A Field Evaluation of Two External Attachment Locations of Radio Transmitters on Non-Venomous Rat Snakes (*Elaphe obsolete*)

DARYON SMITH
Department of Animal Science. Berry College, Mount Berry, GA 30149

MCKENZIE WEISSER
Department of Animal Science. Berry College, Mount Berry, GA 30149

DANIELLE CREAMER
Department of Animal Science. Berry College, Mount Berry, GA 30149

REBECCA J. MCLARTY
Department of Animal Science. Berry College, Mount Berry, GA 30149

GEORGE R. GALLAGHER
Department of Animal Science. Berry College, Mount Berry, GA 30149

ABSTRACT: The objective of this study was to determine the effectiveness of external attachment of radio transmitters at one of two locations on mature rat snakes (*Elaphe obsolete*). Transmitters were attached to mature snakes (n = 10; 136.7cm ± 6.4) on either the ventral surface (n = 5) or dorsal-lateral surface of the rib cage (n = 5), approximately 25cm cranially to the cloaca. Transmitters (18mm × 8mm × 2mm) were attached by one drop of acrylamide gel glue to the adhering side of camouflage duct tape (20cm × 30mm), a single drop of glue on the exposed side of the transmitter, and secured by wrapping the tape to the snake's body with the transmitter in the appropriate location. A second piece of duct tape (20cm × 40mm) overlapped and secured the first piece of tape with the transmitter. Snakes were placed in a 0.1ha plastic fence enclosure, (128.5cm ± 0.5 height, and 17.1° ± 0.5 inward slope) in an unimproved pasture with numerous hides, water and food. Snakes (n = 4) shed their skin and the transmitter, within 6-17d post-attachment (11.7d ± 2.4). Snakes (n = 4) escaping the enclosure and not located, ranged from 1-21d post-attachment, (12.3d ± 4.7). There was no difference ($p > 0.05$) in functional days snakes were located by radio telemetry due to attachment site or sex. Transmitter reception distance was typically < 50m and often problematic. Results of this study suggest that the location of external attachment of transmitters had no influence on duration of effectiveness. However, shedding and limited telemetry range under these conditions should be considered to determine if the methodology is appropriate for the desired objectives.

Key Words attachment site, external transmitter, rat snakes

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The utility of radio telemetry techniques for the study of reptiles is well documented (Kingsbury and Robinson 2016). In addition to traditional uses for habitat determination, home range analysis, and foraging strategies, radio transmitter technology has been shown to be successful in the "Judas" technique to aid in the removal of Burmese pythons in the Everglades National Park (Smith et al. 2016).

Despite improvement in surgical implantation of transmitters (Anderson and Talcott 2006, Weatherhead and Anderka 1984, Reinert and Cundall 1982), problems such as post-surgical infection and inflammation (Lentini et al. 2011, Weatherhead and Blouin-Demers 2004), changes in movement (Breininger et al. 2012, Lentini et al. 2011, Weatherhead and Blouin-Demers 2004) and occasional high mortality rates (Do et al. 2014) have been reported.

External attachment of transmitters using various types of tape to the end of the tail of numerous species tended to impede movement and often resulted in snagging and/or removal of the instrument (Wylie et al. 2011, Gent and Spellerberg 1993, Rathbun et al. 1993). In more recent studies transmitters were attached approximately 70% of the body length from the head, in a dorsal-lateral location, using various types of tape (Sacerdote-Velat et al. 2014, Wylie et al. 2011, Tozetti and Martins 2007), cyanoacelyate glue (Jellen and Kowalski 2007, Cobb et al. 2005) or a combination of tape and glue (Madrid-Sotelo and Garcia-Aguayo 2008). Wylie and coworkers (2011) also examined attachment of transmitters to the ventral surface of snakes suggesting that the transmitter would not interfere with the cross section of the snake due to the location of ribs, thus minimizing interference movement in the environment.

The objective of the study was to examine the effect of dorsal-lateral and ventral radio transmitter attachment locations on rat snakes (*Elaphe obsolete*) utilized in a field based repellent study.

STUDY SITE

This study was conducted on the 1,215 ha Berry College Wildlife Refuge (BCWR) within the 11,340 ha Berry College campus in northwestern Georgia, with approval of the Berry College Institutional Animal Care and Use Committee and under the Georgia Department of Natural Resources Scientific Collecting Permit.

The BCWR was characterized by campus-related buildings and facilities for the 2,100 student body, is interspersed with expansive lawns, hay fields, pastures, woodlots, and larger forested tracts. The site used for this study was characterized as an unimproved pasture at the Berry College Sheep Center. The forage consisted predominantly of fescue (*Schedonorus phoenix*), orchard grass (*Dactylis glomerata*), and interspersed with Bermuda grass (*Cynodon spp.).* Forested areas within 200m include various species of pines (*Pinus* spp.), oaks (*Quercus* spp.) and hickories (*Carya* spp.).

METHODS

Mature wild rat snakes were captured and placed in 40L secure aquariums and provided with bedding, cover, water and food within a climate controlled laboratory. Radio transmitters (Ag392, Biotrack LTD., Dorset, UK) were attached externally using a modification of the procedure by Wylie and coworkers (2011). In addition to total length, the distance from the cloaca to the tip of the tail was obtained and an ink mark was applied that distance cranial to the cloaca to identify the site of transmitter attachment. A single drop of cyanoacrylate glue (234790, Loctite., Westlake, OH) was placed 5cm from the end of a 20mm × 20cm piece of camouflage duct tape (1409574, ShurTech Brands, Avon, OH) on the adhering side. The body of the transmitter was secured to the drop of glue, perpendicular to the tape. A drop of cyanoacrylate glue was then applied directly to the transmitter. The tape and transmitter were secured to the snake by wrapping at the marked location, with the transmitter either in the ventral or dorsal-lateral location and antenna directed toward the tail. A second piece of camouflage duct tape (40mmx20cm)

was applied over the first piece of tape with the transmitter.

Snakes were released in two groups (n = 5) into a 0.1ha, plastic fence enclosure, 128.5cm ± 0.5 height, and 17.1° ± 0.5 inward slope, in a field with natural and artificial hides, water and food. The location of each snake with a transmitter attached was determined using a radio receiver (R-1000, Communications Specialist Inc., Orange, CA), 3 times per day until the transmitter was either dislodged by shedding or no radio signal could be located. To examine activity at the fence, day/night infrared cameras (SN502-4CH; Defender Inc., Cheektowaga, NY) were positioned 10m from each corner of the enclosure, and recorded on DVR's.

Evaluation of the duration snakes were maintained within the enclosure was conducted using one-way ANOVA analysis procedures of IBM SPSS 24.0 (SPSS 24.0 2016).

RESULTS AND DISCUSSION

Results of this study suggests that external attachment of radio transmitters in the ventral or dorsal-lateral location was successful in the rat snake, a semi-arboreal, predominantly terrestrial species. There were no differences ($p > 0.05$) in functional days snakes were located by radio telemetry due to transmitter attachment site, or sex. No observable differences in behavior or movement, including ability to climb, were noted as a result of radio attachment.

Among the snakes released (n = 10), four individuals shed their skin and the transmitter 6-17d post-attachment (11.7d ±2.4) in this study. If possible, maintaining animals until ecdysis is complete before attaching transmitters can significantly increase the duration of attachment as demonstrated by Cobb and coworkers (2005).

Transmitter reception distance was typically < 50m and problematic. During the two releases of snakes (n = 10) into the 0.1ha enclosure, snakes breaching the fence were frequently recovered. However, among those released during the first two periods, some individuals (n = 4) escaped the enclosure from 1-21d post-attachment (12.3d ± 4.7). Jellen and Kowalski (2007) indicted vegetation entanglements of snakes due to antenna length was problematic. The authors further present the challenge facing investigators that while increasing the length of transmitter antenna increases reception distance, the longer antenna increases the chance of entanglement and snagging. In the current study, using transmitters with a relatively short 22cm antenna, likely influenced the distance of reception but there was no evidence of entanglement or snagging on vegetation.

As a part of a repellent study, a third group of snakes (n = 6) were released and remained in the enclosure for 7-days. There was one case of snake mortality within the enclosure on day 6 of this group. However, there was no indication, visual or by necropsy, to suggest the radio transmitter attachment or antenna was a contributory factor. Upon removal of the enclosure fencing, snake dispersal was rapid. In less than 12 hours, no snakes could be located by radio telemetry despite extensive searching efforts. This would suggest that the range of the radio transmitter reception was a limiting factor and not failure of the transmitters.

The results of this study suggest that attachment of radio transmitters to a dorsal-lateral or ventral location does not impair movement of mature rat snakes, nor influence radio transmission. Investigators interested in utilizing the technique should evaluate the duration of attachment required to meet the objectives since ecdysis results in the removal of the transmitter. Care should also be exercised in determining the minimal length of antenna necessary to provide sufficient transmitter reception, yet not

impede movement or increase the chances of entanglement within an environment.

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