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High Predation on Green Snakes, *Opheodrys aestivus*

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In the course of monitoring movements and behavior of gravid green snakes (*Opheodrys aestivus*) by radiotelemetry, I observed predation by kingsnakes (*Lampropeltis getulus*) and racers (*Coluber constrictor*). The high frequency of the observed predation warrants this report.

Miniature radio transmitters (220 MHz, Model SOPI-1038-LD; Wildlife Materials, Inc.) were implanted into nine large (>500 mm snout-vent length, SVL), gravid *O. aestivus*. The snakes were released on 19 June 1988 at the sites of captures made during the previous week in the shoreline vegetation of a small lake 2 km W of Denmark, White County, Arkansas. Snakes were relocated several times each day until oviposition, and at least once each day thereafter.

After relocating *Opheodrys* nos. 255 and 584 several times on 24 June, weak signals were received in the afternoon from each snake indicating extensive movements atypical for the sedentary *O. aestivus*. Both signals were emanating from *L. getulus* (670 mm SVL male; 860 mm SVL female) from which *Opheodrys* nos. 255 and 584 with implanted transmitters were subsequently palped.

On 6 August, signals from *Opheodrys* no. 5 were received from underground, atypical for the arboreal *O. aestivus*. Underground signals continued to be received from no. 5 at various locations within an approximate 30 m^2 area over the next 14 days. On 20 August, I dug into a system of rodent burrows at the signal source and eventually found a 720 mm SVL female *L. getulus*. The *Lampropeltis* was taken to the laboratory where on 23 August it passed the transmitter originally implanted in *Opheodrys* no. 5.

At dusk on 9 July, *Opheodrys* no. 37 was ovipositing in a hollow tree. The next morning three *Opheodrys* eggs were found scattered on the ground at the base of the tree and a signal could not be detected. After extensive searching, a signal was detected, eventually leading to a 960 mm SVL female *Coluber constrictor*. Dissection revealed that the *Coluber* had first ingested an *Opheodrys* egg and then ingested *Opheodrys* no. 37. The posterior gut of the *Coluber* was full of grasshoppers.

Additional observations implicate *Coluber* as a predator of *O. aestivus* during this study. On 24 June, signals from *Opheodrys* no. 605 were lost. The last contact with the snake had been made the previous day at a location within 3 m of an active *Coluber*. A subsequent search for the *Opheodrys* was unsuccessful. On two other occasions (22 and 23 July), two different *Coluber* were observed actively foraging arboreally in the narrow band of alder at the shoreline, the preferred habitat of *O. aestivus* (Plummer, 1981). Studies of telemetered *Coluber* support strong arboreal tendencies (Fitch and Shirer, 1971).

At dusk on 7 July, *Opheodrys* no. 110 retreated into a rotted stump as she moved back toward her activity range after ovipositing in a hollow tree. The next morning, her transmitter was found on the ground next to a large oak tree, but she could not be located. The sutures at the site of implantation were intact on 7 July suggesting that the transmitter was lost as a result of predation, perhaps by a bird or mammal. On several occasions, I and my assistants have observed predation by bluejays (*Cyanocitta cristata*) on *O. aestivus* in an outdoor enclosure (Plummer, unpubl. obs.). Typically, bluejays carried snakes to a tree, pecked them to death, and eviscerated them as they ate. Parts not eaten, including most of the carcass, were allowed to fall to the ground (see also Sledge, 1969; Hammerson, 1988). Mammalian predation would also free the transmitter, but no tooth marks were found on the transmitter.

Both *L. getulus* and *C. constrictor* are known predators of *O. aestivus* in this region (Clark, 1949; Carpenter, 1958). The above observations are interesting because they describe predation on prey with known histories, but perhaps of greater significance is the high frequency of predation and its possible consequences for the population and implications for telemetric studies in snakes. In 47 days of observations, four of nine telemetered snakes were eaten by predators, and circumstantial evidence suggests that two other snakes suffered the same fate. The limited data preclude drawing definite conclusions, but conceivable explanations for these observations include: (1) The possibility that *Lampropeltis* and *Coluber* were attracted to the 220 MHz transmitter signals seems unlikely because no vertebrate is known to detect frequencies of that magnitude. (2) The possibility that the observations reflected the annual rate of predation on the general population also seems unlikely. Annual survivorship of adult female *O. aestivus* in a nearby, stable population was 49% (Plummer, 1985). Assuming constant mortality during the year, an annual survivorship of 49% converts to 91% for a 47 day period (Krebs, 1989). This value is much greater than the observed survivorship for 47 days calculated either as a finite survival rate (44%; Krebs, 1989) or as a Trent-

Rongstad radiotelemetry estimate (17%; Krebs, 1989). (3) A reasonable explanation for these observations is that mortality rates normally are high during nesting because of the risks associated with carrying a clutch (Seigel et al., 1987), and with terrestrial migration to nesting sites (Plummer, 1990). Furthermore, these risks may have been increased for the snakes bearing transmitter implants. Transmitters were approximately the same size as, but slightly heavier than, an *O. aestivus* egg (transmitter means = 7.4 × 10.9 × 22.4 mm, 2.4 g; egg means = 9.9 × 24.8 mm, 1.6 g; Plummer, 1984), and mean transmitter mass/body mass ratio (7%) was less than the recommended 10% maximum for amphibians and reptiles (ASIH et al., 1987). I did not notice any behavioral differences between telemetered and non-telemetered snakes; telemetered snakes oviposited normally (compared to snakes in the laboratory) and appeared to move normally before and after oviposition. Telemetered snakes were observed feeding in the field and produced normal-appearing feces when captured. Despite this apparent contrary evidence, transmitter implants increased by 25% the mass burden of the average clutch (6 eggs; Plummer, 1984) and may have further reduced the already decreased locomotor ability of gravid snakes (Seigel et al., 1987), rendering them more susceptable to predation. Limited recapture data for non-telemetered gravid females suggest greater survivorship from 10 June to 30 August 1988 (0.83, N = 6; Plummer, unpubl. obs.) than for snakes with transmitter implants. Researchers should be aware that the 10% maximum transmitter mass/body mass suggested by ASIH et al. (1987) may be too great, especially for slender-bodied snakes such as *Opheodrys*.

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Overlap Pattern in the Preanal Scale Row: An Important Systematic Character in Skinks

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In his classic monograph of the genus *Eumeces*, Taylor (1935) used as a key character the overlap pattern of the scales bordering the anterior edge of the vent: the inner scales overlapping the outer vs. the outer scales overlapping the inner. Taylor did not discuss this character again in either this or other work. However, subsequent work has shown that the pattern of overlap in the preanal scales is of major significance in skink systematics. The purpose of this note is to make this more widely known.

The pattern of preanal scale overlap is important in skinks for two reasons. Firstly, it concords well with another, classic preanal scale character, relative size of the medial pair, but is much less ambiguous in its interpretation; and secondly, it appears to corroborate major groupings based on other characters.

The dichotomy Taylor suggested in the pattern of preanal scale overlap for *Eumeces* applies throughout skinks. The pattern of the inner preanals overlapping the outer corresponds with what is classically described as "medial pair of preanals enlarged"; the pattern of the outer preanals overlapping the inner corresponds with medial preanals relatively unenlarged or approximately equal in size to the other scales in the preanal row. Although the size of the preanals in all skinks increases medially, the medial