Copeia, 1988(4), pp. 1057–1059

FIELD OBSERVATION OF THE ASSOCIATION OF ADULT AND NEONATAL TIMBER RATTLESNAKES, *CROTALUS HORRIDUS*, WITH POSSIBLE EVIDENCE FOR CONSPECIFIC TRAILING.—For several species of rattlesnakes (*Crotalus* and *Sistrurus*), parturition may occur a considerable distance from the hibernaculum used by adults (Galligan and Dunson, 1979; Reinert and Kodrich, 1982; Duvall et al., 1985; Graves et al., 1986). It has been suggested that this forces most neonates to overwinter at sites different than those used by adults (Woodbury and Hansen, 1950; Swanson, 1952; Hirth, 1966). The age composition at hibernacula, however, is apparently subject to a great deal of interspecific and intraspecific variation among snakes (Gregory, 1982). Recent field observations indicate that many neonatal *Crotalus viridis* and *C. horridus* do use the same winter refugia as adults (Duvall et al., 1985; Reinert, pers. obs.). The method by which these naive neonates locate such hibernacula is open to debate. While visual cues and celestrial orientation may be important for adult snakes during dispersal from, and return to, hibernacula (Landreth, 1973; Newcomer et al., 1974), it seems unlikely that such mechanisms would be useful in the navigation by newborns to a totally novel location. Several studies have indicated the importance of chemosensory cues in eliciting social and anti-social behavior in snakes (Noble and Clausen, 1936; Burghardt, 1983; King et al., 1983), and conspecific scent trailing has been demonstrated under laboratory conditions for a variety of snake species (Heller and Halpern, 1981; Brown and MacLean, 1983; Ford and O'Bleness, 1986). Such scent trailing may be particularly important in aiding naive neonates to find the winter refugium used by adults (Brown and MacLean, 1983; Graves et al., 1986). Not surprisingly, however, convincing field observations of the correlated movements of neonates and adults that would be indicative of trailing are scant. The current note presents radiotelemetric field evidence of coordinated movements of a newborn and an adult timber rattlesnake, *C. horridus*, from summer habitat to a winter refugium and additional field observations of the association of adult and neonatal snakes that strongly suggest trailing behavior. These observations were made as part of a large scale telemetric study of *C. horridus* in the Pine Barrens of southern New Jersey.

On 12 Oct. 1985, an adult male *C. horridus* (117.5 cm TL) equipped with a surgically implanted radiotransmitter (Reinert and Cundall, 1982) was routinely located at 1900 h. The snake was in Pitch Pine Lowland Forest near a Southern White Cedar Swamp (all forest and habitat descriptions follow McCormick, 1970). During the previous 2 wk period, this snake had moved from its summer foraging habitat in upland Pine-Blackjack Oak Forest toward its hibernaculum in a White Cedar Swamp (Fig. 1). At the time of this location a neonatal *C. horridus* was observed coiled on top of the adult male. On the evening of 18 Oct. at 1720 h the male was again relocated. It had traveled 32 m from its previous location into the Maple-Gum-Magnolia Swamp Forest that fringes the White Cedar Swamp. Again a neonatal *C. horridus* was found with the adult. This time the young snake was captured and brought to the laboratory where a small transmitter (an AVM Instrument Co. SM1 and E312 battery with a total package weight of 3 g) was palpated into its stomach. At 1030 h on the following day, 19 Oct., the young snake was released at its point of capture near the adult male, which was still in the same location as the previous evening. At the time of release a second neonatal *C. horridus* was observed coiled 35 cm from the adult male. On 26 Oct. at 1130 h both the adult male and the radio-tagged neonate were again located together at the edge of a small stream in the White Cedar Swamp 30 m distant from the 19 Oct. location. Both snakes remained at this location throughout the subsequent winter and utilized the same burrow as a hibernaculum. The young snake was last seen basking at the burrow entrance on 31 Oct. Both snakes were recaptured upon emergence from hibernation in the spring of 1986. The young snake was found on 22 April and the adult male emerged from hibernation on 5 May 1986. The movements of these snakes are illustrated in Figure 1. Six other monitored adults hibernated in various burrows along the perimeter of the stream for a distance of 300 m in both directions. Unlike populations of *C. horridus* in

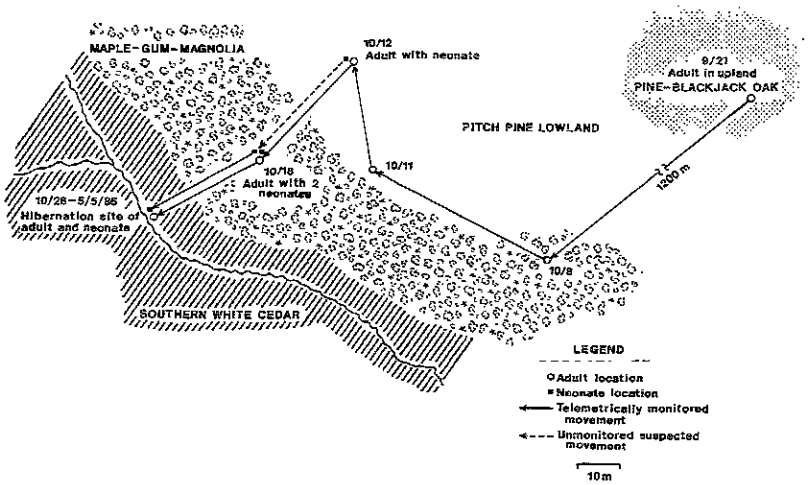

Fig. 1. Corresponding movements to a common winter refugium by an adult and a neonatal *Crotalus horridus*. Habitat descriptions follow McCormick (1970). Elevation change from upland to swamp is approximately 3 m.

mountainous regions, no large communal aggregations appear to occur in the Pine Barrens. These observations suggest that suitable hibernacula were numerous near the stream, making it unlikely that the neonate found this particular hibernating site simply by chance movements.

Two additional field observations which suggest trailing of a conspecific adult by a neonate were made in the vicinity of hibernacula. On 19 Oct. 1985, at 1015 h a recently post-parturient female *C. horridus* (110.5 cm TL) was released at its capture site along a sand road. The snake had been caught 7 d prior and had been held for transmitter implantation. At 1730 h on the same day the snake was relocated. It was found coiled in dense vegetation at the edge of a White Cedar Swamp 18 m from where it was released. While observing this snake, a neonatal *C. horridus* was seen moving along the forest floor approximately 2.0 m from the female. The movements of the young snake brought it in a direct line toward the coiled female from the approximate direction of the female's earlier release site. The young snake crawled across the body of the adult and finally coiled itself adjacent to the female's body. Tongue flicking by the young snake was constant during the movement activity, but no trail contact response (Brown and MacLean, 1983) was noted. The adult snake remained passive and motionless during the entire observation period. By 26 Oct. the female had moved 14 m to a hibernating site in the swamp. It is not known if the neonate also hibernated in the same burrow.

On 30 Aug. 1985, a telemetrically monitored, post-parturient female *C. horridus* (110.0 cm TL) was observed with 14 young in upland Pine-Blackjack Oak Forest. On 25 Oct. 1985, this snake entered hibernation in a burrow at the edge of a stream in a White Cedar Swamp 670 m from the site of parturition. The following spring, on 30 April 1986, a young *C. horridus* that had been born in the fall of 1985 was seen emerging from hibernation at the same burrow. It could not be determined, however, if the young snake was from the adult's litter.

The ability to rapidly locate suitable winter refugia shortly after birth is essential for neonatal rattlesnake survival in regions having seasonally harsh climates. Second chances are not likely if inadequate hibernacula are selected during the first winter. Several investigators have postulated that the initial location of hibernacula by rattlesnakes results from trailing conspecific adults (Messeling, 1953; Hirth, 1966). Recent laboratory experiments have clearly demonstrated that newborn *C. horridus* and *C. viridis viridis* possess the ability to follow conspecific scent trails which are probably derived from skin lipids (Brown and MacLean, 1983; Graves et al., 1986). Our telemetric observations of 25 adult *C. horridus* over a 3 yr period indicate that hibernation occurs in the proximity of streams in low-lying, White Cedar Swamps. Parturition,

however, frequently occurs in upland Pine-Blackjack Oak Forest as much as 1 km from suitable hibernacula. The observations we present indicate that neonatal *C. horridus* do locate and follow conspecific adults under natural conditions and serve to support the idea that such trailing behavior is important in locating suitable hibernating sites.

Acknowledgments.—We would like to thank L. Bushar, W. Callaghan, S. Fiegel, R. Ford, P. Mooney, P. Vargas, and R. Wright for their field assistance. This research was supported in part by a contract with the New Jersey Department of Environmental Protection to RTZ and an Allentown College Faculty Development grant to HKR.

Literature Cited

Brown, W. S., and F. M. MacLean. 1983. Conspecific scent-trailing by newborn timber rattlesnakes, *Crotalus horridus*. Herpetologica 39:430–436.

Burghardt, G. M. 1983. Aggregation and species discrimination in newborn snakes. Z. Tierpsychol. 61:89–101.

Duvall, D., M. B. King and K. J. Gutzwiller. 1985. Behavioral ecology and ethology of the prairie rattlesnake. Nat. Geogr. Res. 1:80–111.

Ford, N. B., and M. L. O'Bleness. 1986. Species and sexual specificity of pheromone trails of the garter snake, *Thamnophis marcianus*. J. Herpetol. 20:259–262.

Galligan, J. H., and W. A. Dunson. 1979. Biology and status of timber rattlesnake (*Crotalus horridus*) populations in Pennsylvania. Biol. Conserv. 15:13–58.

Graves, B. M., D. Duvall, M. B. King, S. L. Lindstedt and W. A. Gern. 1986. Initial den location by neonatal prairie rattlesnakes: functions, causes, and natural history in chemical ecology, p. 285–304. *In:* Chemical signals in vertebrates. Vol. 4. Ecology, Evolution, and Comparative Biology. D. Duvall, D. Muller-Schwarze and R. M. Silverstein (eds.). Plenum Press, New York, New York.

Gregory, P. T. 1982. Reptilian hibernation, p. 53–154. *In:* Biology of the Reptilia. Vol. 13. C. Gans and F. H. Pough (eds.). Academic Press, New York, New York.

Heller, S., and M. Halpern. 1981. Laboratory observations on conspecific and congeneric scent trailing in garter snakes (*Thamnophis*). Behav. Neural Biol. 33:372–377.

Hirth, H. F. 1966. The ability of two species of snakes to return to a hibernaculum after displacement. Southwest Nat. 11:49–53.

King, M. B., D. McCarron, D. Duvall, G. Baxter and W. Gern. 1983. Group avoidance of conspecific but not interspecific chemical cues by prairie rattlesnakes (*Crotalus viridis*). J. Herpetol. 17:196–198.

Landreth, H. F. 1973. Orientation and behavior of the rattlesnake, *Crotalus atrox*. Copeia 1973:26–31.

McCormick, J. 1970. The pine barrens: a preliminary ecological inventory. N.J. State Mus. Res. Rep. no. 2. Trenton, New Jersey.

Messeling, E. 1953. Rattlesnakes in southwestern Wisconsin. Wis. Cons. Bull. 18:21–23.

Newcomer, R. T., D. H. Taylor and S. I. Guttman. 1974. Celestial orientation in two species of water snakes (*Natrix sipedon* and *Regina septemvittata*). Herpetologica 30:194–200.

Noble, G. K., and H. J. Clausen. 1936. The aggregation behavior of *Storeria dekayi* and other snakes, with especial reference to the sense organs involved. Ecol. Monogr. 6:271–316.

Reinert, H. K., and D. Cundall. 1982. An improved surgical implantation method for radiotracking snakes. Copeia 1982:702–705.

———, and W. R. Kodrich. 1982. Movements and habitat utilization by the massasauga, *Sistrurus catenatus catenatus*. J. Herpetol. 16:162–171.

Swanson, P. L. 1952. The reptiles of Venango County, Pennsylvania. Amer. Midl. Nat. 47:161–182.

Woodbury, A. M., and R. M. Hansen. 1950. A snake den in Tintic Mountains, Utah. Herpetologica 6: 66–70.

Howard K. Reinert and Robert T. Zappalorti, *Department of Biology, Allentown College of St. Francis de Sales, Center Valley, Pennsylvania 18034 and Herpetological Associates, Inc., 1018 Berkeley Avenue, Beachwood, New Jersey 08722.* Accepted 6 March 1988.