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RETENTION OF TRANSMITTERS ATTACHED TO PASSERINES USING A GLUE-ON TECHNIQUE

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Abstract.—Retention of transmitters attached to the interscapular region of four species of passerines using an adhesive containing cyanoacrylate was evaluated. Mean retention time was 20 d for Blue Jay (*Cyanocitta cristata*), 19 d for American Robin (*Turdus migratorius*), 16 d for Brown Thrasher (*Toxostoma rufum*) and 5 d for Northern Cardinal (*Cardinalis cardinalis*). Mean retention time for the Northern Cardinal was significantly shorter ($P < 0.05$) than that of the other three species, presumably because cardinals were able to remove transmitters with their strong bills. No evidence was found that cyanoacrylate increased mortality or impaired behavior in radiomarked birds, and this adhesive is believed to be safe for attaching transmitters to passerines.

RETENCIÓN DE TRANSMISORES EN PASSERIFORMES UTILIZANDO LA TÉCNICA DE PEGAMENTOS

Sinopsis.—Se evaluó en cuatro especies de Passeriformes, la retención de transmisores pegados a la region interescapular utilizando un adhesivo que contiene cianoacrilato. El tiempo promedio de retención resultó ser de 20 d para *Cyanocitta cristata,* 19 d para *Turdus migratorius,* 16 d para *Toxostoma rufum* y 5 d para *Cardinalis cardinalis.* El tiempo promedio de retención resultó ser significativamente menor ($P < 0.05$) en *C. cardinalis,* que en las otras especies. Es posible, que estas últimas hayan podido removerse el transmisor con su pico tan fuerte. No se encontró evidencia que indicara que el uso de cianoacrilatos como adhesivos de radiotransmisores incrementaran la mortalidad o impidieran patrones particulares de conducta en las aves. Se cree que la técnica no deba causarle daño a Passeriformes.

Radiotelemetry is a useful technique for monitoring movements, habitat use, behavior, mortality and other parameters of wildlife populations (Mech 1983). Numerous telemetry investigations have been conducted on upland game birds, waterfowl, and raptors. Comparatively fewer telemetry studies have been conducted on passerines, presumably because of early difficulties with transmitter attachment and a lack of suitable transmitters (Godfrey 1970, Martin and Bider 1978). Advances in transmitter design and development of transmitter attachment methods for small birds now make it possible to radiomark most birds (Cochran et al. 1967, Godfrey 1970, Martin and Bider 1978, Perry et al. 1981, Raim 1978, Sykes et al. 1990).

We needed to radiomark passerines as part of a study to evaluate effects of insecticides on wildlife associated with corn fields. Perry et al. (1981) compared several transmitter attachment techniques and adhesives and concluded that gluing transmitters to the interscapular region using cyanoacrylate is the best attachment technique for Mourning Doves (*Zenaida macroura*). Our objective was to evaluate this attachment technique

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on Blue Jays (*Cyanocitta cristata*), American Robins (*Turdus migratorius*), Brown Thrashers (*Toxostoma rufum*), and Northern Cardinals (*Cardinalis cardinalis*) by determining mean transmitter retention times, causes of transmitter loss and survival of radiomarked birds, and to determine if differences in transmitter retention occurred between species. With the exception of an early study conducted with an American Robin (Graber and Wunderle 1966), we know of no previous published telemetry studies conducted with these four species.

STUDY AREA AND METHODS

We conducted the study during the spring and summer of 1989 in Wayne, Lucas, and Warren counties in south-central Iowa. The study area was composed of croplands, pasture and recently seeded grasslands interspersed with deciduous woodlands, wooded drainages and shelter belts. Topography varied from flat to hilly. Birds were captured in wooded areas adjacent to corn fields using mist nets (all four species) and modified Stoddard traps (Wilbur 1967) baited with chicken scratch (Blue Jays, Brown Thrashers, Northern Cardinals). Mist nets were set in the morning and evening, and were checked at least once an hour, whereas funnel traps were set continuously and checked late in the morning and again late in the evening. Trapping sessions occurred 5 April–10 May and 10–22 June 1989. Birds were banded with U.S. Fish and Wildlife Service and colored leg bands.

We used lithium battery-powered transmitters in the 217 and 218 MHz range manufactured by Holohil Systems, Inc. (Ontario, Canada). The expected battery life was 6–8 wk. Transmitters had a 13.5-cm antenna and averaged 1.4 g (generally $<3\%$ of the body weight of individuals captured). Mean transmitter dimensions were 22 × 10 × 6 mm. Transmitters were potted using epoxy and were slightly concave along the longest axis. Our transmitter attachment procedure generally followed that used by Raim (1978) on Brown-headed Cowbirds (*Molothrus ater*) and Sykes et al. (1990) on captive Common Yellowthroats (*Geothlypis trichas*) and wild Kirtland's Warblers (*Dendroica kirtlandii*), except that we used cyanoacrylate (Super Glue®) rather than a latex-base adhesive. Transmitters were glued onto a piece of cotton mending fabric slightly larger than, and similar in shape to, the transmitter. Spinal tract feathers on each bird's interscapular region were clipped to within approximately 2 mm of the skin. A film of Super Glue® was applied to the cloth and the cloth was attached to the feather stubble and skin. Birds were released as soon as the transmitter was in place and the glue was dry, generally within 15 min of capture.

Birds were tracked off road using directional three-element hand-held antennas and from roads using seven-element antennas on fixed towers. Attempts were made to locate all birds once a day from time of capture until 14 d after conclusion of pesticide applications on the corn field where the bird was first captured. Attempts were made to locate all birds for a minimum of 21 d, but some birds were located for up to 49 d depending

upon when each bird was caught prior to pesticide application. Intact radiomarked birds found dead were examined for possible cause of death and analyzed for pesticide residues.

Mean transmitter retention time, number of dropped transmitters and lost signals, and number of mortalities were determined for each species over the 21-d period that all birds were monitored. Differences in transmitter retention time between species were compared using one-way ANOVA. Individual birds that were never located after attaching the radio (one Blue Jay, three American Robins, eight Brown Thrashers, two Northern Cardinals), presumably because of emigration or radio failure, were excluded from analysis.

RESULTS

One-hundred twenty-eight passerines were captured and radiomarked during the study (Table 1). Mean transmitter retention time ranged from 5 ± 0.2 d (SE) for Northern Cardinal to 20 ± 0.5 d for Blue Jay. Differences in mean transmitter retention times between species were significant ($F = 7.66$; $P = 0.0001$) (Table 1). For all species except the Northern Cardinal, the mean would likely have been several days longer if we had continued to track them, as 38% of the Blue Jays, 39% of the American Robins, and 20% of the Brown Thrashers were still carrying functional transmitters when tracking was terminated. The longest a transmitter remained attached and functioning ranged from 14 d for Northern Cardinal to 49 d for American Robin (Table 1). All except the Northern Cardinal were still being monitored upon study termination; thus we were not able to determine the maximum length of time these individuals carried transmitters.

After 7 d, 19% of the Northern Cardinals, 75% of the Blue Jays, 80% of the American Robins and 67% of the Brown Thrashers retained functional transmitters (Table 1). After 21 d, these percentages were 0% for Northern Cardinal, 50% for Blue Jay, 44% for American Robin and 47% for Brown Thrasher (Table 1).

Loss due to dropped transmitters ranged from 13% for Brown Thrasher to 38% for Northern Cardinal (Table 2). Dropped transmitters and transmitters recovered from dead cardinals were all damaged; many were lacking antennas or had antennas that had been coiled to only 1–2 cm in length. Antennas on transmitters recovered from Blue Jays were generally broken off to a length of 1–2 cm, whereas none of the transmitters recovered from American Robins or Brown Thrashers showed any damage. We lost signals for 21% of Blue Jays, 31% of American Robins, 33% of Brown Thrashers and 31% of Northern Cardinals (Table 2).

Mortality was similar for all species except the Northern Cardinal; 8% of Blue Jays, 5% of American Robins and 7% of Brown Thrashers died during the study. In contrast, 31% of radiomarked Northern Cardinals died, all within 3 d of transmitter attachment.

Although birds were not monitored intensively enough to quantify effects of transmitters on behavior or breeding success, we noticed no

TABLE 1. Frequency and duration of transmitter retention for radiomarked Blue Jays, American Robins, Brown Thrashers and Northern Cardinals in south-central Iowa, April–July 1989.

Species (n)[a]	Range of dates trapped	# birds retaining transmitters after			Retention time (d)		
		7 d	14 d	21 d	Range	$\bar{x}$	SE
Blue Jay (24)	6/10–6/20	18	17	12	1–36	20	0.5
American Robin (59)	4/06–6/19	47	35	26	2–49	19	0.2
Brown Thrasher (15)	4/19–6/22	10	8	7	5–32	16	0.6
Northern Cardinal (16)	4/05–4/13	3	1	0	2–14	5[b]	0.2

[a] Does not include one Blue Jay, three American Robins, eight Brown Thrashers and two Northern Cardinals that were never located after attaching the radio and were excluded from further analysis.

[b] Mean is significantly ($P < 0.05$) different from other species (Tukey's Multiple Comparison Test).

abnormal behavior in the birds we located. American Robins seemed especially adaptable to the transmitters, as two radiomarked individuals were observed nesting during the study.

DISCUSSION

We were able to track Blue Jays, American Robins and Brown Thrashers for as long as or longer than other radiomarked passerines (e.g., Brigham 1989, Martin and Bider 1978, Raim 1978, Sykes et al. 1990) and believe our attachment technique is suitable for these three species, provided retention time is considered when determining study objectives. The short transmitter retention time for the Northern Cardinal suggests that this species may not be a suitable candidate for telemetry investigations using our technique. We believe our lack of success with this species was due to its behavior. Apparently, this species has little tolerance for attached foreign objects, and, because of its strong bill, it has the ability to remove or destroy transmitters. In addition to removing transmitters, most cardinals recovered had removed colored leg bands attached at the time of capture.

Signal loss was a major cause of attrition for all four species. We

TABLE 2. Number of transmitter failures, dropped transmitters and mortalities for radiomarked Blue Jays, American Robins, Brown Thrashers and Northern Cardinals in south-central Iowa, April–July 1989.

Species (n)	# signals lost first 21 d	# transmitters dropped first 21 d	# mortalities first 21 d
Blue Jay (24)	5	5	2
American Robin (59)	18	12	3
Brown Thrasher (15)	5	2	1
Northern Cardinal (16)	5	6	5

attributed loss of signals to a variety of factors. Transmitter failure certainly caused some loss; many signals became erratic shortly before they were lost, which generally indicates failure is imminent. The condition of transmitters recovered from Blue Jays and Northern Cardinals suggests that transmitter and/or antenna damage caused by the birds may have resulted in some radio failure. A significant proportion of the signals lost for American Robins and Brown Thrashers marked during the first interval (5 April–10 May) were probably due to emigration or migration because these species were marked prior to the time of territory establishment.

Dropped transmitters also resulted in significant losses of marked birds. Due to the damaged condition of transmitters that dropped off Blue Jays and Northern Cardinals, it is likely that most were removed by the birds. None of the transmitters recovered from American Robins or Brown Thrashers were damaged, suggesting the birds did not try to remove them or did not have strong enough bills to remove them. Weather may also affect glue bonds (Sykes et al. 1990). We encountered temperatures ranging from −8.3 to 37.2°C during the period we monitored birds. Rainfall, ranging from a trace to 3.4 cm, occurred on 34 of the 98 d radiomarked birds were monitored. These temperature extremes and periods of rainy weather may have weakened glue bonds and caused some of the transmitters to fall off.

Based on presence of pesticide residues in the gastrointestinal tract, we attributed one American Robin death to pesticide exposure. One radiomarked Blue Jay was recaptured in a funnel trap and was killed by a predator while in the trap. The one Brown Thrasher that died was found buried, and was probably killed by a predator. We did not determine cause of death for the other mortalities. Carcasses of two American Robins, one Blue Jay and one Northern Cardinal were scavenged and only feather spots were recovered. Four Northern Cardinal carcasses were found intact and did not show any evidence of trauma or contain pesticide residues.

As cyanoacrylates may irritate skin and block skin pores, use of this adhesive may potentially injure birds and result in mortality. This adhesive was used to attach transmitters to Mourning Doves (Perry et al. 1981) and to Least Terns (*Sterna antillarum*) and Snowy Plovers (*Charadrius alexandrinus*) (Hill and Talent 1990) without any apparent detrimental effects, however. If cyanoacrylate did contribute to the mortality observed in this study, we believe similar rates of mortality should have occurred for all four species, as it seems unlikely that Northern Cardinals would be more susceptible than the other three species. Based on this evidence, and the fact that no apparent abnormal behavior was noted in radiomarked birds, we believe cyanoacrylate is a safe adhesive for attaching transmitters to passerines.

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