Evaluation of a Radio-Belt for Ranid Frogs

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Although biologists have developed numerous ways of marking anurans (Heyer et al. 1994), there are relatively few reports regarding the performance of radio-tags attached successfully to frogs and toads (e.g., van Gelder et al. 1986). Because of the delicate nature of frog skin, most efforts to attach radios have involved harness devices made of plastic (silicon) tubing (Jon Loman, pers. comm.) or latex rubber straps and bands (Richards et al. 1994). We developed a simple waist-belt made of aluminum ball or beaded chain (size #3, Ball Chain Manufacturing Co., 471 South Fulton Avenue, Mt. Vernon, New York 10550, USA; tel. 914/664-7500; or Bead Industries, 110 Mt. Grove Street, Bridgeport, Connecticut 06605, USA; tel. 203/334-4124) to attach radio transmitters to free-ranging, adult California red-legged frogs (*Rana aurora draytonii*). The chain lacks sharp edges, is flexible, and rolls or slides easily over the skin, thus conforming to the contour of the frog with little friction.

We use gloss black enamel spray paint to reduce reflection of the shiny chain; flexibility is restored with gentle twisting after the paint is dry. Devcon two-ton epoxy serves to cement a #3 aluminum chain connector to the tip of a radio transmitter (model BD-2G, 8 mm wide x 6 mm deep x 17 mm long, 12 cm long whip antenna, 1.8 g without attachment, battery life about 140 days; Holohil Systems Ltd., 112 John Cavanagh Rd., Carp, Ontario, Canada K0A 1L0, tel. 613/839-0676). To accomplish this, we file a small hole in the back of the connector, clean the connector and transmitter attachment site with fine steel wool, and then apply epoxy and allow it to flow through the hole, being careful to prevent the inside of the connector from being fouled. We apply the epoxy in two stages; a small amount to position the connector followed by a larger amount to ensure a strong bond. Our radio-tag weighs about 2.0 g, but smaller assemblies weighing as little as 1.0 g (with a battery life of about 20 days) can be fabricated.

Two people are needed to radio-tag a frog: one to hold the animal, the second to fit the belt. To obtain a good fit, we slip representative chain/connector belts of different sizes, each labeled with the number of balls in the chain, over the extended rear legs of a

frog until we find the one that fits best. A perfect fit occurs when the belt slides snugly over the extended legs, and slightly compresses the upper leg muscles as it slips onto the waist. Once the belt of best fit is determined, the correct number of balls is cut from a painted length of chain, and a transmitter is attached. The fully assembled radio-belt is then slipped over the extended legs, making sure that the smoothest side of the transmitter faces the frog's skin (Fig. 1). The tagging process, from capture to release, takes about five minutes.

We release the frogs with the transmitter riding on the dorsum, but when they are recaptured the transmitter is often on the ventrum; transmitter position does not appear to affect the frogs. Because of corrosion and wear, a new chain is always fitted when frogs are recaptured for transmitter replacement. When the physical condition of a frog changes due to an increase or decrease in rear leg muscle mass, one or two balls are added to, or subtracted from, the belt to achieve an optimal fit. Belts too loose are sometimes shed, while those too tight sometimes cause indentations and small sores on the skin.

With an "H"-style receiving antenna (Telonics, Mesa, Arizona 85204, USA) connected to our radio receiver (model TX1000S, Wildlife Materials, Carbondale, Illinois 62901, USA), and under near-ideal field conditions, we routinely obtained a signal range of about 100 m when a frog was on land. Below clear, fresh water we usually received a signal from a distance of about 5 m.

We deployed 89 transmitters on 47 (24 males and 23 females) individual *Rana aurora draytonii* in coastal arroyos and lagoons of northern San Luis Obispo County, California, USA, from July 1992 through November 1995. Snout-urostyle lengths of these individuals ranged from 83 mm to 127 mm (three individuals were in the 80–89 mm size-class, 15 individuals in each of the 90–99 mm and 100–109 mm classes, 12 in the 110–119 mm class, and two in the 120–129 mm range). Twenty-two individuals were tagged once, 12 twice, 7 three times, 5 four times, and 1 five times. The 47 frogs were radio-tagged a total of 4155 days with a mean of 88.4 days/individual (SD = 73.2, range = 13–296).

We found about six cases where small (1–2 mm diam) skin sores developed from the chain belt passing over the sides of the waist. Early in the study we maintained a captive frog with skin sores; healing without a belt attached took two days. When subsequent cases of skin sores arose, we added one or two balls to the replacement chain and released the frogs. We recaptured some of these individuals and found that their wounds had healed in less than 14 days. We also assessed weight change between initial radio-tagging and recapture in 16 frogs. Two males and a female lost 2.0, 4.0, and 5.0 g after 42, 63, and 60 days, respectively. Average weight loss was 3.0% of mean initial weight. Five males and eight non-gravid females gained an average of 7.9 g over a mean of 61.6 days (SD = 19.5, range = 21–118). The average weight gain was 7.2% of their mean initial weight. These data suggest that the radio-belt did not significantly affect the frogs' weight.

Transmitter failure.—We lost radio contact with 23 frogs before the predicted exhaustion of their transmitter batteries. We recaptured seven of these with intact radio-belts, but dead transmitters. Water leakage probably caused the failure of some of these radios. The fate of the 16 missing radio-belts or frogs is unknown—the radio-belts may have been shed in salty lagoon water and lost due to signal attenuation, or the frogs may have left the study area after being ingested by herons or egrets. It is also possible that the frogs evaded recapture and are still in the population carrying failed transmitters. We believe it is unlikely that they traveled beyond the study area on their own.

Belt loss.—We recovered 24 functioning transmitters that had been shed by frogs; the belts failed in four of these early in the study while we were experimenting with different types of epoxy and chain. The remaining 20 radio-belts were recovered intact; some had tooth marks, suggesting raccoons or some other predator had removed the frogs from their belts. One intact radio-belt was found in a tree on a red-shouldered hawk roost. However, not all belt losses were due to predation; ten of the 23 frogs, identified by passive integrated transponder (PIT) tags, were recaptured. We speculate that these frogs shed their belts over their extended rear legs while moving through dense vegetation.

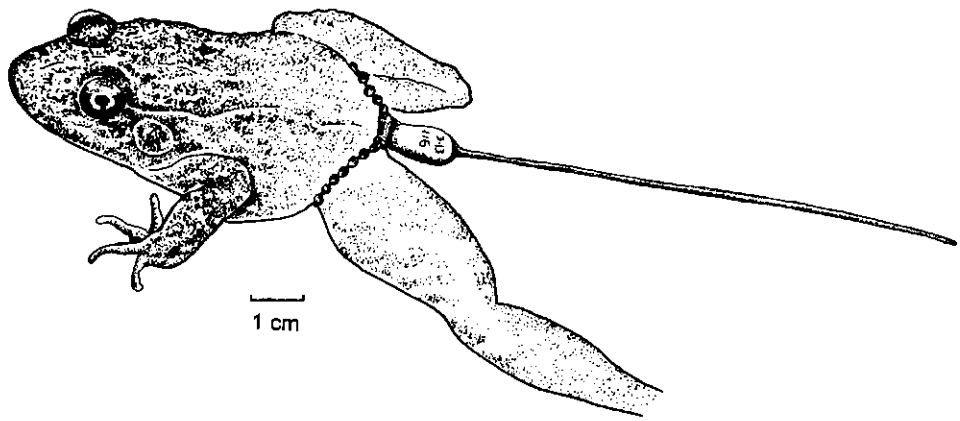

FIG. 1. Beaded chain radio-belt applied to an adult *Rana aurora draytonii*.

In any species, attaching radios with collars or belts has its risks (see Chapter 5 in Kenward 1987). During our study, we found four radio-tagged frogs dead in February and March when bulrushes send new growth up through the water column. In two cases, the frogs probably drowned when underwater bulrush shoots became threaded between the belt and the frog. We suspect the same happened to a third frog, but it was too decomposed to determine cause of death. The fourth frog had a broken mandible associated with a deep cut, suggesting that its death was unrelated to the radio-tag assembly. Despite these mortalities, we believe that attaching radios to large ranid frogs using a ball or beaded chain belt is relatively safe and effective, and represents an improvement over other radio-tagging techniques reported in the literature.

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Note added in press.—We have confirmed that significant radio-belt loss and frog mortality may occur in bulrushes. In late September 1996, we radio-belted eight frogs in a pond dominated with bulrushes. Within 16 days one frog was lost to natural predation, two shed their belts among bulrush stems, and two died from entanglement on bulrush shoots. We removed the radio-belts from the three remaining frogs.