Clutch Sizes in Two Populations of the Eastern Garter Snake (*Thamnophis sirtalis*) in Pennsylvania

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The Common Garter Snake (*Thamnophis sirtalis* Linnaeus 1758) is a geographically widespread species in North America (Conant and Collins 1998), with at least nine currently recognized regionally distinct subspecies (Collins and Taggart 2009). The Eastern Garter Snake (*T. s. sirtalis* Linnaeus 1758) is widespread and the only member of the *T. sirtalis* clade of Garter Snakes in Pennsylvania (Hulse et al. 2001, Meshaka and Collins 2009). Despite its ubiquity in the commonwealth, systematic studies on the life history of the Eastern Garter Snake are rare (Meshaka 2010, Meshaka et al. 2009). The objective of our research was to examine clutch sizes of *T. s. sirtalis* from two different Pennsylvania populations: One in south-central and the other in western Pennsylvania. We also compared data from these locations with those of Pennsylvania generally (Hulse et al. 2001).

Methods

Using cover boards in 2009, we captured female Eastern Garter Snakes for individual identification as part of a long-term ecological study at Powdermill Nature Reserve (PNR), Westmoreland County in western Pennsylvania (Meshaka 2010, Meshaka et al. 2009) and at Letterkenny Army Depot (LEAD), Chambersburg, Franklin County in south-central Pennsylvania (Delis et al. 2010; Meshaka and Delis, unpubl. data). Both sites are comprised of a mosaic of grasslands or shrublands, coniferous and mixed hardwood forests, as well as a variety of lentic and lotic aquatic systems. Most human-mediated habitat modification at PNR consists of mowing to maintain grasslands. LEAD is subjected to a variety of anthropogenic disturbances derived from its military mission and mild agricultural and silvicultural activities.

We employed palpation as a method to estimate clutch size from 21 females from PNR on 22 July, and 10 females from LEAD on 1 (n = 8), 13 (n = 1), and 18 (n = 1) July. Body sizes (snout-vent lengths, SVL) are presented in cm, and means are presented ± one standard deviation. We compared female body sizes and clutch sizes by using F-tests for variance and *t*-tests for means, respectively (Sokal and Rohlf 1981). In light of differences in location, food bases, and sample sizes, we expected inter-site differences in female body sizes and clutch sizes, and the *t*-test analyses were consequently one-tailed. We used ANCOVA on SYSTAT 11 to remove the effect of body size in order to determine if individuals of about the same size in the two populations were producing more or fewer young.

Results

Mean body size of females at PNR (49.3 ± 6.0 cm; range = 39.4–64.8 cm; n = 21) was significantly smaller (t = -2.334; df = 30; $P < 0.01$) than those from LEAD (55.1 ± 7.6 cm; range = 42.6–65.4 cm; n = 10). Likewise, mean clutch size from PNR (13.0 ± 5.4; range = 7–29; n = 21) was significantly smaller (t = -1.735; df = 30; $P < 0.05$) than that at LEAD (16.4 ± 5.4; range = 8–24; n = 10). Body size was a statistically significant predictor of clutch size in each of the two sites (see graph on facing page). ANCOVA revealed no location effect in clutch size (mean-square = 0.417; F ratio = 0.100; $P > 0.05$). These statistical tests taken together mean that, although PNR females were on average smaller in body size and produced on average smaller clutches than those from LEAD, females from both sites that were similar in body size to one another produced similar clutch sizes.

Discussion

These data are interesting because body size (Fitch 2004) and clutch size (Seigel and Fitch 1985) of garter snakes can be affected by food supply. Consequently, we wondered if the smaller body sizes of Eastern Garter Snakes

BETTY FERSTER

Field and mixed hardwood forest at Powdermill Nature Reserve, Westmoreland County, Pennsylvania.

PABLO R. DELIS

Field overlooking mountain at Letterkenny Army Depot, Franklin County, Pennsylvania.

PABLO R. DELIS

Walter E. Meshaka, Jr. processing two female Eastern Garter Snakes (*Thamnophis sirtalis sirtalis*) from Letterkenny Army Depot, Franklin County, Pennsylvania. Snakes were palpated to estimate clutch sizes.

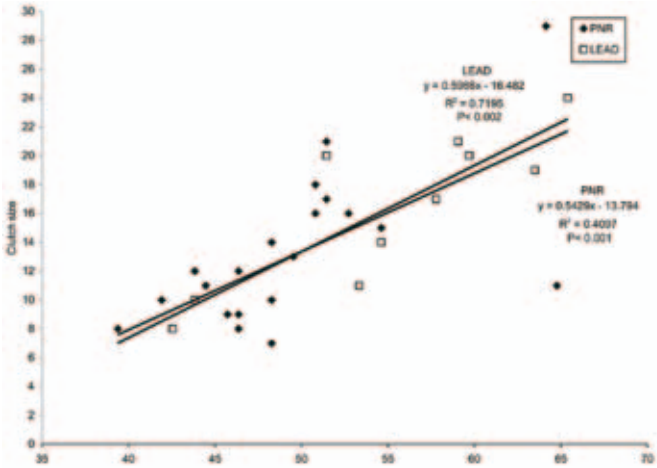
WALTER E. MESHAKA, JR.

Pablo R. Delis holds a gravid Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) and a Milk Snake (*Lampropeltis triangulum*) from Letterkenny Army Depot, Franklin County, Pennsylvania. These two snake species were occasionally found together at both study sites.

from PNR was related to their overall greater relative density at that site (Delis et al. 2010; Meshaka 2010; Meshaka et al. 2009; Meshaka and Delis, unpubl. data). The inference is that the greater densities of Easter Garter Snakes at PNR, perhaps combined with limited food resources, are stunting growth. Another likely reason for the body size disparity between the sites could be that predation pressures differed at the two sites. This hypothesis suggests that before reaching large body sizes, more female Eastern Garter Snakes were killed at PNR than at LEAD. In this scenario, the suggestion is that snakes at LEAD are on average larger and older because of higher survivorship than those at PNR. Of course, a genetic component to body size might exist, explaining the inter-site differences in body sizes. Female Eastern Garter Snakes at PNR might be genetically programmed, with negligible influence from other factors, to be smaller in body size than those at LEAD. Regardless of the cause of body-size differences, the result was a reduction in fecundity — but, according to our data, only because PNR females were smaller. Those PNR females similar in body size to those from LEAD produced similar clutch sizes. Therefore, the ability of PNR females to produce larger clutch sizes seems to be hampered only because of their smaller body size.

Combined, females from both sites averaged 51.1 ± 7.1 cm and produced an average clutch size 14.0 ± 5.4 young. Larger samples of female Eastern Garter Snakes taken in Pennsylvania generally averaged 43.9 ± 6.3 cm (range = 36.0–64.0, n = 52; Hulse et al. 2001). From a sample of 39 Pennsylvania female Eastern Garter Snakes of unreported body sizes, clutch sizes, as estimated by dissections of museum specimens, averaged 22.4 ± 2.6 young (range = 4–30; n = 39) and was positively associated (r = 0.76; P < 0.001) with female body size (Hulse et al. 2001).

The Eastern Garter Snake is a very adaptable animal, for which traits such as body size and clutch size can vary among populations and over years. Our findings from PNR and LEAD suggest that body size difference alone was responsible for the inter-site difference in fecundity. These sorts of research questions, whether examined between sites during the same year or within sites



Relationship between clutch size and female body size in the Eastern Garter Snakes (*Thamnophis sirtalis sirtalis*) at two sites in Pennsylvania in 2009; Powdermill Nature Reserve (PNR) and Letterkenny Army Depot (LEAD).

between years, provide a better understanding of the range of responses in the life history traits of this species. We believe that our study might have implications for the assessment of future demographic trends and potential habitat management for the ubiquitous Eastern Garter Snake. Furthermore, given the current and widespread biodiversity crisis, additional long-term studies focused on life history traits and the systematics of northeastern ophidians are necessary to confirm or complement our current findings.

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Homosexual Reproductive Behavior in the African Brown House Snake (*Lamprophis fuliginosus*)

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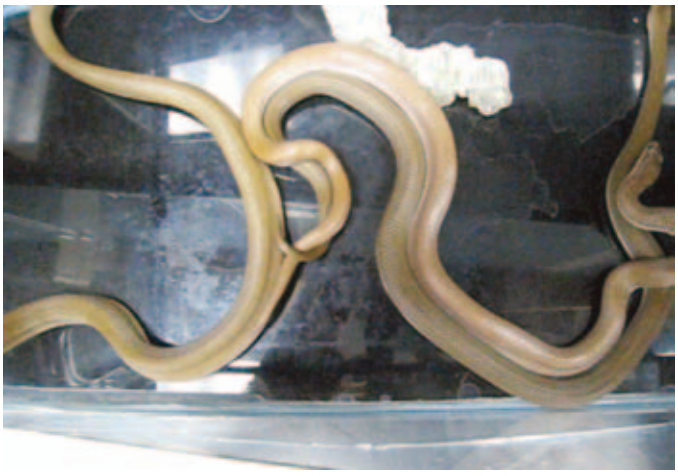
The occurrence of homosexual behavior in male snakes is complicated by the presence of female-like reproductive pheromones in at least one species, *Thamnophis sirtalis*. The production of female-like pheromones by male *T. s. sirtalis* was first described by Noble (1937) in the "homosexuality" section of his paper. Noble (1937) suggested that males may have evolved female odors to confuse other males or that perhaps the courting males were conditioned to court by exposure to attractive females. Mason and Crews (2005) studied the occurrence and function of female-like reproductive pheromones in male *T. s. parietalis* from Manitoba, Canada, and concluded that the production of female-like pheromones by males (termed she-males) was a reproductive strategy that enhanced the mating frequency of males producing these pheromones.

Although males produce female-like pheromones, copulation between males is rare. Pfrender et al. (2001) observed a copulatory plug in the cloaca of a male *T. s. parietalis* that was being courted by several other males and postulated that this male, because it was courted by several males, was a she-male. They added that because of its moribund condition, this male might have been unable to resist copulation by the courting males. We do not consider male courtship of she-males an example of true homosexual behavior.

For species in which males are not known to produce female-like pheromones, male-male courtship or copulation has been observed only in captivity. Hardy (1998) described male-male copulation in *Crotalus scutulatus*. He suggested that the copulation might have resulted from the presence of female pheromones from the male's body or from the cage floor. Shaw (1951) described male-male courtship in captive *Pituophis melanoleucus* and postulated that this could have been due to the failure of chemical discrimination. Smith (1968) suggested that homosexual mating in snakes



Male African Brown House Snake (*Lamprophis fuliginosus*) courting another male. Note that the bodies are parallel, the head of the courting male is along the dorsolateral surface of the target male and Male 1 is performing a tail search of the target male. A freshly shed skin of the courted male is present.