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A NEW PROCEDURE FOR TRANSMITTER ATTACHMENT: EFFECTS ON BROOD ATTENDANCE AND CHICK FEEDING RATES BY MALE COMMON TERNS[1]

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Abstract. A transmitter crystal and battery were covered with epoxy and wired to a size 2 USFWS aluminum leg band. The male partners of 10 Common Tern (*Sterna hirundo*) pairs were captured during late incubation at a Port Colborne, Ontario tern colony and the transmitter units fixed to their legs. The total package weighed an average 1.08 g more than the usual mass of a single band. The brood attendance patterns and feeding frequency rates of transmittered-males and of their female partners were contrasted over a 20-day period with those of non-transmittered males and their partners. No differences were found. Advantages of the attachment procedure are speed of attachment, light mass, rapid loss of antennae following battery exhaustion, and lack of adverse effect on parental behavior.

Key words: Transmitter effects; foraging; brood attendance; radiotelemetry; Sterna hirundo; *Common Terns.*

INTRODUCTION

We have recently been studying parental care behavior and aspects of the foraging ecology of Common Terns (*Sterna hirundo*) at a colony near Port Colborne, Ontario (42°52′N, 79°15′W). The feeding of chicks at this colony is primarily the responsibility of the male (Wiggins and Morris 1987; but see Wagner and Safina 1989) and to address the question of variance in parental performance of individual males, we required details of movement patterns on specific individuals as they foraged away from the colony.

Data on the foraging locations and activities at a distance from a breeding colony can be reliably obtained only with the use of radio transmitters. Early studies that used the new technology to investigate movement patterns often claimed no noticeable effects despite heavy packages up to 15% of the body mass of test birds (Graber and Wunderle 1966, Michener and Walcott 1966). Despite subsequent warning that transmitter devices may seriously effect performance (e.g., Cochran et al. 1972), and evidence from experimental studies of subtle behavioral effects (e.g., Boag 1972, Gilmer et al. 1974), more recent studies sometimes still claim no obvious behavioral changes associated with radio backpacks (see Lance and Watson 1979).

The technique has a history of variable success (Massey et al. 1988, Wanless et al. 1989), but often produces valuable data on the foraging patterns of individual birds (Anderson and Ricklefs 1987, Jouventin and Weimerskirch 1990). Of tern species, only Least Terns (*S. antillarum*) have been subjects in previous radio telemetry studies. Both studies used glue to fix the transmitter units to the back of study animals with positive (Hill and Talent 1990) and negative (Massey et al. 1988) results. With the use of Common Tern subjects, we here report a new transmitter attachment procedure with wide applicability to a variety of bird species. We test for negative consequences by contrasting attendance with the brood and feeding rate to chicks of experimental (transmitter-equipped) males with control (non-transmitter-equipped) males.

METHODS

THE ATTACHMENT PROCEDURE

Our objective was to use a transmitter that would last for at least two weeks during the period of chick feeding, that would require minimal handling time for attachment, and that would not inhibit the foraging capabilities of these specialized plunge-divers. We chose to test the use of a transmitter crystal and battery fused by epoxy to the aluminum leg band in normal use for banding Common Terns. The completed unit was built by Holohil Systems Ltd. of Woodlawn, Ontario. The crystal (LD-2) and round lithium battery were encased in epoxy and the unit fastened by epoxy to the metal band (Fig. 1). A thin copper

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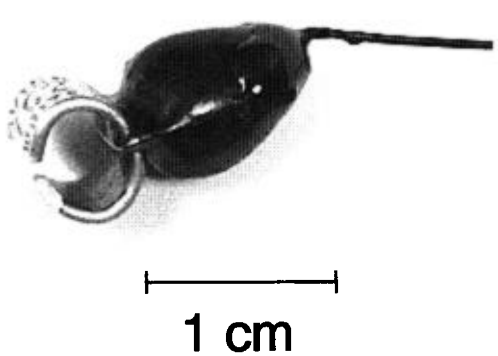

FIGURE 1. The transmitter attached by epoxy to a metal band. The whip antenna extends an additional 12 cm to the right of the photograph.

wire, embedded in the epoxy that encased the crystal and battery, circled the aluminum leg band at a point opposite the opening to assure additional fidelity of the unit to the band. Placement of the copper wire is important as if it is too close to the band opening, the epoxy can crack as the band is closed around the leg of the study animal. A 13-cm braided steel wire antenna projected from the epoxy such that when the band was closed on the leg of the bird, the aerial lay in a plane parallel to the upright orientation of the bird's body. Removal of a small, external magnet after banding activated the transmit crystal moments before release of the bird. The mass of USFWS aluminum leg bands normally used on Common Terns is 0.20 ± 0.0008 g (SE, n = 40). The mass of the 10 units used in 1990, including the metal bands to which each was attached, was 1.28 ± 0.004 g (SE).

CHOICE OF STUDY PAIRS

Prior to the arrival of terns, an observation blind was erected at one edge of a 4 × 15 m area where many pairs traditionally establish nest sites during the first two weeks of May each year (Morris et al., in press). Daily or twice daily nest checks (starting on 1 May 1990) confirmed clutch initiation dates and clutch size, and observations of copulation and courtship feeding established the sex of potential study pairs in which one partner was recognizable (i.e., already banded or otherwise phenotypically distinct). Males from ten pairs were captured with a walk-in trap during the last few days of incubation. Two trapping periods were used: 23–27 May for peak nesters and 11 July 1990 for late nesters. Each captured animal was weighed and head-bill and wing span measurements were taken; color-bands and picric acid dye were placed on the legs and tail respectively. The transmitter, fused to an aluminum band, was attached in the normal fashion to the leg, and the bird was released. Eleven additional pairs, each with clutches that hatched in approximate synchrony with those of transmittered birds, served as non-transmittered controls. One member of each pair was trapped and banded, or sprayed with picric acid dye. We used regular observation periods each day to record attendance and departure patterns, and twice-daily visits were made into the study area during hatching to color-dye chicks from study broods in order of hatching sequence. Six hours were spent in the blind each day from 28 May–7 June and from 12–25 July in two, 3-hr periods after sunrise and before sunset. Three-hour observation sessions, alternating morning and evening periods, were performed from 9–24 June and 26 July–9 August 1990. Data were obtained on attendance with the brood by all partners in the 21 pairs, and on the feeding frequency by each parent to each chick within each study brood. Similar capture and handling procedures were used in 1991 as part of a larger study (Burness 1992).

RESULTS AND DISCUSSION

The first Common Tern was sighted over the colony on 15 April 1990. Terns were on the ground by 24 April and the first egg was laid in the study site on 1 May. Peak nesting experimental (males carried transmitters) and control (males did not carry transmitters) pairs initiated clutches between 2–6 May; late nesting pairs did so between 19–25 June.

POST-RELEASE BEHAVIOR

Captured birds were processed quickly and released; the time from capture to release for each of the 10 birds was not recorded in 1990 but was less than 5 min (4.4 ± 0.40 min, n = 5) for similar procedures in 1991. The most common behavior upon release was for the bird to fly out over the water behind the blind, to "dip" into the water at frequent intervals, and to rise periodically to shake out the feathers. Return times were not recorded in 1990. In 1991, there was some variation in the amount of time taken to return to the nest site following release. Of seven birds

TABLE 1. Time (mean ± 1 SE min/hr) in attendance with the brood of peak and late nesting control and experimental Common Terns. *P* values were assessed using the Mann-Whitney *U* test.

Time	Sex	Attendance		Significance *Z*	Significance *P*
		Peak nesters			
		Control (7)	Experimental (5)		
AM (47.5)[1]	Male	16.0 ± 1.8	16.9 ± 2.1	−0.6	0.54
	Female	23.1 ± 2.2	22.2 ± 2.7	−0.1	0.90
PM (49.8)	Male	10.6 ± 1.4	11.4 ± 1.8	−0.3	0.73
	Female	22.5 ± 2.4	23.0 ± 3.0	−0.1	0.88
		Late nesters			
		Control (4)	Experimental (5)		
AM (62.0)	Male	7.9 ± 1.5	11.6 ± 1.7	−1.6	0.12
	Female	19.2 ± 2.7	16.0 ± 2.0	−0.6	0.58
PM (53.5)	Male	11.8 ± 2.1	12.3 ± 1.5	−0.8	0.42
	Female	20.2 ± 3.0	17.3 ± 2.5	−0.5	0.62

[1] Hours of observation.

processed, four returned within 30 min (11.8 ± 5.56 min, range = 2–29 min); three did not return before the end of the trapping session but were all present during the next observation.

ATTENDANCE WITH THE BROOD

For most seabird species, coordinated biparental care and partner compatibility during a breeding cycle is essential for successful parenting (Niebuhr and McFarland 1983, Hand 1985, Morris 1987). Risks to eggs or chicks from parental neglect or excessive absence is particularly acute during hatching or early in the chick care period (Morris and Chardine 1990, Burger and Gochfeld 1991), a time shortly after we attached transmitters. Attendance data were collected from hatching of the last chick in each study brood, to the day that the chick was capable of free flight. Data were pooled into two-day blocks of chick age. For males trapped between 23–27 May, the length of time that transmittered birds (n = 5) spent in attendance at the nest site during morning (06:15–09:30) observation periods did not differ from that of control (non-transmittered, n = 7) males (Table 1). Similarly, we found no significant difference in the amount of time the two groups of males spent in attendance with their brood during evening (17:00–21:00) observation periods. For males trapped on 11 July 1990, the equivalent times spent in attendance during morning and evening observation periods were not significantly different between experimental (n = 5) and control (n = 4) males (Table 1).

Transmitter-induced negative effects on the foraging efficiency of males might increase the time spent away from the brood by female partners. This did not occur. There was no difference in brood attendance time between female partners of control and experimental males in either the peak or late sampling periods (Table 1).

FEEDING FREQUENCY

Feeding data were collected from hatching of the last chick in each study brood to the day that the chick was capable of free flight. The feeding frequency was standardized for differences in brood sizes among the control and experimental pairs within each trapping period by dividing feeds/hr by the number of chicks in each brood and data were pooled into two-day age blocks of chick age. Analyses of the number of feeds chick^{-1} hour^{-1} indicate that transmitters had no measurable negative effects on the foraging efficiency of the birds that carried them (Table 2). For peak nesting birds, the delivery rate of fish to chicks by transmittered males (n = 5) did not differ from that of control males (n = 7) in either the morning or evening observation periods. As a transmitter on one partner may force greater levels of parental activity from the non-transmittered individual, we also contrasted feeding rates for the female partners of control and transmittered males (Table 2). One significant difference was identified but in a direction opposite to that ex-

TABLE 2. Feeding rate (feeds $chick^{-1}$ $hour^{-1}$, mean ± 1 SE) of peak and late nesting control and experimental pairs of Common Terns. *P* values were assessed using the Mann-Whitney *U* test.

Time	Sex	Feeds $chick^{-1}$ $hour^{-1}$		Significance	
				Z	*P*
		Peak nesters			
		Control (7)	Experimental (5)		
AM (47.5)[1]	Male	0.4 ± 0.03	0.4 ± 0.05	−0.3	0.76
	Female	0.3 ± 0.03	0.2 ± 0.04	−2.0	0.04
PM (49.8)	Male	0.5 ± 0.05	0.5 ± 0.05	−0.3	0.76
	Female	0.2 ± 0.02	0.2 ± 0.03	−0.7	0.51
		Late nesters			
		Control (4)	Experimental (5)		
AM (62.0)	Male	0.7 ± 0.1	0.7 ± 0.1	−0.2	0.87
	Female	0.6 ± 0.1	0.7 ± 0.1	−1.0	0.25
PM (53.5)	Male	1.0 ± 0.2	0.6 ± 0.1	−1.3	0.18
	Female	0.8 ± 0.2	0.7 ± 0.1	−0.3	0.79

[1] Hours of observation.

pected for a "transmitter effect"; females of transmittered males fed at a lower rate than females of control males.

There was no difference in the rate of fish delivered to chicks by late nesting males that carried a transmitter (n = 5) compared to that of control males (n = 4), nor was there a difference in the feeding rates of their female partners (Table 2).

TRANSMITTER BEHAVIOR

The typical prey capture technique used by Common Terns is "plunge-diving" in which the bird dives under the water following a straight drop from up to 5 m above the surface. We had a concern that the shock of repeated entry into the water would disrupt the transmit crystal and/or fracture the epoxy shell around the unit. Neither of these concerns were realized. Three of the transmitters changed cadence following several "dips" by the released birds into the water, becoming either very slow (15 signals/min) or very rapid (120 signals/min). Both conditions are problematic. The slow cadence, while conserving battery power, can readily be missed in a channel-scan, whereas the rapid cadence, quickly drains the battery and shortens the life of the transmitter. The functional lifetime of a transmitter crystal is determined by output strength of the battery and the integrity of the whip antennae. Excluding one transmitter that failed immediately, the mean lifetime of the remaining batteries was 14.89 ± 1.77 days (n = 9). The whip antenna is essential to distance transmission of the signal and most (n = 8) remained attached to the transmitter package for the duration of the battery lifetime (16.38 ± 1.82 days). One antenna was still attached to the unit after 20 days.

In May 1991, we located and caught three Common Terns in the immediate area of our principal study site that carried the transmitter unit still attached to their leg bands. All birds were healthy with no indication of mass loss or unusual feather or body wear. Inspection of the bands and transmitter units on removal revealed no wear or abrasion to the legs of the birds, and the smooth epoxy covering intact over the copper wire on the inside of each band. The whip antennae had broken cleanly off immediately at the point of emergence from the epoxy. We observed but did not capture one other bird with the unit attached to the band. The tern colony at Port Colborne contained almost 1,000 pairs in May 1991, and extends almost 100 m along the length of the breakwall (see Morris 1986 for colony description). Other 1990 transmittered birds may have been present but escaped our attention. These observations suggest minimal long term effects of the procedure.

Some examples of the numerous techniques for attachment of radio transmitters to study animals include back-packs (Morris and Black 1980), breast packs (Gilmer et al. 1977), tail clips (Bray et al. 1975), adhesives (Sykes et al. 1990), and sewing into the retrices (Pennycuick et al.

1990). While most investigations limit the mass of the transmitter package relative to the body mass of the study animal, flying ability and the energy cost of transport may be more important than unit mass (Caccamise and Hedin 1985), and loads of 2.5% body mass can significantly affect flight performance (Gessaman and Nagy 1988). The advantages of the attachment technique described above are (1) speed of attachment, (2) light mass including that associated with the normally applied leg band, (3) rapid loss of antennae following battery exhaustion, and (4) lack of an adverse effect on parental behavior.

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