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A Radio Transmitter Belt for Small Ranid Frogs

ERIN MUTHS
USGS-Biological Resources Division, Fort Collins Science Center
2150 Centre Avenue, Bldg C, Fort Collins, Colorado 80526, USA
e-mail: erin_muths@usgs.gov

Radio telemetry is a useful technique for gathering information about amphibians when associated caveats are applied (Bartelt and Peterson 2000). A number of designs for transmitter attachment are available for larger anurans including a harness-type attachment (van Nuland and Claus 1981) and various belt designs (Bartelt and Peterson 2000; Rathbun and Murphey 1996; Waye 2001). Attaching radios to small anurans is particularly problematic because of their mass, shape, and delicate skin. Small radios, 0.61 grams or less, are available, although battery life is usually only 2–3 wks (e.g., Holohil Systems Ltd; Carp, Ontario, Canada[1]). The issues remaining are the weight and longevity of the attachment system, ease of application to the animal, and effect on the behavior and health of the animal.

Here I describe an attachment assembly tested in the laboratory on juvenile leopard frogs (*Rana pipiens*) and used on wood frogs (*Rana sylvatica*) in the field.

The goal of the field study was to fit radio assemblies to 8 wood frogs (4 males and 4 females) and to follow them for approximately 2 wks (the life of the battery) during and immediately after the breeding season (May–early June). Male wood frogs generally breed in their second spring when they are between 34 and 40 mm snout–vent length (SVL); females generally breed in their third spring when they are between 45 and 54 mm SVL (Hammerson 1999). Currently available attachment methods were unacceptable for these small ranid frogs.

I used Holohil BD-2A transmitters (0.61 g). The transmitters were configured so that the battery was placed on top of the transmitter rather than in front of it (Fig. 1b). In earlier trials, using the belt system described by Bartelt and Peterson (2000) and the original, linear arrangement of the transmitter, frogs were unable to properly orient themselves in the water. This was because the length of the assembly system made the transmitter ride too far up on the frog's back and because the belt material was too bulky.

I used very fine craft elastic (gossamer floss, B. Toucan, Inc., US $1.64 for 5 yds) and size 14 Japanese glass seed beads in olive

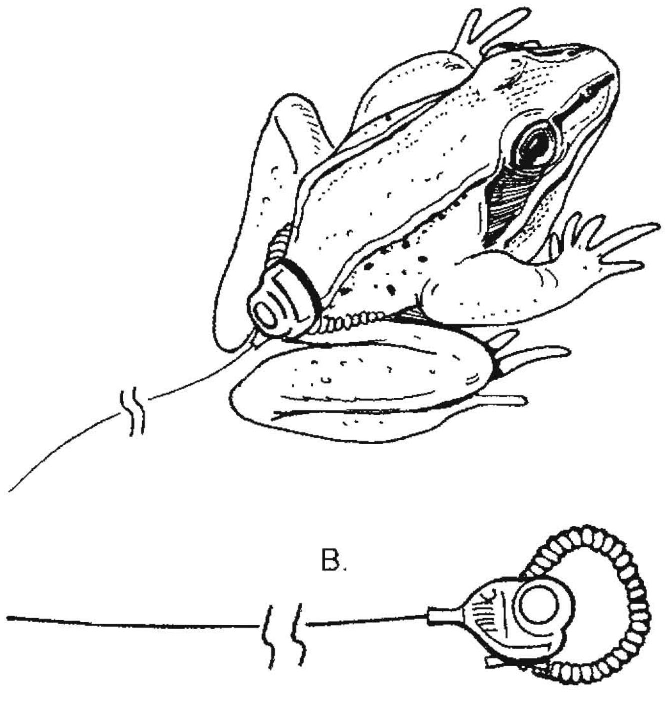

FIG. 1. (A) Male wood frog with transmitter and belt assembly. (B) Sketch of belt assembly with radio for small ranid frogs.

matte (F458, US $3.45 for thousands) to make the belt. The elastic was threaded through the small attachment tube on the transmitter pack and beads were strung on the elastic. The elastic was tied in a knot and the knot stuffed into the tube on the pack. This small belt (Fig. 1a) was able to stretch enough to be held open by 2–3 fingers while the back legs of the frog were pushed through with the other hand. It was easy to determine if the belt fit correctly: too tight and the frog's skin was pinched and it was unable to move naturally, too loose and daylight was visible between the frog and the belt. When fitted properly, the belt should roll easily when manipulated. Because we were interested only in relatively small movements, in and near the breeding pond, I shortened the 14 cm whip antennae to 9.5 cm. This reduced the range of the transmitter and the mass of the assembly (slightly), but more importantly, reduced the possibility of entanglement for the frog.

I used 2 captive, juvenile leopard frogs to test the harness prototype before the 2002 field season. Both animals were ca. 9 g. Animals were housed together in a 15 gal. aquarium with rocks, plants, and an upturned plastic tub for shelter. The aquarium was set on an angle to provide aquatic and non-aquatic habitat. Frogs were fed small crickets, ca. 8 per animal per week.

After a number of fitting trials, a belt assembly (22 beads) with dummy transmitter (0.73 g total mass), was placed on leopard frog 1 (ca. 9 g, 41.3 mm SVL) on 10 March. The other frog was approximately the same size and was not fitted with a belt. The frogs were checked 2–4 times daily. Hiding and feeding behaviors were noted and frog 1 was assessed visually for abrasions. The assembly was removed on 14 and 18 March to check for abrasions manually and then replaced. I isolated frog 1 to confirm that it was eating and defecating 18–25 March. The assembly was removed on 7 April.

Pilot data collected in 2001 provided an estimate for our expected size of individuals: mean mass = 8.7 g, mean SVL = 43.1 mm (N = 8). Our criterion for selecting individuals to carry the transmitter was adult animals ≥ 8.5 g. This follows the general rule that transmitters and assembly systems should not exceed 10% of total body mass (Richards et al. 1994).

Neither the movements of the two leopard frogs around their environment, nor their appetites appeared to be affected by the assembly on frog 1. Both belted and non-belted frogs consumed crickets (7 and 8 crickets, respectively) and produced approximately equal amounts of waste (3 and 4 pellets, respectively), when housed together and separately. On 7 April, a small (2–3 mm) cut was found underneath the belt on frog 1. The assembly was removed and the cut cleaned. The assembly was not refitted. The leopard frog tolerated the belt assembly for 4 wks, about 2x longer than I expected the batteries to last. It was not until the fourth week that there were any signs of abrasion. After the belt was removed, the wound healed within 2 days.

In May we fitted 11 different wood frogs with transmitters (Table 1, Fig. 1) at the field site. The smallest frog fitted was 8.5 g and the complete belt assembly with 22 beads weighed 0.73 g, 8.6% of the frog's mass. Of these, 5 frogs (3 M and 2 F) shed the belts soon after they were fitted (≤ 4 days) and 6 frogs retained the belt assembly from 7 to 30 days (mean = 21 days, males; 16 days, females). There is a relationship between mass and the number of beads needed for the belt ($R^2 = 0.81$) (Fig. 2), but there are too few data to build a reliable predictor.

Animals were located 3 times daily (1200, 1800 and 2400 h), but inspected visually (for abrasions or problems with the belts) only once per 24 h period. In 4 of 5 cases the animals that shed their belt assemblies within 24 h of attachment were smaller than their counterparts that retained their belts of the same number of beads. Detectability of the transmitter signal was not related to the length of the whip antennae although transmitters varied in battery life (Table 2). All females fitted with belt assemblies were gravid and lost appreciable mass (0.9–4 g) over the course of the study after their eggs were deposited. Males either lost or gained minor amounts (± 1–1.5 g) except for one. This male retained the belt assembly for 22 days before any abrasions were noted. At that point, the belt was removed, the frog weighed and the small abrasion was treated with Bactine®, and a second belt was attached. When the assembly was removed on 31 May, 10 days later, the

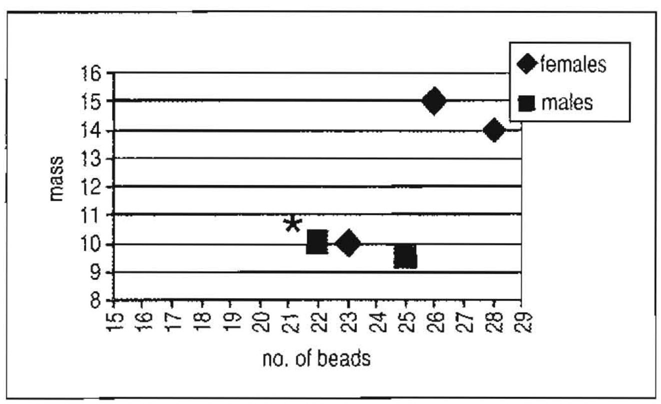

FIG. 2. Mass of frog versus number of beads used in belt assembly (N = 6: 3 females and 3 males). * This point represents 2 males.

TABLE 1. Animals that received radio transmitter belt assemblies, sex, SVL, mass, belt construction and length of time belt worn.

Animal i.d.	Frequency	Sex	SVL (mm)	Initial mass (g)	Final mass (g)	Number of beads on belt	Date transmitter attached	Date transmitter removed/lost	Reason transmitter removed/lost	Number of days with belt on	Number of locations
212	164.048	M	—	8.5	—	22	7 May	8 May	Shed by frog	1	2
222	164.048	F	49	14 (gravid)	13.1	28	16 May	1 Jun	Battery dead/ transmitter removed	16	24
233	164.143	F	47.8	10	—	23	22 May	28 May	Battery dead/ transmitter removed	7	6
202	164.170	M	—	10.5	—	28	2 May	3 May	Shed by frog	1	3
214	164.170	F	44.3	15 (gravid)	11.0	—	9 May	23 May	Battery dead/ transmitter removed	15	22
214	164.007	F	44.3	15 (gravid)	11.0	—	23 May	4 Jun	Shed by frog	13	18
221	164.007	F	—	13 (gravid)	—	29	16 May	17 May	Shed by frog	1	1
43	164.007	F	—	17.5 (gravid)	—	—	18 May	21 May	Shed by frog	4?	1
1811	164.085	M	41.9	10	10.5	22	4 May	20 May	Battery dead/ transmitter not recovered	15	30
210	164.1J9	M	—	9.0	—	22	3 May	6 May	Shed by frog	4	1
55	164.248	M	43	10.5	11.0	22	1 May	22 May	Battery dead/ transmitter removed	22	40
55	164.119	M	43	11.0	8.5	22	22 May	31 May	Battery dead/ transmitter removed	8	16
53	164.207	M	43	9.5	9.5	25	1 May	21 May	Battery dead/ transmitter not recovered	19	45

TABLE 2. Battery life of BD-2A transmitters, antennae length, and fate.

Transmitter No.	Frequency	Battery life* (days)	Antennae length: Original = 14 cm Modified = 9.5 cm	Number of detections (= frog locations)	Fate of transmitter: Received = R Lost = L
70643	164.007	18	O	20	R
70644	164.048	17	O	26	R
70645	164.085	15	M	30	L
70646	164.119	12	O	17	R
70647	164.143	7	O	6	R
70648	164.170	16	M	25	R
70649	164.248	22	M	40	L
70650	164.207	19	M	45	R

* transmitter was turned off with magnet when not on frog.

frog had lost 2.5 g (23% of its mass determined on 22 May).

Advantages to this system are its weight, flexibility in sizing, and low cost. Secondarily, the color can be adjusted easily for the target species given the wide variety of bead colors available. The belt also has the potential to tear away if the frog becomes entangled in vegetation, although this was not tested in the field.

The weight of the assembly depends on the number of beads used in the belt. The difficulty in fitting the belt was in estimating the number of beads to use. The relationship between mass and number of beads serves as a rough guideline to determine the length necessary for the belt (Fig. 2).

The process of assembling the belt system requires the use of tweezers or a fine needle to thread the beads. This can be a disadvantage when ambient air is cold enough to make nnmb hands an issue. Collars can be assembled before the field session, but a certain amount of fine-tuning when the frogs are captured should be expected.

This belt assembly is recommended for relatively brief studies where long-distance movements are not expected. We found no frogs with skin irritations or abrasions during the first three weeks of this study.

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[1]Product use does not imply endorsement by USGS and is present for informational purposes only.