Use of Heat-Shrink Tubing To Attach Radio Transmitters To Bird Rectrices

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ABSTRACT

Researchers have been attaching radio transmitters to birds for over 50 yr, which has greatly increased our knowledge about the behavior of many bird species. However, because researchers are interested in studying the behavior of birds, it is important to attach the transmitters in a manner that mitigates any potential effects the transmitter may have on a bird's behavior. We present a new method to attach radio transmitters to the rectrices of birds, specifically passerines, using heat-shrink tubing. We attached 27 0.8-g transmitters to 40 Yellow-breasted Chats (*Icteria virens*), and 10 1.1-g transmitters to 10 American Robins (*Turdus migratorious*). The mean duration of transmitter attachment was 16.5 days for chats and 48.5 days for robins. Our observations suggest that this method had little effect on the behavior of the birds. We discuss species and questions for which this method is most suited.

INTRODUCTION

Radio telemetry allows researchers to address questions that are not addressed easily by direct observation, including questions about individual behavior (Derleth and Sepik 1990, Schulz et al. 1996, Mays and Ritchison 2004). To study the natural behavior of wildlife, it is critical that attachment be accomplished quickly and that transmitters be as unobtrusive as possible. Different transmitters are created for different species and research questions, and different attachment methods can be species and question specific. No single technique is applicable to all species (Cochran et al. 1963, Dunstan 1973, Raim 1978, Rappole and Tipton 1991, Powell et al. 1998, Haramis and Kearns 2000).

Some waterfowl and other large birds can carry relatively heavy transmitters, although aerodynamic theory suggests that heavier birds are less capable of carrying the same proportionate weight as lighter birds are (Caccamise and Hedin 1985). These are often applied using the harness-style method (Dwyer 1972, Robert et al. 2006) and facilitate tracking for long periods but have been documented to affect some individuals negatively (Greenwood and Sargeant 1973, Chabaylo 1990, Pietz et al. 1993, Robert et al. 2006). Conversely, for some smaller birds such as passerines, the harness-style is less desirable due to the effects on behavior, and an adhesive method might be preferred (Sykes et al. 1990). The back-adhesive method has an advantage because it does not restrict the movement of the bird; however, disadvantages are that a bird could remove the transmitter prematurely (Johnson et al. 1991), and the amount of time required to hold the bird until the glue dries may increase stress on the bird.

We developed a new radio transmitter attachment method that is inexpensive ($0.02 per bird for tubing), can remain on individuals for relatively long periods (90 days), and can be applied very quickly (< 3 min).

METHODS

We attached transmitters to Yellow-breasted Chats *(Icteria virens)* and American Robins *(Turdus migratorious)* in two spatially separate locations in

Illinois. The chats we captured weighed, on average, 27.26 g (SE=0.26 g); robins were not weighed in our study but weigh, on average, 77.3 g (Clench and Leberman 1978). Chats were captured at Kennekuk County Park in Vermilion County, IL, and robins were captured in Champaign, IL. Chat transmitters and antennae (Sparrow Systems, Fischer, IL) weighed, on average, 0.8 g, were 120 mm in length (transmitter: 20 mm, antenna: 100 mm), and the transmitters were 3 mm deep and 7 mm wide. Robin transmitters and antennas (Sparrow Systems, Fischer, IL) weighed, on average, 1.1 g, were 135 mm in length (transmitter: 20 mm, antenna: 115 mm), and the transmitters were 5 mm deep and 10 mm wide.

Upon capture, a field technician restrained the bird by tucking its head towards the technicians stomach while using both hands to secure the bird's wings and body, thus allowing accessibility to the tail feathers. Next, a section of electrical heat-shrink tubing (Radio Shack heat-shrink tubing, 7 mm diameter for chats, 10 mm for robins, 125° C) was measured and cut so that the transmitter protruded 2 mm from the anterior end of the material and 5 mm from the posterior end. This ensured that, when heated, the material would shrink tightly around the transmitter. After cutting the tubing to the correct size, the material was then positioned at the distal end of the bird's rectrices, and for chats, three central tail feathers were placed in the tubing. Because robins' tail feathers are larger, only two feathers were used when attaching the transmitter. The tubing was then pushed toward the base of the rectrices.

While positioning the tubing, we made a special effort not to obstruct the uropygial gland, which may interfere with a bird's preening behavior. We found that attaching the tubing 7 to 14 mm from the gland was the ideal location for chats (Fig. 1). Closer to the gland may cause preening interference, while farther away may increase feather stress. The transmitter was then inserted into the heat-shrink so it was positioned on the dorsal side of the tail feathers with the antenna facing posteriorly.

At this point, the anterior and posterior ends of the transmitter were visible while the tubing covered the middle portion. We used a 15-watt, cordless battery-powered soldering iron (Radio Shack, model # 64gh-150, $19.99) to shrink the tubing. The soldering iron was heated to approximately 150° C. Heat was then lightly applied to the tubing by direct contact, which caused it to shrink uniformly. We applied heat to all parts of the material, excluding the ventral side of the

Fig. 1. This shows the location of an attached transmitter on a Yellow-breasted Chat. Note the relationship of the tubing on the transmitter and the distance from the uropygial gland. Photograph taken prior to applying heat to the tubing.

heat-shrink as the other rectrices were obstructing this side. However, we carefully applied heat to the sides of the heat-shrink as close to the rectrices as possible. This partially shrank the ventral side to supplement the process (Fig. 2). After assessing the strength of the bond by gently pulling on the transmitter, the bird was released. On average, it took less than three minutes from when a bird was extracted from the mist net to when it was released with a transmitter.

We recorded the length of time between transmitter attachment and transmitter loss from the bird. Because some birds emigrated or migrated from our study systems before losing transmitters, we counted the duration of attachment until the day the bird left. Birds were determined emigrants or migrants if they were tracked or found outside of the study system, or if they were tracked emigrating by an Automated Radio Telemetry System that we deployed. When transmitters failed while attached to a bird, the date of transmitter failure was considered the last day of attachment. We report mean length and standard error for chats and robins.

RESULTS

Twenty-seven radio transmitters were attached to 40 adult Yellow-breasted Chats between May and Jul of 2008, and 10 transmitters were attached to 10 adult American Robins during all months of 2007 and 2008. The mean duration of attachment was 16.5 days (SE=1.89 days; range 1-65 days) for Yellow-breasted Chats and 48.5 days (SE=11.23 days; range 14-133 days) for American Robins. Many chats lost their transmitters due to feather loss. The mean length for transmitter attachment for robins was more difficult to determine because the transmitters either failed before falling off, or the birds migrated or emigrated from the study region. Three of the ten (30%) robin transmitters fell off before the expected molting period, whereas 22 of the 40 (55%) chats lost their transmitters before the molting period.

DISCUSSION

The heat-shrink method has several advantages over the two most popular attachment methods, the back-adhesive and harness techniques (Raim 1978, Rappole and Tipton 1991). Compared to the back-adhesive method, the heat-shrink method is faster and does not

Fig. 2. This shows a transmitter on a chat after heat was applied via 35-watt soldering iron. Note how tightly wrapped the tubing is around the transmitter.

require the feathers be trimmed (Raim 1978, Sykes et al. 1990). The amount of time the back-adhesive mount requires depends on the amount of glue used, but can require 10 to 60 min of handling time with the bird (Raim 1978, Sykes et al. 1990) compared to less than three min for the heat-shrink technique.

Although the harness-technique tends to take less time than the back-adhesive method, there appears to be a greater chance that the backpack will affect the behavior of the bird. Bedrosian and Craighead (2007) found that backpack attachments were the most difficult and time-consuming to fit correctly. Bowman and Aborn (2001) found that Florida Scrub-Jays (*Aphelocoma coerulescens*) behaved similar to sick or injured birds when fitted with harnesses. Haramis and Kearns (2000) concluded that using the harness-technique on Soras (*Porzana carolina*) resulted in limited leg movement and adjustments had to be made before it worked correctly. The harness method has also been shown to cause weight loss, atypical behaviors, and may remain on the bird far after the transmitter's battery is dead (Bray and Corner 1972, Sykes et al. 1990), thus prolonging these negative effects. When using the harness method, researchers also need to take into account the individual's size, because a relatively small difference in size may affect the application of the harness transmitters (Rappole and Tipton 1991).

The heat-shrink method may be ideal for many species when addressing certain questions such as within-season movements, nesting behavior, migratory behavior, and roosting behavior. In addition to the chat and robin data presented in the results, we have also attached transmitters to American Crows (*Corvus brachyrhynchos*) and Mourning Doves (*Zenaida macroura*) using the heat-shrink method with excellent results. In fact, two of the three crows migrated to Michigan (+ 200 km) while retaining the transmitter (Ward, unpublished data). We have also attached 13 transmitters using the back-adhesive method to seven adult robins, four adult Soras, and two adult Northern Cardinals (*Cardinalis cardinalis*; MPW unpubl. data). Their combined mean duration of attachment was 10 days. Robins with the heat-shrink attachment retained transmitters for approximately 49 days, while robins in another study retained transmitters for 19 days using the back-adhesive technique (Johnson et al. 1991). This suggests that the heat-shrink method has the ability to stay attached longer, especially when used with larger and longer rectrices.

More investigation is needed but it appears that the back-adhesive technique and heat-shrink technique both have limited effects on the behavior of birds. Birds with tail mounts appeared to forage, sing, and display without any interference, but the energetic costs of the heat-shrink transmitter and how they compare to other methods are not known. The primary difference with the heat-shrink technique is that one does not have to trim feathers, which may affect thermoregulation, and the duration of attachment is lessened when using the heat-shrink method.

There are several potential drawbacks of using the heat-shrink method. First, it often requires the use of two people, one to secure the bird safely while the other attaches the transmitter. One person may be able to hold and apply the heat-shrink, possibly by placing the bird in Vetrap (Fuller 1975) or an aba (Maechtle 1998) with the tail feathers exposed; however, we have not attempted this. The second drawback is that this method is not ideal for species with very short or small tails. If the transmitter antenna extends far beyond the tail it may affect both flight and become entangled in vegetation, thus reducing the duration of transmitter attachment.

The weight of the transmitter more than likely is displaced differently depending on the size of the tail feather. For example, we selected three tail feathers for chats because it appeared that two provided less support than what was needed if we expected the transmitter to stay on longer-term. However, robin tail feathers are larger and required only two. For crows, only one tail feather was needed. The main reason for transmitters falling off prematurely from chats was follicle release. We believe our transmitter may have been too heavy for a small birds' tail; however, some individuals retained the transmitter for

two months, suggesting that placement on the tail may be the deciding factor in transmitter retention.

Differences in the habitats used by species may also affect how long a transmitter remains attached. We found chat transmitters entangled in thorns on four occasions, while we never found robin transmitters entangled in vegetation. This may be because chats breed in dense vegetation while robins were usually located in open, manicured habitats.

Third, attaching transmitters to nestlings using the heat-shrink method would not be beneficial, as the lack of robust tail feathers would prohibit attachment. Additionally, it is unknown whether our method of applying heat directly to the transmitter has any negative effects on functionality. While applying heat, the pulse of the transmitter increases because the crystals in analog transmitters are temperature sensitive. Therefore, the heat is affecting the transmitter, but whether this causes long-term damage is unknown; yet, the transmitters we attached appeared to function normally. It is also feasible that feathers could be burned if the bird or holder moved at an inappropriate time; yet, this never occurred.

We acknowledge that chats had a relatively low retention period of our transmitters, but the variation among individuals was large. Several individuals retained their transmitter for 60 days where others only retained them for as little as one day. Differential behavior between males and females, nesting stage, and location of the transmitter may all determine the duration of transmitter retention and requires further research.

Given the advantages and disadvantages of these three different methods, most research should be able to use one of these techniques. For larger species, in which the research question requires prolonged transmitter attachment, either the backpack or heat-shrink technique would probably be best. However, researchers should be aware of the molting schedule of the species of interest, because the most common reason for transmitter detachment was molt. For smaller species, with short tails relative to the transmitters, the back-adhesive technique would be the preferred method. Nonetheless, for species with tails where the antenna does not extend past the tail by more than a few centimeters, the heat-shrink method may be a good alternative.

Many studies that are currently using the back-adhesive method may experience longer transmitter attachment duration by using the heat-shrink method. Furthermore, the materials for attaching transmitters with heat-shrink are inexpensive. There are other tail mount attachment techniques, such as gluing the transmitter to the tail and using thread to attach the transmitter and antenna (Kenward 1978) and using a plastic clip (Bray and Corner 1972). However, the thread and glue technique may have the same drawbacks as the back-adhesive technique; whereas, the use of thread may work similarly to the heat-shrink method but may require more time than the heat-shrink method and attachment duration may not be as long. The use of plastic clips appears to work well; however, we do not know of any commercially available clips, and constructing molds or creating your own clips as outlined by Bray and Corner (1972) may require more time and resources than simply using the heat-shrink method.

ACKNOWLEDGMENTS

We thank Jim and William Cochran for providing the transmitters. We are grateful to Kimberly Hazelwood and Kevin Sierzega for providing assistance while in the field. We also thank T.J. Benson, Nick Anich, Mark Fuller, and two anonymous reviewers for providing helpful comments. Without the cooperation of Vermilion County Conservation District, more specifically, Ken Konsis and Mark Pittman, this research would not have been possible. The Illinois Natural History Survey, the Champaign County Audubon Society, Mr. and Mrs. Robert Fisher, Vicky Sroczynski, and John Burke provided funding for this research. This method was developed as part of two ongoing research projects and followed the Institutional Animal Care and Use Committee protocol #06248 and #06239. Birds were banded using master permit #06507.

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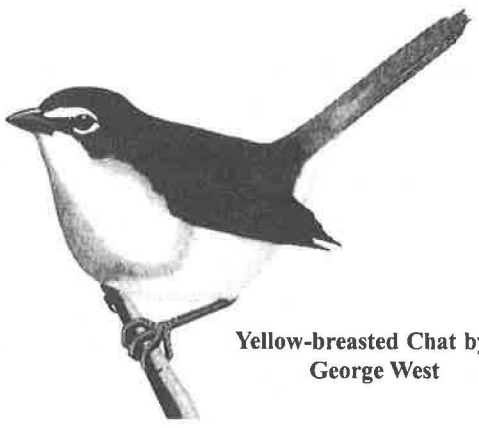

Yellow-breasted Chat by George West