Herpetological Conservation and Biology 1(2):129-131
Submitted: 10 August 2006; Accepted: 11 September 2006

A Simple and Reliable Method for Attaching Radio-transmitters to Lizards

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***Abstract.*—Simple and effective techniques for attaching transmitters to animals are essential for radio-telemetric studies. We modified a harness design for attaching radio-transmitters to Jacky Dragons (*Amphibolurus muricatus*), a semi-arboreal lizard from southeastern Australia. Fifty-three females were fitted with the harnesses and were tracked for up to three weeks to study their nesting behavior. No transmitters were dislodged from the animals during the study and our design did not appear to affect the animals' natural behavior. Herein, we provide a detailed description of our technique and its efficacy.**

Key Words.— *Amphibolurus muricatus*; Jacky Dragon; nesting behavior; radio telemetry; transmitter

Introduction

Studies using radio telemetry are central to our understanding of animal behavior under natural field conditions. It is critical that biologists attach transmitters to animals in ways that minimize adverse effects on behavior. We developed a lightweight transmitter harness that could be easily attached to gravid female Jacky Dragons (*Amphibolurus muricatus*), a common agamid lizard found in coastal heathland habitats of southeastern Australia (Cogger 2000), to study their nesting behavior. It was imperative that the harness did not impair sprint performance or mobility, as gravid females are already vulnerable to predation (Olsson et al. 2000). Furthermore, because *A. muricatus* is semi-arboreal, the harness and transmitter should not reduce climbing ability or become entangled in vegetation. The technique described herein utilizes a harness (backpack) design similar to that described previously for attaching transmitters to horned lizards (*Phrynosoma* ssp.; Fisher and Muth 1995; Richmond 1998). The harness was simple to make, inexpensive, and highly reliable. The lightweight material and method of attachment ensured that it did not inhibit climbing or nesting behavior.

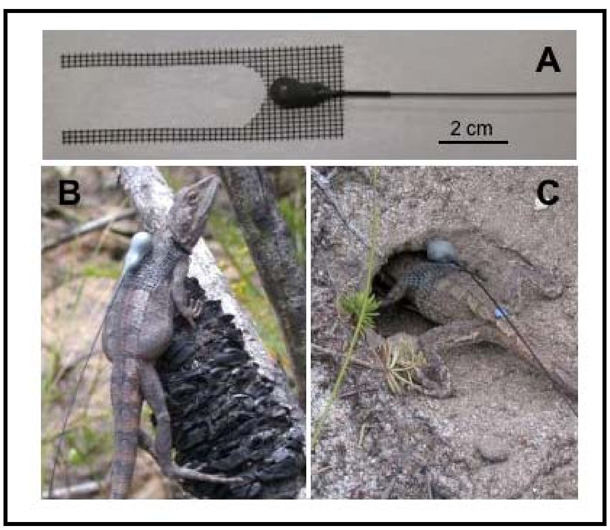

Figure 1. Photographs of the harness and lizards in the field. (A) U-shaped design of the harness with a transmitter attached. (B) Gravid *Amphibolurus muricatus* fitted with the harness and transmitter. (C) Female *A. muricatus* fitted with a transmitter harness digging a nest.

Materials and Methods

The backpack harness that we constructed was similar to that described by Fisher and Muth (1995) and Richmond (1998), but differed in that the harness was made of black nylon mesh material (mesh size = 2 mm), which can be purchased at most hardware stores. A 240 × 240 mm sheet of nylon mesh provides enough material to make about 27 harnesses. The nylon mesh was cut into a 'U' shape leaving a rectangle of approximately 26 × 22 mm at the bottom of the U (Fig. 1A); the rectangle served as a location of attachment for the transmitter. The two 'arms' of the U (each approximately 60 mm long and 4 mm wide) served as shoulder straps when the harness was fitted to the lizard. Overall, the harness was 83 mm long and 26 mm wide. A single harness size fitted all females (which ranged from 77-103 mm snout-vent length [SVL]), thus numerous harnesses could be made in advance of fieldwork. Prior to fitting the harness to a lizard, we used superglue (UHU Australia Pty. Ltd.) to attach the transmitter to the rectangle at the bottom of the U-shaped harness. The transmitter (Holohil Systems Ltd., Carp, Ontario, Canada, Model BD-2, Battery life = 5 months, mass = 2.0 g) was positioned so that the whip antenna faced away from the 'arms' on the U (Fig. 1A).

The active and nervous nature of *A. muricatus*, made fitting the harness easiest when one person restrained the lizard while another person attached the harness. First we positioned the harness on the lizard so that the shoulder straps (i.e., the 'arms' on the U) lay beside the lizard's head with the curve of the 'U' around the dorsal side of the lizard's neck. This situated the transmitter along the midline dorsally with the anterior edge in line with the exertion of the forelegs and the antenna protruding distally. Next, the person restraining the lizard used their thumb to hold the harness in place (with the transmitter held firmly against the lizard's back) while the other person pulled the straps over the lizard's shoulders, then crossed the straps under the lizard's chest, and then pulled them snugly through the axilla of the opposite foreleg (similar to Fig. 1 in Richmond 1998). We then attached the straps dorsally to the rectangular section of the harness using two drops of superglue. Holes in the mesh material enabled the harness to become partially glued to the lizard's back when the straps were attached, providing extra stability. We cut off any excess strap material with scissors. We applied an additional drop of glue where the straps crossed the chest to prevent the harness from shifting around the body and to keep the transmitter positioned on the lizard's back. We held the straps in the desired positions with forceps for approximately 30 seconds until the glue dried. Attaching the harness took about 3-5 minutes per lizard. The harness was easily removed by cutting the straps with scissors, thus a single harness can only be used once. We did not attempt to remove the mesh that remained glued to the lizard's skin, as these were naturally sloughed within a month after harness removal. The lizards' skin did not appear to be irritated by the glue.

We located radio-tagged lizards at hourly intervals each day until they oviposited. Thus, we tracked some animals for only one day, whereas others we tracked for over 3 weeks. During our frequent observations, we recorded the number of predation events, the number of times the harness and/or transmitters became entangled in vegetation, and recorded observations on various behaviors.

RESULTS

We used this harness design on 53 gravid *A. muricatus*. Female size varied widely (SVL range = 77-103 mm; gravid mass range = 21.0-48.3 g). The harness weighed 0.14 g, and the average weight of the harness and transmitter was 2.14 g (range = 1.65-2.32 g). On average, the total package weighed 6.7% of the gravid female mass (range = 3.9-10.3%), and 8.7% of non-gravid female mass (weighed immediately after oviposition; range = 5.0-12.9%). No harnesses or transmitters were dislodged from the females during our study. However, after tracking one individual for 18 days, one strap of the harness was torn but the harness remained firmly attached to the animal because of the three glue points. The nylon mesh appeared unaffected by exposure to intense sun, heat and rain. The backpack became entangled in vegetation on eight occasions. Four individuals were preyed upon by monitor lizards during this study (Warner in press).

DISCUSSION

The nylon mesh that we used differed from the material used in previous designs (Fisher and Muth 1995; Richmond 1998), and provides some advantages. For example, the nylon mesh harness is durable, permeable to air, and weighs substantially less (0.14 g) than the rubber material (4.5 g) suggested by Richmond (1998). The stretchable nylon mesh conforms tightly to the lizard's body, but allows flexibility during normal activities. The mesh allowed us to place drops of glue on the surface of the material to effectively attach the straps to the underlying rectangular section of the harness and to the lizard's skin.

Overall, our harness design had no apparent effect on the behavior of female *A. muricatus*. They exhibited normal nesting behavior when compared to our observations of lizards without transmitters. Also, the harnesses appeared to have minimal impact on lizard mobility; we observed radio-tagged individuals fleeing at top speeds and climbing higher than 2 m in trees. Contrary to a study on snakes (Lutterschmidt 1994), this non-effect of transmitters on locomotion was evident even for the few individuals that had transmitters > 10% of their body mass. We do not know if the presence of a transmitter increased vulnerability to predators as only four individuals were preyed upon during this study (Warner in press), and we have no comparative data for untagged individuals. Monitor lizards were responsible for all four predation events (Warner in press). In each case, the monitor lizards were unharmed by swallowing the harness and transmitter, as the transmitters were eventually found after defecation and most nylon mesh was apparently digested. Thus, the nylon material is likely to have minimal impacts on wildlife if swallowed.

The harness (or in some cases the transmitter itself) became entangled in vegetation on eight occasions. However, this frequency of entanglement was relatively low considering that radio-tagged individuals were active an estimated 2,376 hours during our study. On three occasions, lizards were 'caught' by sticks that were lodged between the harness and their body, and the other five occasions involved transmitters becoming entangled in long dense grass when lizards were moving on the ground. Given the high densities of sticks and grassy areas at our study site, the low rate of entanglement suggests that our harness design was effective. Moreover, our impression is that these entanglement events would have occurred even if Richmond's (1998) method of attachment was employed. Nevertheless, as a result of entanglement, animals could be highly vulnerable to predation or over-heating. Therefore, we highly recommend performing frequent observations to minimize accidental mortality.

Overall, our technique was essential to studying the nesting behavior of Jacky Dragons. Jacky Dragon nests, like other lizard nests, are difficult to locate because females conceal them extremely well (Harlow and Taylor 2000). Thus, it was imperative that we observe females in the process of digging in order to locate the nests. Indeed, using our transmitter-attachment method and by regularly relocating females, we were able to observe 41 females constructing nests. Our impression is that the harness design can be used for other purposes as well. For example, recent methodologies for studying lizard thermal biology have used thermochron iButtons glued to the backs of lizards (Robert and Thompson 2003; Robert et al. 2006). We are aware of one study that had trouble keeping iButtons firmly attached to lizards in the field (Allsop et al. 2006), and we feel that use of our harness design could overcome this issue. Furthermore, our harness design could easily be modified for other lizard species that differ considerably in size from the Jacky Dragons that we studied.

Acknowledgments.—We thank T. Bunt, T. Child, and T. Schwartz for assistance in the field. This project was supported by grants from the Australian Society of Herpetologists (to DAW) and by the Australian Research Council (to RS), and was approved by the University of Sydney Animal Care and Ethics Committee (protocol #L04/5-2005/1/4123) and the New South Wales National Parks and Wildlife Service (permit # S10658).

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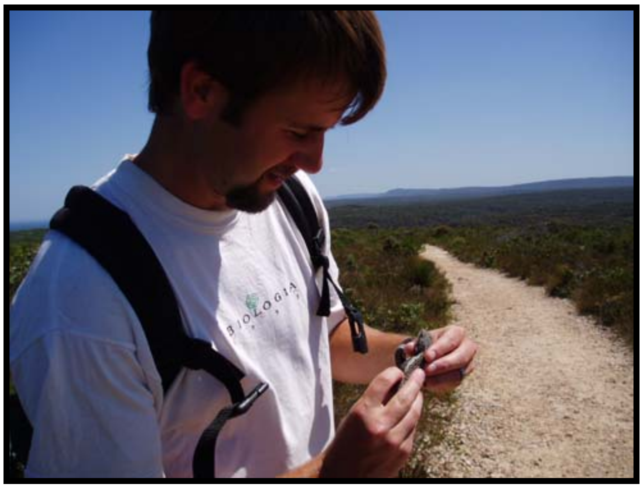
ERRATA: *This manuscript was updated from its originally published form on 27 January 2007.*



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