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MOVEMENTS OF A BULLSNAKE (*PITUOPHIS CATENIFER*) FOLLOWING PREDATION OF A RADIO-COLLARED NORTHERN POCKET GOPHER (*THOMOMYS TALPOIDES*)

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Life history and foraging data for the bullsnake (*Pituophis catenifer*) include home range of 1–2 ha, density of $<1 \cdot ha^{-1}$, unimodal activity peak between April and September in most temperate climes, and estimated longevity of ~16 years (Gibbons and Semlitsch 1987, Parker and Plummer 1987, Hammerson 1999). Extensive food habits data for the bullsnake show that diverse species of rodents and lizards comprise the bulk of the diet (Hisaw and Gloyd 1926, Brown and Parker 1982, Reynolds and Scott 1982, Mushinsky 1987, Hammerson 1999), but observations of actual predation events and of subsequent movements of these predators in the field are rare.

Carpenter (1982) reported on the stereotyped, soil-excavation behaviors of the bullsnake (*P. m. sayi*), a behavior initially described by Hisaw and Gloyd (1926). These authors inferred that bullsnakes dig to open and search burrows for pocket gophers and to prepare cavities for nesting. In laboratory trials (Carpenter 1982), 7 of 8 bullsnakes were observed using their snouts to penetrate soil and head-neck flexures to move scooped soil posterior from the dig sites. These trials revealed that an excavating bullsnake can move up to 3400 cm^3 of soil per hour. Moreover, soil obtained from actual pocket gopher mounds and placed in test cages induced excavation behaviors in 11 snakes during 60% of trials; this compared to bullsnake digging activity during only 7.5% of trials in control soil.

We report here on the likely predation of a radio-collared northern pocket gopher (*Thomomys talpoides*) and subsequent movements of a bullsnake that we believe ingested the gopher. These serendipitous observations were obtained during a field study to evaluate the use of chemical irritants in soil to expel gophers from burrows.

The site is located in a 64.75-ha field (40°45′20″N and 105°02′30″W) near Wellington, Colorado; at the time of the study the field had a 5+-year-old stand of alfalfa (*Medicago sativa L*) and mixed grasses with center-pivot irrigation. The soil is characterized as a sandy loam texture (62% sand, 26% silt, and 12% clay), with 7.9 pH and 2.5% organic matter (Agvise® Laboratories, Northwood, ND). Numerous mounds (~1 mound or plug per 5–8 m^2) of northern pocket gophers were present in the field.

The gopher (♀, 146 g) was live-trapped (CO License 99-TR621A2) on 18 August 1999. Within 6 hours of capture (trap last checked at ~0900 hours MDT, capture detected at 1320 hours MDT, and release at capture site accomplished at 1440 hours MDT), the gopher was anesthetized using a 2- to 3-minute inhalation exposure to Metofane® (Mallinckrodt Veterinary, Inc., Mundelein, IL) in a large glass jar. A 2.45-g radio-transmitter (Holohil Systems, Ontario, Canada) containing a 1.5 × 1.0 × 0.7-cm battery pack (40–50 day projected life) with a wire whip antenna (~10 cm) was affixed snugly around the gopher's neck using shrink-tubing–covered wire, leader sleeves, and Duro Super Glue® (Loctite Corp., Newington, CT).

We visually located the ground-surface location nearest the transmitter using a handheld, 3-element Yagi antenna and a portable

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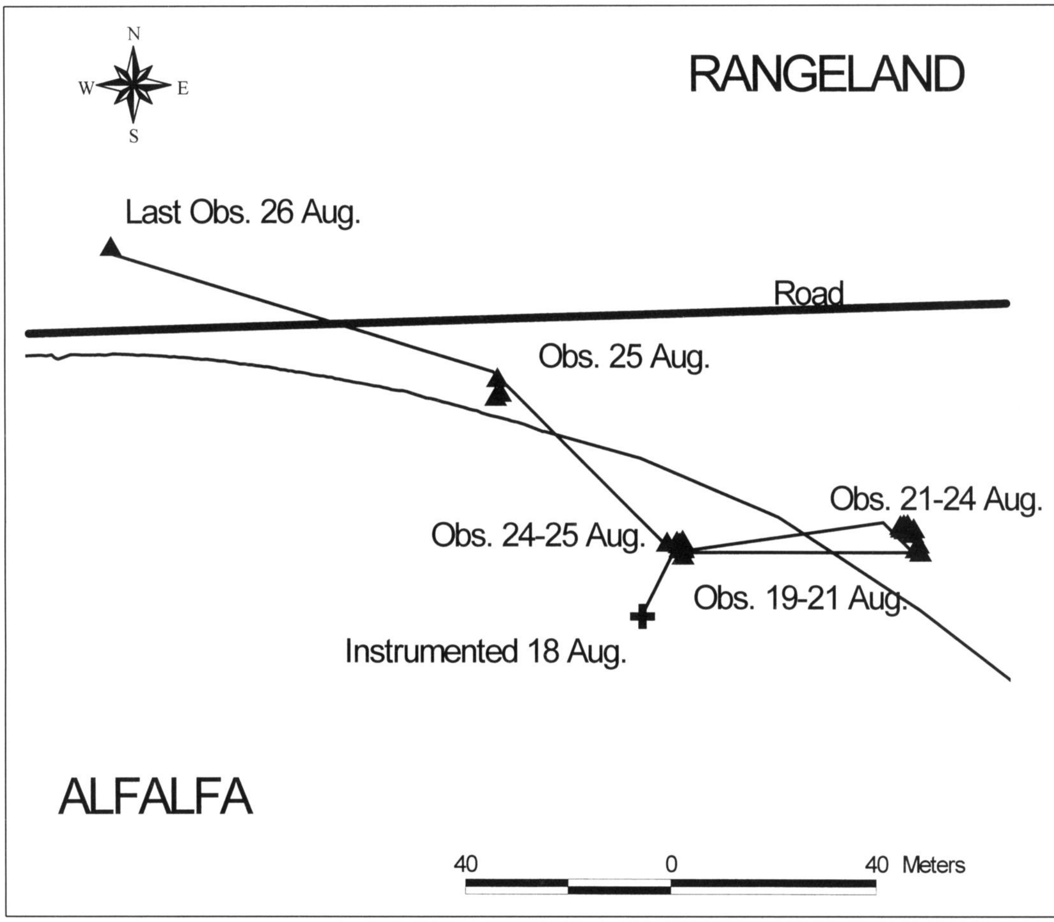

Fig. 1. Schematic showing GPS transmitter locations between 18 and 26 August 1999.

radio receiver (Advanced Telemetry Systems, Inc., Isanti, MN). Typically, we obtained these locations during 4 daily tracking sessions: 0801–1000, 1201–1400, 1601–1800, and 1901–2000 hours MDT. Geographic locations were marked and determined using a Global Positioning System (GPS) receiver (GeoExplorer®, Trimble Navigation, Sunnyvale, CA). Data were differentially corrected via Pathfinder® software (Pathfinder®, Trimble Navigation, Sunnyvale, CA) and imported into ArcView GIS software (ESRI, Redlands, CA). To estimate accuracy, we always collected GPS data for a predetermined reference location prior to each series of transmitter locations; estimates of the reported ground-surface locations were within 2 m of true.

Between 18 and 26 August 1999, the transmitter was located 29 times (Fig. 1). The first 14 locations (3.5 days) were typical of northern pocket gopher movements (≤20 m from the point of capture for the gopher). However, late on 21 August 1999, the transmitter could not be detected during routine tracking. A more extensive search of the area the next morning yielded detection ~63 m northeast of the original gopher capture/release site. The transmitter remained within 2 m of this location during the subsequent 2 days (8 locations), before returning to near the last 21 August location (~16 m north of the capture/release site) for <8 hours. Subsequently, the transmitter was located ~60 m northwest of the capture site and remained there for about 12 hours (25 August). Finally, on the morning of 26 August (~1000 hours MDT), the transmitter signal was detected moving in a westerly direction on or adjacent to a field road along the northern edge of the alfalfa field. The source of the signal was sighted—a 90- to 110-cm-long bullsnake. The snake then entered a livestock pasture to the north and later disappeared into a small rodent hole ~20 m north of the fence line or 145 m west-northwest of the capture/release site (see Fig. 1). This was the final detection of the transmitter's signal.

Based on our observations, it is apparent that the gopher and transmitter were ingested by the bullsnake on, or about, the afternoon of 21 August. We have rarely, if ever, recorded movements of a northern pocket gopher >45 m from the point of capture/release. Thirteen other radio-collared northern pocket gophers tracked in this same vicinity had a maximum movement distance (from the point of capture/release) of 45 m. Additionally, the subsequent lack of movement for ~72 hours is consistent with hypothesized restive/digestive activities of the bullsnake post-predation; but, counter to Hammerson (1999), this snake did not "sun-the-stomach" to aid digestion. We believe that the snake remained stationary and belowground from at least 21 to 24 August.

Considering that an adult bullsnake is active for about 5.5 months per year in Colorado, weighs ~1.0–1.5 kg, and ingests ~1.0–2.0 kg of prey per year (see Hisaw and Gloyd 1926, Mushinsky 1987), this predation event was likely 1 of <20 feedings for the snake during 1999 (i.e., assuming 80–150 g rodents/lizards/birds). Whether it survived the ingestion of the hardware is unknown.

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