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TAIL-MOUNTED RADIO TRANSMITTERS FOR WATERFOWL

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Abstract.—We successfully tested tail-mounted radio transmitters on Pink-footed Geese (*Anser brachyrhynchus*), Barnacle Geese (*Branta leucopsis*), Brant (*Branta bernicla*) and Eurasian Wigeon (*Anas penelope*). The range of detection of the transmitters was approximately 1 km and some birds were tracked for up to 4 mo. Movements and activity of the birds were not affected by the packages. We conclude that this technique overcomes some of the problems associated with harnesses.

MONTAJE DE RADIOTRANSMISORES EN EL RABO DE ANSERIFORMES

Sinopsis.—Probamos éxitosamente el montaje de radiotransmisores en el rabo de individuos de *Anser brachyrhynchus, Branta leucopsis, B. bernicla* y *Anas penelope.* El área de detección de los transmisores fue de aproximadamente 1 km, y algunas aves fueron detectadas a 4 m de distancia. Los movimientos y actividades de las aves no fueron afectadas por los transmisores. Concluímos que neustra técnica soluciona algunos de los problemas asociados con la utilización de arneses.

Most studies of radio tracking assume that transmitters do not impair the animals. This affirmation, however, should not be accepted without proper assessment. During a series of studies on the wintering ecology of three species of geese and one species of duck in Great Britain, we evaluated the effect of tail-mounted radio transmitters (Kenward 1978) on the birds' behavior.

A wide range of radio transmitters have been developed to follow the movements and activity of individual birds (see recent review by Kenward 1987). The system of attachment, however, remains the critical component of the package (Cochran 1980). The ideal attachment should have no

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adverse effects on the survival and behavior of the bird, should not cause excessive feather wear, should remain on the bird for the span of the study and should eventually detach.

For waterfowl, harnesses have been used to hold transmitters in either ventral or dorsal positions. Although Raveling (1969) and Gilmer et al. (1974) reported no adverse effects of such packages, Greenwood and Sargeant (1973), Wooley and Owen (1978), Perry (1981) and D. Bell (unpubl. data) observed feather wear, callousing of the skin, changes in behavior, and weight loss by birds equipped with harnesses. Moreover, Obrecht et al. (1988) reported that aerodynamic drag of back-mounted radio transmitters can reduce flight performance of geese. Swanson et al. (1976) and Perry (1981) successfully tested transmitters mounted on nasal saddles fitted to Mallards (*Anas platyrhynchos*) and Canvasbacks (*Aythya valisineria*) but nasal attachment may not be appropriate for species that spend a large proportion of their time grazing. Transmitters have also been implanted in geese and ducks (Butler and Woakes 1980, Korschgen et al. 1984), but their range is reduced compared to transmitters with external antennae and it is difficult to obtain an implantation license in some countries (e.g., Great Britain). Finally, Bartelt (1987) used transmitters mounted on neck collars fitted to Canada Geese (*Branta canadensis interior*) but this is not suitable for ducks nor smaller geese.

Tail-mounted transmitters were used first for raptors (Kenward 1978). In this paper, we evaluate the tail attachment for fixing transmitters on ducks and geese and comment on transmitter range and length of tracking period.

METHODS

We studied Barnacle Geese (*Branta leucopsis*) on the Inner Hebridean island of Islay in western Scotland, Pink-footed Geese (*Anser brachyrhyncus*) in the Grampian region in northeast Scotland, Brant (*Branta bernicla*) on the north Norfolk coast near Scolt Head Island in England and Eurasian Wigeon (*Anas penelope*) at the Ouse Washes in Norfolk. These studies were conducted between November and May 1986–1988.

Wigeon and Barnacle Geese were caught with cannon nets on the feeding grounds and released immediately after marking. Pink-footed Geese were captured with a clap net along the shore of a roosting lake just prior to the flocks' morning departure, and released at sunset when the other geese were coming back to the roost. Brant were dazzled and captured with a hand net on night roosts at low tide and released the following morning.

Single-stage radio transmitters (Biotrack, Wareham, Dorset BH20 5AJ, UK) weighing 9.9 ± 0.1 g (±SE) were affixed to 10 Barnacle and 11 Pink-footed geese and six Brant. Transmitters weighing 6.2 ± 0.1 g were also placed on 11 wigeon. These packages represented 0.4, 0.8, 0.5 and 0.9% respectively of the body mass of Pink-footed Geese (2429 ± 73 g), Brant (1217 ± 75 g), Barnacle Geese (1850 ± 55 g), and wigeon (710 ± 87 g) at the time of capture. The transmitters were attached at the

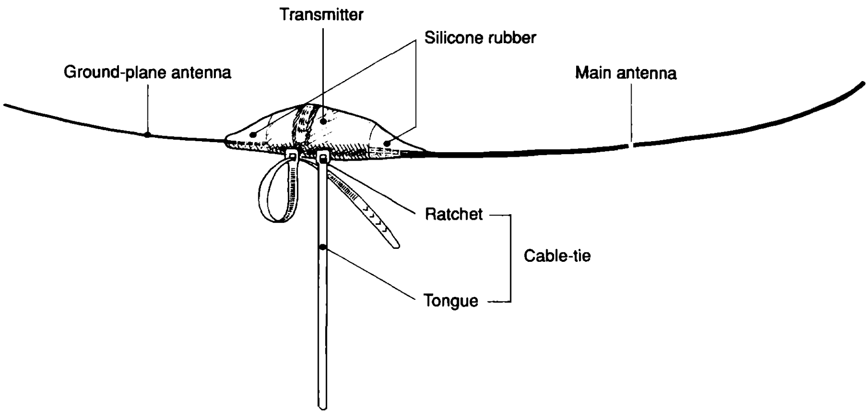

FIGURE 1. Schema of a tail-mounted radio transmitter attached to waterfowl with cable-ties.

proximal end of the tail by two methods. On four Pink-footed and 10 Barnacle Geese, two pairs of cotton threads were sewn through one of the central rectrices and two other pairs were tied around the adjacent feather as described by Kenward (1978). Knots were sealed with cyanoacrylate glue. The main and ground plane antennae of these transmitters measured 32 and 15 cm, respectively. The other packages were fixed with two nylon cable-ties (Fig. 1), each one tied around two central rectrices (one rectrix on wigeon). The tongues were cut near the ratchet and glued with cyanoacrylate. Except for two Brant, glue was also applied between the cables and the rachis to prevent slippage of the package. The length of the main and ground plane antennae of these packages were 24 and 10 cm, respectively (18 and 9 cm for wigeon). In all cases, the main antenna was glued and bound along the length of one rectrix (Kenward 1978). The antennae projected 10–15 cm past the tail.

Each bird was marked with one or two colored plastic leg bands and one British Trust for Ornithology numbered metal band. The white feathers under the tail and abdomen of Pink-footed Geese and wigeon were dyed with picric acid to facilitate relocation of the birds.

Pink-footed Geese and wigeon were observed in detail to determine if the radio transmitters affected their behavior. Observations were conducted at irregular intervals during daylight hours on the feeding grounds starting the day following release until departure of the birds from the study area. Every 5 min (15 min for wigeon), we recorded the activity of the radio-equipped bird and the nearest unmarked bird (the nearest three birds for wigeon). Activities were categorized into feeding (head below horizontal), resting, alert, walking, swimming, comfort movements including preening, and social interactions. For each species, a G-test of independence (Sokal and Rohlf 1981) was used to compare the frequency

TABLE 1. Length of tracking periods and termination causes of tracking of four species of waterfowl fitted with tail-mounted transmitters.

	Length of tracking (d)	No. of cases for each termination cause				
Species (n)	$\bar{x} \pm$ SE (range)	Birds leaving the area	End of study	Loss of package	Technical failure	Unknown
Pink-footed Geese (11)	52 ± 13 (0–127)	10				1
Barnacle Geese (10)	85 ± 21 (1–135)	4		4	2	
Brant (6)	48 ± 19 (0–84)	1	4	1		
Eurasian Wigeon (11)	46 ± 19 (6–76)	11				
Total (38)	58 ± 8 (0–135)	26	4	5	2	1

occurrence of the activities between the experimental and the control (unmarked) birds.

RESULTS AND DISCUSSION

The detection range of the transmitters was approximately 1 km at ground level, but varied from 0.5 km in dense vegetation or behind a hill to 3–4 km when the birds were flying or when tracking from a hilltop. Main antennae breakage reduced detection range for two Pink-footed Geese and four Barnacle Geese after periods of 40–84 d ($\bar{x}$ = 65 ± 7 d) of tracking. Five of these six transmitters had no silicone cone at the base of the main antennae.

The birds were tracked for periods ranging between 0 and 135 d ($\bar{x}$ = 58 ± 8 d, Table 1). In 30 of 38 cases, termination of tracking was associated with birds leaving the area or completion of the study. One juvenile female Pink-footed Goose with a worn tail and some rectrices missing at the time of capture failed to provide any information from tracking. It was observed 12 d after release, but we could not tell if the transmitter that had been sown to the feathers was still present. One transmitter with cable-ties that had not been glued to a Brant slipped down and off the feathers after 5 wk. This bird was recaptured 3 wk later with an intact tail. One transmitter gave no signals, but was retained by a Barnacle Goose throughout the study. Four Barnacle Geese lost the entire package after periods of 73–104 d ($\bar{x}$ = 95 ± 7 d) and one radio failed after 106 days possibly because of breakage of both antennae.

Nine Pink-footed Geese were observed for a total of 106.9 h and 11 wigeon for 107.3 h. There was no significant difference in behavior between birds fitted with radios and their unmarked controls (Table 2). These results indicate that the packages did not adversely affect the activity of the geese nor of the ducks on the feeding grounds.

Based on the roost departure and arrival times of 50% of the flock, Brant spent an average of 72% of the day on grassland in January and

TABLE 2. Frequency occurrence of activities for nine Pink-footed Geese and 11 Eurasian Wigeons fitted with tail-mounted radio transmitters and for unmarked (control) birds.

	Pink-footed Geese		Eurasian Wigeon	
Activities	Marked	Control	Marked	Control[a]
Feeding	917	913	252	238
Alert	165	190	30	35
Resting	90	93	64	66
Comfort	68	59	9	7
Walking	37	22	8	10
Swimming	—	—	66	73
Social interactions	6	6	—	—
Total	1283	1283	429	429
G	3.157		1.228	
df	5		5	
P	>0.5		>0.9	

[a] The totals for the three nearest unmarked birds were divided by three to facilitate comparison.

February. This was similar to the 74 ± 5% for the radio-marked Brant, suggesting a similar pattern of activity. Barnacle Geese fitted with radios were highly site-faithful with occasional forays from their core area similar to birds marked with leg bands.

The radios did not impair flying, since daily movements from the roost to the feeding grounds were observed for all the radio-marked birds. In flights, the experimental birds were indistinguishable from unmarked birds in that they did not lag behind or take off late. Movements of 30 and 80 km between roosts were recorded for Pink-footed Geese. Three Barnacle Geese were located on the spring staging grounds in Iceland a few weeks after they had left Islay; one transmitter was still operating.

One Pink-footed Goose and eight Barnacle Geese equipped with a radio transmitter in 1987 were observed the following year in their respective wintering areas and they all had new tail feathers. Moreover, geese that still had their transmitter before migrating to Iceland or Greenland had no radio confirming that the package had been shed during the molt as intended. Similarly, penned Mallards fitted with dummy tail-mounted transmitters lost their packages when molting their tail feathers (D. Bell, unpubl. data).

Additional trials at The Wildfowl Trust have shown that tail-mounted transmitters are suitable for Mallard, but not for Common Pochards (*Aythya ferina*) because diving ducks have tail feathers which are too flexible (D. Bell, unpubl. data).

CONCLUSION

We believe that radio transmitters mounted on the tail of dabbling ducks and geese is an appropriate technique to follow their movements and activity. Tail-mounted transmitters are lighter than those affixed with harnesses. In this case, they represented less than 1% of the birds' mass which is less than the 5% maximum recommended by Cochran (1980). However, tail-mounted transmitters are lost with rectrice molt, and can be used only on birds with strong rectrices. Cable-ties are quicker to attach to the birds compared with threads sewn through the rectrices (10 vs 40 min) and they do not weaken the feathers. Each cable should go around the rectrices in opposite directions (i.e., one clockwise and the other counterclockwise) to allow the attachment of adjacent rectrices in their natural positions. The tongues should be glued in their respective ratchets as well as on the feathers. Care should be taken to put the radios as near the base of the rachis as possible without allowing the ground plane antenna to interfere with the preen gland. We found it useful to wet the tail feather bases with acetone to improve visibility and facilitate the attachment. We recommend that both antennae be supported at their emergence from the unit with layers of heat shrunk plastic tubing and a cone of silicone rubber to reduce the risk of breakage (Kenward 1987).

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