A Fully Adjustable Transmitter Belt for Ranids and Bufonids

Tracking free-ranging amphibians with radio telemetry yields invaluable data, but is difficult and laborious. Frogs and toads generally weigh <100 g, have thin, delicate skin without a protective covering, and a challenging body form for radio transmitter attachment. Because of these features, investigators must use small (<10 g) radio transmitters with limited range and battery life, and travel to the field on a regular basis to relocate each animal. For all this work and labor, the investigator needs a device that secures the radio transmitters to the animal without damaging its skin or otherwise harming it.

Transmitters can be either implanted (e.g., Carey 1978) or attached externally to anurans. Because external attachment generally has caused little or no effect on behavior or weight gain in anurans (Bartelt and Peterson 2000; Rowley and Alford 2007; Indermaur et al. 2008; Sullivan et al. 2008), and given the much less stress caused to the animal, it is the recommended approach for most study needs (Indermaur et al. 2008). A variety of attachment designs have been used to meet all the requirements of telemetry for anurans (e.g., beaded chains, Rathbun and Murphey 1996; 1 mm outside diameter plastic belts, Bartelt and Peterson 2000; nylon ribbons, P Risdon and D. Pilliod, pers. comm.; see Bull 2000 for review). Some designs have worked better for certain species, study areas, or investigators. For example, plastic belts and nylon ribbons have worked well in some studies, but caused deep wounds on frogs and toads that we study in the Midwest; beaded chains, while working well for larger frogs, can be rather heavy for medium sized (20–30 g) frogs and their relatively widely spaced beads limits fine size adjustments; on toads, beaded chains tend to collect and hold dirt that then cuts into their rough, drier skin (F. Anderka, Holohil Systems, Ltd., pers. comm.). Other belts (e.g., Muths 2003; Rowley and Alford 2007) were designed for relatively short study periods (few weeks to a month) or included small beads that would seem to have a similar effect on toads as beaded chains. A “common” design (i.e., one that works well for both frogs and toads) could help simplify materials needed for telemetry. In addition, a belt that can be easily and finely adjusted to fit the animal as it grows throughout the season may help reduce the problem of skin sores. We developed a fully adjustable belt for our current study of Northern Leopard Frogs (Lithobates pipiens) and American Toads (Anaxyrus americanus). We describe its design and evaluate its performance over two seasons of study in north-central Iowa.

Methods.—We attached 1.8 g model BD-2 radio transmitters (Holohil Systems, Ltd., Carp, Ontario) to post-breeding adult frogs and toads during the 2009, 2010, and 2011 (current) field seasons. These radio transmitters have an expected battery life of 14 weeks and, based upon our field measurements, a typical detection range of 400–650 m. The waist belt was made from two sizes of flexible tubing and a length of thin (0.28 mm diameter), copper wire. Holohil Systems imbedded a 1 mm inside diameter (ID) plastic tube within the epoxy of the transmitter. The length of copper wire, approximately equal to the circumference of the animal’s waist, was passed through this tube. Two lengths of dark gray, flexible PVC tubing (PVC 105–18, 1.0668 mm outside diameter (OD); Alphawire, Elizabeth, New Jersey), each equal to about one-third the animal’s waist circumference, were slipped over the ends of the copper wire (one length on either side of the transmitter). We secured these lengths of PVC tubing against the transmitter by bending the ends of the copper wire over their ends (Fig. 1). The belt is secured around the animal’s waist by passing the ends of the PVC tubing into a length of silicone tubing (1/16” ID and 1/8” OD; Cole Parmer Instrument Company, Vernon Hills, Illinois), cut to approximately one-half the circumference of the animal’s waist (Fig. 2). The belt was adjusted for fit by changing the amount of PVC tubing extending inside the silicone tubing. Because the OD of the PVC tubing was very close to the ID of the silicone tubing, friction held the belt together (i.e., similar to a Chinese finger trap). The average (~ SD) weight of twelve finished belts was 0.274 ± 0.041 g.

Results.—We used this belt on a total of 14 frogs and 20 toads during the 2009 and 2010 seasons, and seven frogs and 34 toads during the 2011 season. Making and attaching the belt required 5–10 minutes and the double-tube design made it easy to make fine adjustments in the field in less than one minute. During 2009–2010, frogs weighed an average (~ SD) of 38.3 ± 11.0 g (range = 20–65 g); toads weighed an average of 34.6 ± 7.7 g (range = 22.5–55.5 g). The average length of time that frogs and toads wore the belt was 29 ± 24 and 34 ± 16 days, respectively. Factors limiting the time of telemetry with these animals included escaping the belt (~50%), predation (~20%), lost signal (~9%) and death (~9%) (Table 1). Six of the 20 toads and two of the 14 frogs developed minor skin abrasions that were easily and effectively treated in the field by applying Vitamin E to the sore and adjusting the belt; two additional toads developed more serious abrasions that required removal of the belt. Half (N = 8) of those animals that escaped did so after the long whip antenna became entangled in dense herbaceous vegetation. We eliminated this problem by shortening the whip antenna from a length of 15 cm to 10 cm.

During 2011, frogs weighed an average of 3.2 ± 8.7 g (range = 27–52 g); toads weighed an average of 35.9 ± 6.9 g (range = 22–52 g). Additional experience with this belt resulted in fewer lost animals and much longer tracking periods (Table 2). At the time of this writing (mid-July 2011), no animals have been lost due to antennas becoming entangled in herbaceous stems. We have released only one animal due to skin wounds and only four others have escaped the belt. Rates of others include predation (~32%), death (~20%), and lost signal (~7%).

Discussion.—This belt is light-weight (i.e., adds < 0.3 g to the radio transmitter), was easily attached and adjusted in the field...
by one individual in under five minutes, seemed to be minimally invasive (affected normal behavior little and caused minimal injuries), and released the animal when it became entangled in dense vegetation. Two other attachment methods (a plastic belt, Bartelt and Peterson 2000, and a nylon ribbon, Pilliod and Ritsos, pers. comm.) caused deep skin wounds on 19 of 30 animals. The smooth, rounded, larger diameter tubing of this belt distributed the point of contact over a larger area of the delicate skin. Its ease of attachment minimized the amount of time each animal was handled, lessening stress to the animal, and its ability to be finely adjusted throughout the season helps reduce skin sores. The belt did not seem to interfere with normal, daily movements and behavior, or amplexus. Perhaps the biggest problem we encountered was when the long whip antenna became entangled in the dense growths of vegetation of restored prairies. The smooth, rounded, larger diameter tubing of this belt distributed the point of contact over a larger area of the delicate skin. Its ease of attachment minimized the amount of time each animal was handled, lessening stress to the animal, and its ability to be finely adjusted throughout the season helps reduce skin sores. The shortened antenna reduced the detection range of the radio signal by 50 m, or 10–15% of its previous detection range, but for this study the elimination of entangled antennas made this shortened range worthwhile. However, the shortened antenna may not be appropriate for tracking species that make longer distance movements, or use habitats that reduce detection ranges. Belts with a feature that allows the radio transmitter to fall off the animal after many weeks helps ensure any animal whose signal is lost will not permanently carry the radio transmitter. We have recently discovered (2011) that the thin copper tends to

<p>| Table 1: Average weight, fate, and number of days tracked for Northern Leopard Frogs (NLF) and American Toads (AT) during 2009 and 2010 field seasons. Half of those that escaped did so when the antenna of their radio transmitters became entangled in dense vegetation; shortening the antenna eliminated this problem. |</p>
<table>
<thead>
<tr>
<th>No. of NLF</th>
<th>Avg. Wt.</th>
<th>Fate</th>
<th>No. Days Tracked</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>36.0 ± 9.1</td>
<td>released</td>
<td>49.0 ± 13.8</td>
</tr>
<tr>
<td>7</td>
<td>40.1 ± 13.7</td>
<td>escaped</td>
<td>26.7 ± 16.1</td>
</tr>
<tr>
<td>2</td>
<td>32.2 ± 3.2</td>
<td>predation</td>
<td>19.5 ± 13.4</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>died</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>33</td>
<td>signal lost</td>
<td>27</td>
</tr>
<tr>
<td>No. of AT</td>
<td>Avg. Wt.</td>
<td>Fate</td>
<td>No. Days Tracked</td>
</tr>
<tr>
<td>2</td>
<td>34.5 ± 0.7</td>
<td>released</td>
<td>78.5 ± 31.5</td>
</tr>
<tr>
<td>9</td>
<td>35.2 ± 6.9</td>
<td>escaped</td>
<td>23.2 ± 13.3</td>
</tr>
<tr>
<td>5</td>
<td>36.3 ± 12.7</td>
<td>predation</td>
<td>29.0 ± 9.7</td>
</tr>
<tr>
<td>2</td>
<td>28.0 ± 4.0</td>
<td>died</td>
<td>31.5 ± 0.71</td>
</tr>
<tr>
<td>2</td>
<td>34.5 ± 2.1</td>
<td>signal lost</td>
<td>54.5 ± 23.5</td>
</tr>
</tbody>
</table>

<p>| Table 2: Average weight (Avg. Wt.), fate, and number of days tracked for Northern Leopard Frogs (NLF) and American Toads (AT) during the 2011 field season (as of mid-July 2011). |</p>
<table>
<thead>
<tr>
<th>No. of NLF</th>
<th>Avg. Wt.</th>
<th>Fate</th>
<th>No. Days Tracked</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>35.4 ± 11.6</td>
<td>predation</td>
<td>26.5 ± 9.6</td>
</tr>
<tr>
<td>3</td>
<td>30.3 ± 2.1</td>
<td>died</td>
<td>25.3 ± 12.8</td>
</tr>
<tr>
<td>No. of AT</td>
<td>Avg. Wt.</td>
<td>Fate</td>
<td>No. Days Tracked</td>
</tr>
<tr>
<td>9</td>
<td>34.5 ± 0.7</td>
<td>still tracking</td>
<td>&gt; 70</td>
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<tr>
<td>1</td>
<td>47</td>
<td>released</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>32.3 ± 4.5</td>
<td>escaped</td>
<td>10.5 ± 10.3</td>
</tr>
<tr>
<td>3</td>
<td>30.3 ± 15.6</td>
<td>belt broke</td>
<td>61.9 ± 10.7</td>
</tr>
<tr>
<td>9</td>
<td>35.0 ± 7.6</td>
<td>predation</td>
<td>20.1 ± 12.4</td>
</tr>
<tr>
<td>5</td>
<td>33.8 ± 8.3</td>
<td>died</td>
<td>26.6 ± 9.0</td>
</tr>
<tr>
<td>3</td>
<td>37.3 ± 2.1</td>
<td>signal lost</td>
<td>34.7 ± 29.7</td>
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</table>
break after 9–12 weeks of wear in the field (= approx. battery life of the transmitter); we cannot yet claim this will happen consistently, but five have fallen off tracked toads (two radio transmitters were lying directly adjacent to the toads and reattached). If one needs to ensure the radio transmitter remains on an animal longer, a slightly thicker wire may be used, or the wire may be replaced with a continuous length of PVC tubing (the radio transmitter manufacturer will need to embed a tube with an ID of 1.1 mm). The weight of the 0.28 mm copper wire is approximately equal to the additional length of PVC tubing, so total transmitter weight would remain the same.

We tested this belt only on Northern Leopard Frogs and American Toads, but think it would be suitable for other medium to large species of ranids and bufonids for long-term (i.e. 3–5 month) studies. Like all other attachment methods, experience with this belt improved its success. We caution researchers to choose tubing colors that blend into the animals’ natural habitats, check the animals frequently (e.g., once/week) for any sores or health problems, and to remove dead skin from the belt (dead skin clinging to belts seems to facilitate skin sores). This diligence can greatly diminish skin and health problems.

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Literature Cited


