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Aggregating Behavior and Exploitation of Subterranean Habitat by Gravid Eastern Milksnakes (*Lampropeltis t. triangulum*)

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Abstract. At a site in southeastern Wisconsin, aggregations of from 2 to 5 gravid *Lampropeltis t. triangulum* utilized a discarded piece of steel shelving alongside a paved road. Associated with the shelf was a tunnel that led beneath the road which enabled gravid females to move distances of up to ca. 40 m underground. Using implanted radio transmitters, we determined that the snakes used the subterranean retreats at night and maintained stable body temperatures. They ascended to the surface at daybreak and thermoregulated beneath the shelf. Females which select a microhabitat which allows body temperatures to be optimally regulated during gestation and also provides cover for avoiding predators would seem to have a selective advantage.

Aggregating behavior in gravid snakes is known in viviparous colubrids (Gregory, 1975), elapids (Shine, 1979) and viperids (e.g., Fitch, 1960), but aside from communal nesting it has apparently been unknown in oviparous colubrids. Here we describe and discuss a pronounced case of this behavior in gravid *Lampropeltis t. triangulum* in SE Wisconsin. In addition, we describe how female milksnakes exploit a particular microhabitat for thermoregulation and predator avoidance.

Study Area and Materials and Methods

Study area — The study site is located ca. 3.2 km SE of Whitewater, Walworth Co., Wisconsin in the southern Kettle Moraine State Forest. It is bordered on the NE by Co. Hwy. P and running parallel to the hwy is a low (4-5 m high) ridge which, at the turn of the century, was a (never used) railroad embankment. The embankment was built up of large rocks, tree trunks and other natural litter, and now serves as a denning site for several species of snakes (*L. triangulum, Nerodia sipedon, Regina* *septemvittata, Storeria dekayi, S. occipitomaculata* and *Thamnophis sirtalis*). A trout stream (Bluff Creek) flows at a more or less 90° angle to the highway. Southwest of the ridge is a fen which, characteristically, has a soft, spongy substrate. Conspicuous vegetation includes sedges (*Carex*), staghorn sumac (*Rhus typhina*) and cottonwood (*Populus deltoides*). Walworth Co. Hwy P, at the study site, was constructed in the late 1840's, regraded to its present condition in 1936, paved in 1937, and resurfaced in the mid-1950's (and again in 1979); the roadbed is clay or "granular" fill and "filled 2.5-3.0 ft" (Source: Walworth Co. Highway Commission, Elkhorn, WI). Thus, the roadbed beneath the highway surface likely consists of a network of tunnels through which snakes, and other animals, can travel.

Materials and Methods. — All snakes caught were weighed, measured, sexed, and had a unique combination of ventral scutes clipped for future identification. Four females were tagged with surgically implanted transmitters (either Model L., Mini-Mitter Co., Inc.; or SM-1 mouse style, AVM Instrument Co.) in order that we could monitor their movements and body temperatures (see Henderson et al., 1976 and Nickerson et al., 1978 for details). A small mid-ventral longitudinal incision was made posterior to the stomach and anterior to the oviducts and the transmitter was placed in the coelom. The incision was closed with monofilament nylon sutures. Transmitters weighed 5.0% or less of each snake's body weight and animals that underwent surgery oviposited successfully and fed voluntarily after transmitter removal. Movements and temperatures (body, air and substrate) were monitored every 0.5 h over several 24 h periods.

RESULTS

On 14 June 1978, upon turning a piece of discarded steel shelving lying in the grass alongside Hwy. P, we found five gravid *L. triangulum* (Fig. 1). We had turned this piece of shelving routinely since mid-April without ever finding a snake. Subsequently, additional gravid *L. triangulum* were found under the metal on 16 June, 18 June, 23 June (2), and 26 June. Thus, a total of ten gravid *L. triangulum* was collected over a 12-day period from beneath this single piece of roadside debris. No male *L. triangulum* or individuals of any other snake species were found beneath the shelf in that 12-day period.

The piece of shelving was 122 × 61 cm with turned-up edges 3 cm high. It was 1.5 mm thick and painted a dark olive green. Associated with the piece of shelf was a hole ca. 5 cm in diameter and 8 cm from the shelving. The hole led underneath the highway (NE of the shelving) and possibly in other directions away from the metal. The hole was probably the entrance to a burrow excavated by a thirteen-line ground squirrel (*Citellus tridecemlineatus*), a species commonly seen associated with roads in the immediate area. At least one tunnel extended for ca. 38 m

Figure 1. Location of the steel shelf along Highway P in Walworth Co., Wisconsin used by aggregating *L. t. triangulum.* August 1978.

beneath and parallel to the highway. The shelving was 75 cm from the base of the denning hill, 30 cm from the slope of the highway's shoulder and 3 m from the blacktop. Beneath the shelving was long matted grass, deeper in some areas than in others and thus not providing a uniform substrate; some areas were nearly devoid of grass. Using a digital temperature probe (Model 2100, IMC Instruments, Inc., Glendale, WI), we found that on a clear day with the shelf in open sunlight temperatures on the surface of the grass beneath the shelf (but not in contact with the metal) varied by 11.6 C depending on which part of the cover object was tested. When the probe was buried in the matted grass (not in the ground) the temperature range was 5.3 C. At any one place under the shelving the temperature range was as high a 16.4 C depending on whether the probe was on the grass surface or buried in the grass. Therefore, the substrate environment beneath the shelf was not uniform and the snakes could modify their body temperatures by burrowing within, or lying on top of, the grass substrate.

On 8 occasions between 14 June and 5 July 1978 we found from 2 to 5 gravid *Lampropeltis* sharing a cover object at the same time. On 7 of those 8 occasions the cover object was the shelf. Five snakes were found once, 3 snakes twice and 2 snakes 5 times. Sometimes snakes were in contact with one another and at other times they were not. Occasionally the snakes were partially buried in the matted grass beneath the shelf but usually they rested on the grass surface. In 1979 the ground beneath the shelf was devoid of any cover vegetation, but two unmarked females were found together there on 13 June. It was not unusual for two gravid females to remain together beneath the shelf for several hours at a time.

From 21 June to 7 July 1978 we periodically monitored movements of four females and recorded body temperatures (T_b) from two of them. While recording T_b we also monitored the substrate (grass mat) temperature (T_s) beneath the shelf and air temperature (T_a) with stationary Schultheis thermometers.

We never observed a snake move out from under the shelf except to the nearby hole leading underground. Radio telemetry allowed us to determine subterrestrial movements once a snake entered the hole. Four different females were radio-located above and below ground (Fig. 2). All four snakes moved beneath the highway and one, #26 (square symbols, Fig. 2), moved at least 38 m parallel to and beneath the center of the hwy. Female #18 (closed circles, Fig. 2) moved subterrestrially from the N side of the ridge to the S side and into the fen. Two of the females were observed above ground and one of them, #16 (triangles, Fig. 2), moved from the shelf area to some rockwork in the wall of a bridge crossing the highway. Perhaps that movement, of about 40 m, was also subterrestrial. Although the snakes sometimes moved away from the shelf, such as #16's movement to the bridge and #18's movement to the fen, they subsequently returned to it either the same day or possibly several days later.

At night the snakes usually left the shelf and moved into the roadbed beneath the highway. Here they were able to maintain stable T_b's well above T_a and T_s. One female (#18) was monitored during a 24-h period on 23-24 June 1978 (Fig. 3). Under cloudy skies T_b approximated T_s when the snake was under the shelf (0900-1200 h, Fig. 3). Whenever the snake left the shelf and moved under the shoulder of the road there was a sharp drop in T_b until the animal was under the blacktop. T_b rose dramatically when the shelf was in sunlight (1630-1730 h, Fig. 3). At night, beneath the blacktop, T_b remained remarkably stable at around 20 C until after sunrise when the snake left the highway, moved through the thermal depression in the shoulder, and crawled under the shelf in the sun.

DISCUSSION

Cases of communal nesting are not uncommon in colubrids (e.g., Brodie et al., 1969; Cook, 1964; Foley, 1971; Palmer and Braswell, 1976; Parker and Brown, 1972; and Swain and Smith, 1978). However, aggregations of gravid conspecifics are unreported in oviparous colubrids, although reported in viviparous colubrids (Gregory, 1975), elapids (Shine, 1979) and viperids (e.g., Finneran, 1953; Fitch, 1960;

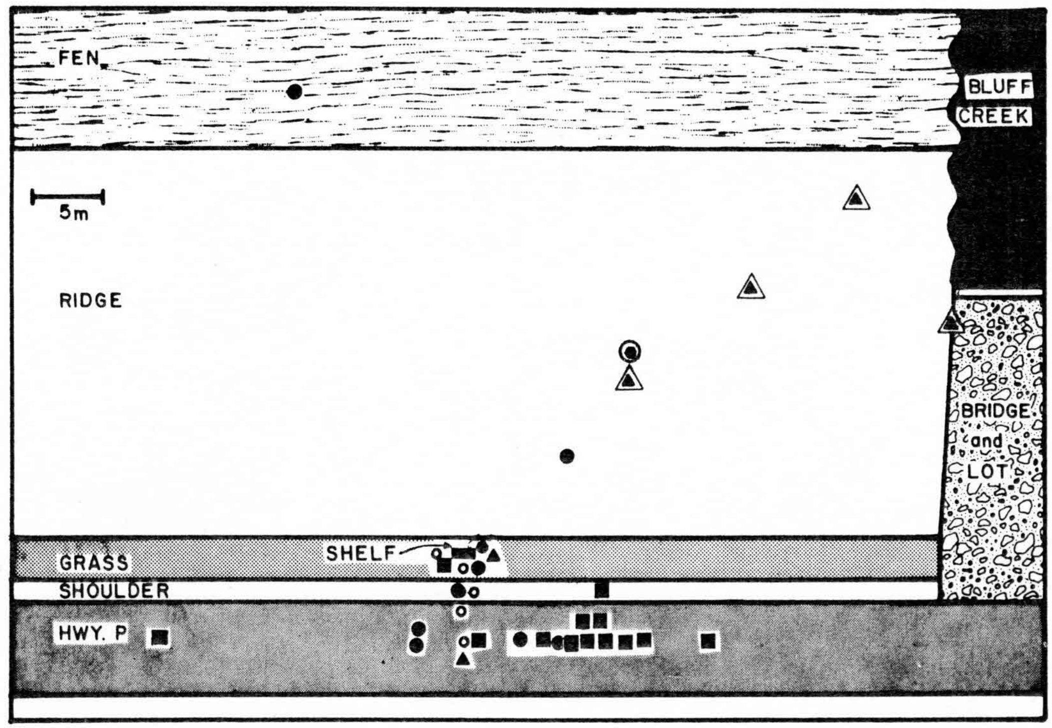

Figure 2. Schematic representation of a portion of the study area and points at which *L. t. triangulum* were radio-located subterrestrially. Triangles = female #16, closed circles = #18, open circles = #24, and squares = #26. (An outlined symbol designates a point at which a snake was located above ground.)

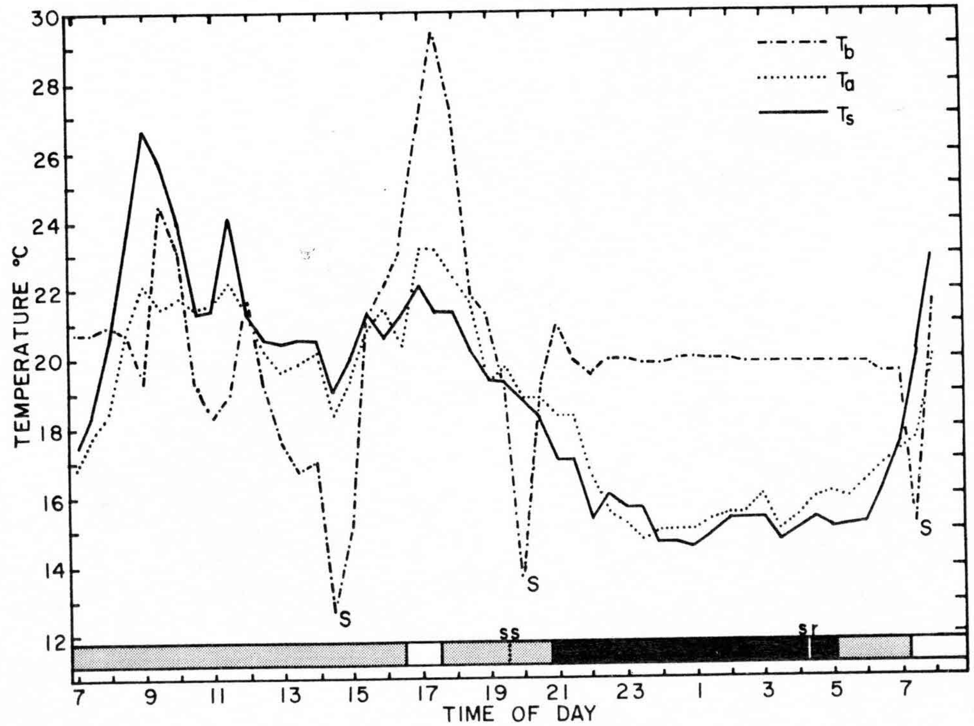

Figure 3. Air, body and substrate temperatures monitored for female #18 on 23-24 June 1978. S = snake is under shoulder of road or has just left area under the shoulder. The bar along the bottom of the graph indicates sky conditions: stippled = cloudy sky or shelf is in shade; white = shelf is in sunlight; black = night; ss = sunset; sr = sunrise.

Goyd, 1934; Klauber, 1956). In fact, in at least one viviparous colubrid (*Storeria dekayi*) in which aggregative behavior is common, Noble and Clausen (1936) found that only gravid females do not aggregate. As in the known cases of communal nesting (e.g., Brodie et al., 1969; Covacevich and Limpus, 1972), the gravid *L. triangulum* reported here probably aggregated at the site of the metal shelf because it provided optimum conditions (which were not available elsewhere) for thermoregulation and protection rather than for social reasons.

The blacktop road and the fortuitously discarded steel shelf played seemingly important roles in the ecology of gravid milksnakes at the study site. We do not know how long it had been lying alongside the road before we began checking it for snakes in early April 1978. Whether any of the females hibernated at the ridge den is unknown.

We do not know where the females oviposited, but it was not beneath the shelf. One radio-tagged female (#18) oviposited sometime between 1230 h on 6 July (when she was located under the road) and 1000 h on 7 July (when she was found, spent, under the shelf), and another spent female (#16) was found beneath the shelf at 1030 h on 3 July. Both snakes may have laid their eggs in the roadbed.

Our disturbance of the aggregating site may have disrupted the main aggregation somewhat. The five females collected on 14 June were held in the laboratory for 6 days while awaiting transmitters before being released at the capture site. Females caught after 14 June were either processed in the field and released immediately, or they were brought back to the laboratory for transmitter insertion and released within 24 h of capture.

Male *Lampropeltis* were not observed at the shelf until 24 and 30 August. At least some males have been observed to disperse from the denning site soon after spring emergence (Henderson and Binder, unpublished). Why males that possibly remained in the area avoided the shelf is unknown, but several possibilities seem plausible: (1) The shelf site may be too hot during the day for males and non-gravid females; (2) The site, at least during the day, was usually occupied by one or more females and, after spring mating, males may naturally avoid interaction with conspecifics (of either sex); or (3) The shelf site was already crowded and therefore undesirable to males. Gravid females, on the other hand, may have a greater tolerance of crowding in order to exploit desirable microhabitat.

The gravid females' habit of going into seclusion and becoming sedentary has been reported in *Storeria dekayi* (Noble and Clausen, 1936; Seibert and Hagen, 1947). Although the *L. triangulum* became secretive (i.e., rarely left cover) they did not become particularly sedentary.

The snakes successfully utilized the space beneath the blacktop road, especially at night when above-ground air temperature dropped (as did T_s under the shelf). The blacktop surface absorbed radiant heat during the day and at night this absorbed heat may have provided higher ambient and substrate temperatures than above ground. The thermal depression which occurred beneath the shoulder of the road apparently was not an obstacle to movements between the above-ground substrate (beneath the shelf) and below-ground retreats. The snakes had to crawl under the road shoulder a minimal distance of 3.5 m. Presumably, that distance could be traversed in several minutes.

The potentially extensive network of subterranean passageways beneath the highway, roadside and ridge made movement by gravid females from one desirable retreat or thermoregulation site to another essentially predator-free. The gravid milksnakes have probably ceased feeding several weeks before oviposition, and time and energy were devoted to egg development and searching for a suitable site for egg deposition. A snake heavily laden with eggs is likely more susceptible to predation than one that is not, since its movements are slower. Also, gravid females of most oviparous snake species may need to maintain higher and more stable T_b's than non-gravid individuals for proper egg development, devoting more time to thermoregulatory behavior in situations where they may be vulnerable to predation. The ability to optimally thermoregulate without increased risk of predation would seem to have selective value.

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