Burrowing ecology of the rare and elusive Louisiana pine snake, *Pituophis ruthveni* (Serpentes: Colubridae)

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Abstract. The burrowing ecology of 12 adult and nine juvenile Louisiana pine snakes, *Pituophis ruthveni*, was studied during 1995-1997 in north-central Louisiana, U.S.A. Significantly more adult burrows connected to pocket gopher (*Geomys breviceps*) tunnels than did juvenile burrows, although a relatively high number of adult and juvenile snake burrows were blind-ended. Significantly more adult snake burrows were located in pine plantations and grasslands and significantly less were located in clearcuts than expected. Significantly more juvenile snake burrows were located in pine plantations than expected. Adult and juvenile snake burrows were located in areas that had relatively less leaf litter and canopy closure than expected. Excavation behavior by *P. ruthveni* was stereotyped and similar to excavation behavior by the bullsnake, *Pituophis catenifer sayi* and the northern pine snake, *Pituophis melanoleucus melanoleucus*.

Introduction

The genus *Pituophis* (Serpentes: Colubridae) contains three species of snakes in the United States: *P. catenifer*, *P. melanoleucus* and *P. ruthveni* (Collins, 1997). A diversity of habitats are inhabited by these species, from pine forests in the east (Burger and Zappalorti, 1988, 1989; Dundee and Rossman, 1989; Conant and Collins, 1991; Franz, 1992) and prairies in the midwest (Anderson, 1965; Conant and Collins, 1991) to deserts and brushlands in the west (Parker and Brown, 1980; Stebbins, 1985). Through most of its distribution, *Pituophis* is a fossorial snake that spends relatively short periods of time on the surface (Martof et al., 1980; Parker and Brown, 1980; Conant and Collins, 1991; Franz, 1992). Thus, it is not surprising that *Pituophis* is capable of excavating the soil and constructing its own burrow.

The excavation habits of *Pituophis* are reflected in its morphology: the head is laterally compressed and the rostral scale on the tip of the snout is enlarged and upturned (see Stull,

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1940, for an overview of *Pituophis* morphology). In addition, the premaxilla-nasal articulation in the skull of *P. catenifer sayi*, *P. melanoleucus melanoleucus* and *P. melanoleucus mugitus* is modified to better distribute the mechanical stress of excavation along the length of the nasal bones, giving increased rigidity to the skull during excavation (Knight, 1986). These morphological adaptations enable *Pituophis* to dig into and loosen the soil with the snout (Moore, 1893; Stebbins, 1954; Carpenter, 1982; Burger and Zappalorti, 1991). Furthermore, the forepart of the body is used as a scoop to extract a load of loosened soil from the burrow under construction and deposit it onto the surface (Schmidt and Davis, 1941; Stebbins, 1954; Shaw and Campbell, 1974; Carpenter, 1982; Burger and Zappalorti, 1991). As the excavated soil accumulates on the surface, it forms a characteristic "dump pile" that surrounds the burrow opening (Burger and Zappalorti, 1991).

Pituophis may burrow into a pocket gopher (Geomyidae: *Geomys*) mound on the surface (Carpenter, 1982) to gain entry into the mammal's underground tunnel (Franz, 1992), thus enabling the snake to hunt the pocket gopher (Hisaw and Gloyd, 1926; Shaw and Campbell 1974). Some *Pituophis* burrows are blind-ended, however (pers. obs.), and thus *Pituophis* may burrow to avoid aboveground temperature extremes (Burger et al., 1988), although inactive snakes in burrows are vulnerable to mammalian predators (Burger et al., 1992). In addition, female *P. m. melanoleucus* in New Jersey may excavate nesting burrows that are sometimes communal and contain multiple egg-laying chambers (Burger and Zappalorti, 1986, 1991, 1992).

The Louisiana pine snake, *Pituophis ruthveni*, is endemic to western Louisiana and adjacent Texas, U.S.A. (Thomas et al., 1976; Conant and Collins, 1991; Reichling, 1995). The limited distribution (Thomas et al., 1976; Reichling, 1995), low population density (Jennings and Fritts, 1983; Reichling, 1989), and secretive nature (Reichling, 1988) of *P. ruthveni* have made research on this species difficult. Thus, few natural history data have been collected since its original description by Stull in 1929. In fact, nothing has been published on excavation behavior or location of burrows of *P. ruthveni* in the wild.

I radiotracked *P. ruthveni* in north-central Louisiana from 1995-1997. During this study, pine snakes were occasionally located in snake burrows and observed to excavate. The objectives addressed in this paper are to (1) determine destinations of snake burrows, (2) determine macro- and microhabitat characters of areas containing snake burrows, and (3) describe the excavation behavior of *P. ruthveni* in comparison to other *Pituophis*. For objectives (1) and (2), a comparison of burrows that were excavated by adults and juveniles of *P. ruthveni* is made.

Materials and Methods

The study site is located in Bienville Parish, Louisiana (32°20′N, 93°06′W) and consists of low sandy hills divided by ravines (elevation 60-90 m). Temporary creeks form at the bottom of the ravines during rainy weather. Pine forest is the dominant plant formation

Table 1. Background information on specimens of *Pituophis ruthveni*. Sexual size dimorphism (e.g., different tail lengths) is unknown in this species and thus only total length (rather than snout-vent length) is reported. Second measurements were not recorded of snakes that died in the field. A = adult, F = female, J = juvenile, M = male.

Snake ID No.	Sex	Size Class	Total Length (cm)		Weight (g)		Date of First Measurement	Date of Last Measurement
			Initial	Final	Initial	Final	Implant (D/M/Y)	(D/M/Y)
8	F	A	141.7	–	732.5	–	04/04/95	–
11	F	A	124.5	129.5	629.0	500.8	07/06/95	05/12/97
12	M	A	130.9	–	553.0	–	07/06/95	–
15	M	A	156.9	157.3	996.9	606.4	06/07/95	13/08/96
17	M	A	120.7	123.5	485.0	580.0	10/07/95	08/10/96
18	M	A	127.5	131.8	588.0	543.6	10/07/95	10/12/97
21	M	A	151.0	–	1013.0	–	22/08/95	–
24	F	A	131.1	–	776.9	–	07/09/95	–
25	F	J	96.6	108.9	199.0	242.5	19/03/97[a]	10/12/97
30	F	A	152.0	–	760.2	–	08/08/96	–
33	M	A	132.5	134.0	528.4	479.4	01/09/97	10/12/97
34	F	J	88.5	106.1	200.7	327.0	05/11/96	10/12/97
35	F	J	98.5	106.2	277.6	330.8	05/11/96	10/12/97
36	F	J	86.2	103.3	240.0	386.0	25/04/97	10/12/97
37	M	A	141.0	–	889.5	–	05/11/96	–
38	F	J	101.0	–	284.0	–	05/11/96	–
39	F	J	95.7	–	246.2	–	05/11/96	–
40	M	J	83.5	–	262.5	–	25/04/97	–
41	M	J	83.8	–	231.0	–	25/04/97	–
42	F	J	85.4	–	240.5	–	25/04/97	–
43	F	A	143.2	–	765.3	–	04/07/96	–

[a] Snake initially measured and released on 25/04/97 and 30/04/97, respectively.

seven days a week during the summer. During the summer of 1996, fall of 1996, and fall of 1997, snakes were located two times a day, except during one week in the fall of 1997, when snakes were located three times a day. Consecutive trackings of individual snakes took place > 5 h apart.

The exact site on which radiotracked snakes were located was flagged and the ground surface at each of these sites was visually scanned for the presence of a snake burrow. Habitat data were collected in an area (plot) with a radius of 11.2 m (1/25 ha) centered on each snake burrow (n = 79 snake burrow plots) and in areas that were randomly selected (n = 100 random plots) from 15 minute series topographical maps (U.S. Geological Survey, Denver, CO). Data were usually collected immediately after locating the snake; however, when a snake was located on the surface, habitat data were collected the following day to minimize disturbance of the snake.

Habitat type (pine forest, pine-hardwood forest, hardwood-pine forest, hardwood forest, pine plantation, grassland, or clearcut) of each plot was determined. Canopy closure percent was determined from a cardboard sighting tube (James and Sugart, 1970). Percentages of understory cover (foliage, branches, leaf litter) were visually estimated.

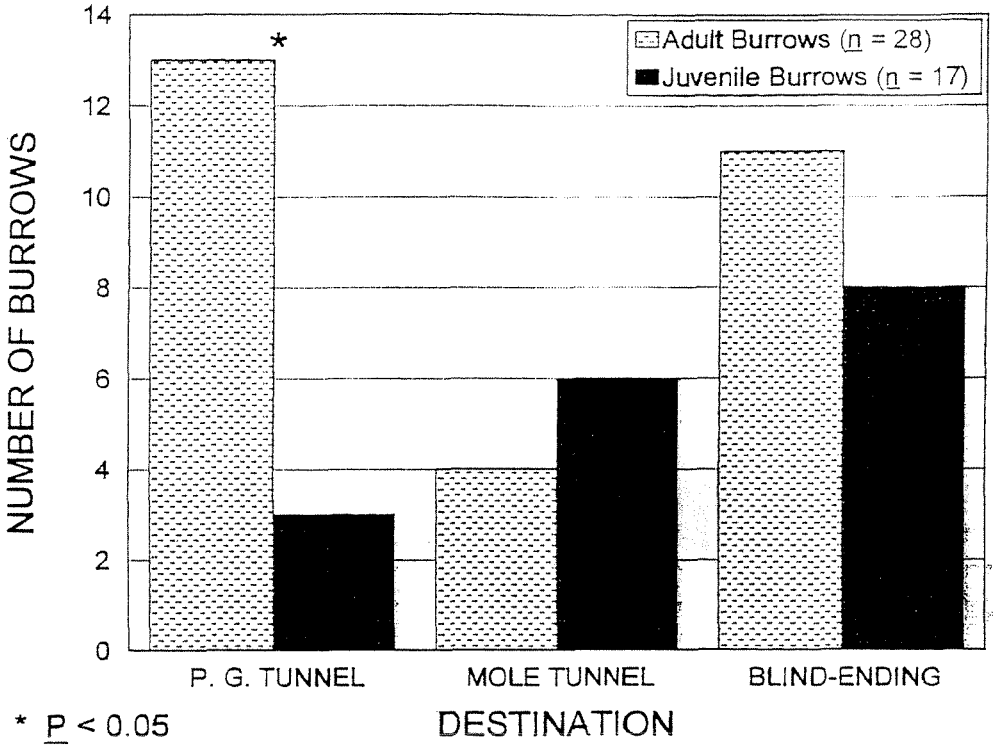

Figure 1. Destination of adult and juvenile snake burrows. P. G. = pocket gopher. An asterisk indicates a significant difference between number of adult and juvenile burrow destinations. For only 45 of the total 79 burrows could the destination be ascertained.

The snake repeated the spading and scooping actions, usually pausing for approximately one minute between actions.

On none of the three occasions was the entire excavation process observed. On two occasions, the snakes ceased excavation after five minutes of viewing by the investigator. However, on one occasion I observed a pine snake excavating over a period of two and one-half hours. When first observed, the head and neck of this snake were inside a burrow it had begun to excavate. The portion of the snake's body above ground did not move during the following 5 min, after which the snake brought its anterior body forward, removing a pile of soil with its crooked neck. This sequence of events was repeated until the mound of soil (dump pile) on the surface was approximately twice its original volume. Two and one-half hours after initial observation, the snake entered the burrow completely and did not leave it until the next day.

Of the three excavations observed, one each occurred in the morning, afternoon, and evening. A different juvenile snake performed each excavation. On six and seven occasions, respectively, adult and juvenile snakes were observed with the posterior one-

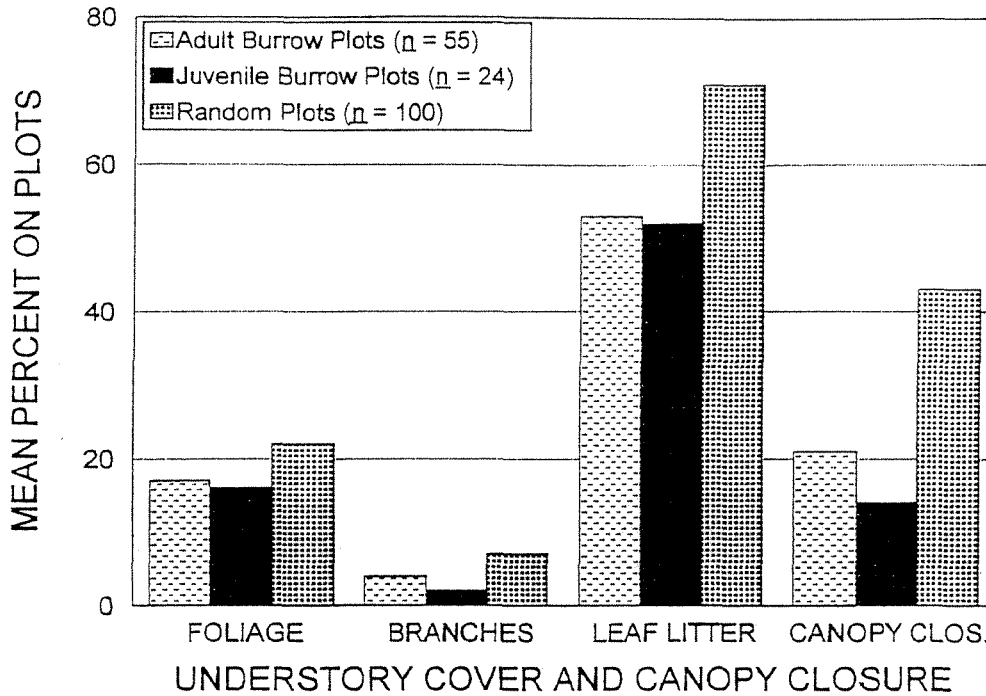

Figure 3. Understory cover percentages on adult and juvenile snake burrow plots and canopy closure percent over the center of adult and juvenile snake burrow plots compared to random plots. CLOS. = closure.

identifiable prey items were moles (Rudolph et al., in review). Moreover, examination of the only fecal sample from a juvenile study snake indicated that a mole had been consumed (Rudolph et al., in review).

Adult *Pituophis ruthveni* burrows were more frequent in pine plantations and grasslands and less frequent in clearcuts than expected. In contrast, female *P. catenifer deserticola* and *P. m. melanoleucus* excavate nesting burrows in open clearings (Zappalorti et al., 1983; Burger and Zappalorti, 1986), where the sparser vegetation results in fewer root obstructions and higher incubation temperatures than in surrounding areas. Thus, the lack of need for maintaining higher incubation temperatures in non-nesting burrows excavated by *P. ruthveni*, as well as the higher vulnerability of snakes to predators in open habitats, may explain the scarcity of *P. ruthveni* burrows in clearcuts.

Although burrow excavation by a juvenile *P. ruthveni* took over two and one-half hours, this may be an exceptionally lengthy time, especially for adults. In fact, because excavation of only three of 79 burrows was observed, this may normally be a short process that an investigator is unlikely to observe. Alternatively, snakes may have excavated during times of less intense study (e.g., during rain or at night). However, snakes were seldom surface-active during these times (pers. obs.). During the 13 occasions in which one-quarter to

Burger, J., Zappalorti, R.T. (1988): Habitat use in free-ranging pine snakes, *Pituophis melanoleucus*, in New Jersey Pine Barrens. Herpetologica **44**: 48-55.

Burger, J., Zappalorti, R.T. (1989): Habitat use by pine snakes (*Pituophis melanoleucus*) in the New Jersey Pine Barrens: individual and sexual variation. J. Herpetol. **23**: 68-73.

Burger, J., Zappalorti, R.T. (1991): Nesting behavior of pine snakes (*Pituophis m. melanoleucus*) in the New Jersey Pine Barrens. J. Herpetol. **25**: 152-160.

Burger, J., Zappalorti, R.T. (1992): Philopatry and nesting phenology of pine snakes *Pituophis melanoleucus* in the New Jersey Pine Barrens. Behav. Ecol. Sociobiol. **30**: 331-336.

Burger, J., Zappalorti, R.T., Dowdell, J., Georgiadis, T., Hill, J., Gochfeld, M. (1992): Subterranean predation on pine snakes (*Pituophis melanoleucus*). J. Herpetol. **26**: 259-263.

Burger, J., Zappalorti, R.T., Gochfeld, M., Boarman, W.I., Caffrey, M., Doig, V., Garber, S.D., Lauro, B., Mikovsky, M., Safina, C., Saliva, J. (1988): Hibernacula and summer den sites of pine snakes (*Pituophis melanoleucus*) in the New Jersey Pine Barrens. J. Herpetol. **22**: 425-433.

Carpenter, C.C. (1982): The bullsnake as an excavator. J. Herpetol. **16**: 394-401.

Collins, J.T. (1997): Standard common and current scientific names for North American Amphibians and Reptiles, 4th ed. SSAR Herp. Circ. **19**: 1-40.

Conant, R., Collins, J.T. (1991): A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Third ed. Boston, Massachusetts, Houghton Mifflin Co.

Dundee, H.A., Rossman, D.A. (1989): The Amphibians and Reptiles of Louisiana. Baton Rouge, Louisiana State Univ. Press.

Franz, R. (1992): Florida pine snake. In: Rare and Endangered Biota of Florida. Volume III. Reptiles and amphibians. p. 254-258. Moler, P.E., Ed., Gainesville, Univ. Press of Florida.

Hisaw, F.L., Gloyd, H.K. (1926): The bull snake as a natural enemy of injurious rodents. J. Mammal. **7**: 200-205.

James, F.C., Sugart, H.H., Jr. (1970): A quantitative method of habitat description. Audubon Field Notes **24**: 727-736.

Jennings, R.D., Fritts, T.H. (1983): The status of the black pine snake *Pituophis melanoleucus lodingi* and the Louisiana pine snake *Pituophis melanoleucus ruthveni*. U.S. Fish and Wildlife and Univ. of New Mexico Mus. of Southwestern Biol., p. 1-32.

Knight, J.L. (1986): Variation in snout morphology in the North American snake *Pituophis melanoleucus* (Serpentes: Colubridae). J. Herpetol. **20**: 77-79.

Lowery, G.H., Jr. (1974): The Mammals of Louisiana and its Adjacent Waters. Baton Rouge, Louisiana State Univ. Press.

Lutterschmidt, W.I. (1994): The effect of surgically implanted radiotransmitters upon the locomotory performance of the checkered garter snake, *Thamnophis m. marcianus*. Herpetol. J. **4**: 11-14.

Martof, B.S., Palmer, W.M., Bailey, J.R., Harrison, J.R., III. (1980): Amphibians and reptiles of the Carolinas and Virginia. Chapel Hill, Univ. of North Carolina Press.

Moore, J.P. (1893): The eggs of *Pityophis melanoleucus*. Amer. Natur. **27**: 878-885.

Parker, W.S., Brown, W.S. (1980): Comparative ecology of two colubrid snakes, *Masticophis t. taeniatus* and *Pituophis melanoleucus deserticola*, in northern Utah. Milwaukee Pub. Mus. Pub. Biol. Geol. **7**: 1-104.

Reichling, S.B. (1988): Louisiana's rare and elusive snakes. Louisiana Conservationist **40**: 12-14.

Reichling, S.B. (1989): Reproductive biology and current status of the Louisiana pine snakes, *Pituophis melanoleucus ruthveni*. In: Proc. 13th Annual Internat. Herpetol. Symp. p. 95-98. Uricheck, M.J., Ed., Danbury, Connecticut, Internat. Herpetol. Symp., Inc.

Reichling, S.B. (1995): The taxonomic status of the Louisiana pine snake (*Pituophis melanoleucus ruthveni*) and its relevance to the evolutionary species concept. J. Herpetol. **29**: 186-198.

Reinert, H.K, Cundall, D. (1982): An improved surgical implantation method for radio-tracking snakes. Copeia **1982**: 702-705.

Rudolph, D.C., Burgdorf, S.J., Conner, R.N., Collins, C.S., Duran, C.M., Ealy, M., Himes, J.G., Saenz, D., Schaefer, R.R., Trees, T. (In review): Prey handling and prey composition of Louisiana pine snakes (*Pituophis ruthveni*) and black pine snakes (P. melanoleucus lodingi).

Schmidt, K.P., Davis, D.D. (1941): Field Book of Snakes of the United States and Canada. New York, G.P. Putman's Sons.

Shaw, C.E., Campbell, S. (1974): Snakes of the American West. New York, A.A. Knopf.