piscivorusr* were observed during two years of weekly surveying of the latter site), as well as an adult of the latter species from the former site. All adult snakes were maintained individually in 451 terraria, exposed to a 12:12 light:dark cycle, provided with supplemental warmth from heating pads (creating an air temperature gradient of 18-25°C), provided with fresh water daily and fed five subadult golden shiners (*Notemigonus crysoleucasar*) per week prior to parturition (gravid snakes) or testing (non-gravid snakes). Litters of neonatal snakes were maintained in 851 plastic containers, provided with fresh water daily, and fed juvenile *N. crysoleucasar* (5 fish/snake/week) prior to testing. I maintained all snakes and conducted all tests at the Natural Sciences Park of the University of Southern Mississippi.

I used a Y-maze consisting of a base arm (87 × 16 × 4 cm) and two side (= experimental) arms (each 89 × 6 × 4 cm, extending off the base arm at a 30° angle, and open-ended). The maze was covered with a clear sheet