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RADIO-TRACKING TRIALS WITH REGENT HONEYEATERS *Xanthomyza phrygia* AND OTHER HONEYEATERS

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We trialled three methods of attachment of radio-transmitters to develop a safe and effective method to use on the endangered Regent Honeyeater *Xanthomyza phrygia*. Radio-tags glued onto the backs of one Red Wattlebird *Anthochaera carunculata* and three Noisy Friarbirds *Philemon corniculatus* were lost within 12 days. One Friarbird was unable to fly after a heavy rain storm, but recovered after being dried and was seen several days later, apparently in good health. His mate laid eggs, which did not hatch, probably because the tagged bird had not fertilized them. Transmitters glued onto tail-clips were attached to one Friarbird and two Regent Honeyeaters. The Friarbird kept its radio-tag for at least 34 days, without any obvious effect. The Regent Honeyeaters lost their transmitters after 2 and 12 days, with one slipping off the tail and the other being lost when the central tail feathers were moulted. The second bird flew unsteadily at first, but later behaved normally. Radio-tags were tied and glued to the tails of two more Regent Honeyeaters. One lost its radio-tag within two days, probably because it had been attached to the second and third rectrix on opposite sides, as its central tail feathers had been lost previously. The other bird kept his radio-tag for 16 days, when the central tail feathers were moulted. During this time it continued to feed nestlings and fledglings at a high rate.

Both Friarbirds and Regent Honeyeaters travel considerable distances from their nests or fledglings to feed, up to 2 km and nearly 1 km respectively. We do not recommend that transmitters be glued onto the backs of Regent Honeyeaters, on the basis of our experience with this method on large honeyeaters. Transmitters clipped, or tied and glued, onto the tail appear to be safer, though they are appropriate for use before the breeding season rather than after it when honeyeaters moult.

INTRODUCTION

Most species of honeyeaters travel between nectar and other food resources within their home ranges and wander among neighbouring habitats, whereas a few species undertake regular or complex seasonal migrations (Keast 1968). To understand honeyeater ecology, we need to measure the extent of these movements and identify the range of resources and habitats used. This is especially true for the endangered Regent Honeyeater *Xanthomyza phrygia*, which is regarded as a nomad or moderate distance migrant (Franklin *et al.* 1989) and whose use of habitats is poorly known. Radio-tracking has been employed to examine the movements of several honeyeaters. Runciman *et al.* (1995) studied natal dispersal of the normally sedentary Helmeted Honeyeater *Lichenostomus melanops cassidix*, whereas Pyke and O'Connor (1993) studied the time that New Holland *Phylidonyris novaehollandiae* and White-cheeked Honeyeaters *P. nigra* spent out of their normal home ranges foraging in nearby habitat. Clarke and Schedvin (1997) used transmitters to follow the movements and survival of translocated Noisy Miners *Manorina melanocephala*. All of these researchers glued transmitters on to the backs of birds, a modification of Raim's (1978) method.

In this paper we describe trials of radio-tracking on Noisy Friarbirds *Philemon corniculatus*, a Red Wattlebird *Anthochaera carunculata* and Regent Honeyeaters. Our primary aim was to develop an effective method for attaching radio-transmitters to wild Regent Honeyeaters that causes minimum stress and risk of injury to the bird. We also present some data on the local movements of these species.

METHODS

Study sites

Noisy Friarbirds and a Red Wattlebird were radio-tagged at Eastwood State Forest (now Imbota Nature Reserve: 30°35'S, 151°43'E), 8 kilometres south-east of Armidale in 1992, 1993 and 1995/6. Eastwood is a patch of eucalypt woodland, which, with adjoining woodland on private land, covers about 350 hectares. It is surrounded by mostly cleared land and is 7 kilometres from the nearest extensive woodland or forest.

In 1996, one Regent Honeyeater was radio-tagged at Gwydir Park Travelling Stock Route near Torryburn (30°26'S, 151°14'E) and one at Two Mile Creek 24 kilometres south of Bundarra (30°19'S, 151°12'E). In 1997, two Regent Honeyeaters were radio-tracked in roadside vegetation, 26 kilometres south of Bundarra (30°20.5'S, 151°13'E). All sites contained open eucalypt forest or woodland with Mugga Ironbarks *Eucalyptus sideroxylon* interspersed with boxes and gums (see Oliver *et al.* 1998 for a map of the region and Ley and Williams 1994, and Oliver *et al.* 1999 for information on habitat).

Attachment of transmitters

After capture in mist nets, birds were banded with ABBBS bands and colour-banded. One Friarbird was captured when it swooped the observer, who was by a net below her nest. In 1996, Regent Honeyeaters were attracted to mist nets using tapes of the territorial and aggressive calls. In 1997, a stuffed Grey Butcherbird *Cracticus torquatus* and a stuffed Noisy Miner *Manorina melanocephala*, painted to resemble a Regent Honeyeater, were placed by the net. The nets were close to active nests and begging calls of fledgling Regent Honeyeaters were played on a cassette recorder. Male Regents responded by swooping these stuffed birds.

In 1992 and 1993, we used single stage Titley LT1 transmitters. In 1995/6, SIRTRACK single stage transmitters were used, with #365 batteries for the Friarbird and CE379 batteries for the Regent Honeyeaters. In 1997, we used Holohil transmitters (see Table 1 for weights of radio-tags). For the Wattlebird and the first three Friarbirds

TABLE 1
Details of birds and method of attachment of radio-tags.

Bird	Weight of radio-tag	Method of attachment	Date attached	Days attached
Wattlebird	2.9 g	Glued to Back	23 Nov 92	12 days
Friarbird 1	2.9 g	"	23 Nov 92	8 days
Friarbird 2	2.9 g	"	10 Nov 93	2 days
Friarbird 3	2.9 g	"	18 Nov 93	4 days
Friarbird 4	3.9 g	Clipped to Tail	7 Dec 95	34 days
Regent 1	2.0 g	"	11 Jan 96	12 days
Regent 2	2.5 g	"	16 Jan 96	2 days
Regent 3	1.05 g	Glued to Tail	10 Jan 97	17 days
Regent 4	1.05 g	"	11 Jan 97	2 days

we glued the radio-tag to the bird's back, the method used by others radio-tracking honeyeaters. Feathers were trimmed to a length of about 1–2 millimetres on the bird's back between the wings. The area was swabbed with alcohol and a piece of cotton gauze was glued to it using Vetbond. The radio-tag was also glued onto a piece of cotton gauze and when both were dry the two pieces of gauze were glued onto each other. It took at least 30 minutes to attach the radio-tag, and birds were held for a further 30 minutes to allow the glue to dry. The aerial of the radio-tag extended only slightly beyond the end of the tail.

For one Friarbird and two Regent Honeyeaters the radio-tag was glued onto a tail mount with superglue, a method modified from East and Hofer (1986) and Johnstone (1994). The mount consisted of a thin rectangular perspex strip with holes at either end into which were countersunk two screws. The screws were passed on either side of the four central tail feathers (five tail feathers in one Regent as it was moulting) and through a small rectangular piece of rubber inner tube and screwed tightly. Initially brass nuts were used, but a nylon nut was used for one Regent Honeyeater. Attachment took about 10 minutes.

Subsequently, for two Regent Honeyeaters the radio-tags were tied around and glued onto the base of the central two tail feathers. First, dental floss was tied and superglued around the radio-tag. The free ends of the dental floss were then tied around the base of the inner pair of tail feathers (rectrices), and superglue added to the knot. This process took about 10 minutes with three people involved. One held the bird upside down in a cloth bag, with only the tail protruding, and helped position the radio-tag with a free finger. The second tied on the radio-tag and the third added glue. The radio-tag was attached above the tail of the first bird and below the tail of the second bird. The knot attaching the radio-tag to the tail was on the opposite side of the radio-tag from the knot attaching the dental floss to the radio-tag to facilitate tying and gluing the dental floss.

Birds were radio-tracked with a Regal 2000 (Titley Electronics) receiver and hand-held SIRTRACK two-element antenna, every one to three days for the Wattlebird and Friarbirds for 15 minutes up to 2 hours, and every day for the Regent Honeyeaters. We noted the approximate positions of birds when they were seen. We could usually detect birds up to about 700 metres, exceptionally to about 2 kilometres, though the signal was often weak and variable. Although no birds were radio-tracked from the air we flew over a person that was holding a transmitter and were able to detect it at a distance of 7 kilometres.

RESULTS

Red Wattlebird and Noisy Friarbirds at Eastwood State Forest

The Red Wattlebird, tagged on 23 November 1992, was found on four other days up to 2 December in an area from 200 to 500 metres from its capture site (Table 1). Its flight was somewhat laboured on release. We received signals on 5, 11 and 13 December from the same location about 500 metres north of the capture site, but the bird was not seen. Although we did not find the radio-tag, it probably had become detached, possibly lodged in a tree. This bird may have been immature, as it had small wattles and showed no sign that it was breeding. It was seen on several later dates, recognized by its colour-bands.

Noisy Friarbird 1 (female B/Y in Fig 1, Ford 1998), tagged on 23 November 1992, flew away strongly and was tracked on four days up to 27 November within 300 metres of its capture site. On 26 and 27 November, she was building a nest. She was seen at the nest on 1 December, but we could not see an aerial nor receive any signal. The nest had three eggs by 9 December, two nestlings and an egg on 24 December, but had been predated by 5 January 1993. This female returned to breed in 1993 and 1994.

Noisy Friarbird 2 (female Bl Yr in Ford 1998) was tagged on 10 November 1993 near a nest that it was building, flew away in a rather lopsided manner and was tracked the following day within 150 metres of her nest. Several times she flew far to the north, north-west and west, so that only a very weak signal was detected. On 12 November, a weak signal was obtained well north of her nest, even when the bird was nearby. We could see no aerial, so presumably the bird had lost the radio-tag. We received signals from private land 2–3 kilometres north of Eastwood, where there was a clump of flowering Snow Gums *Eucalyptus pauciflora* and possibly the Friarbird had been visiting these. This female laid eggs, but they were predated. She has returned to breed every year up to 1999.

Noisy Friarbird 3 (male LGl Or in Ford 1998) was tagged on 18 November 1993 and flew away with difficulty. He was tracked to about 400 metres away and then his location was uncertain with only a weak signal being detected. A signal was also detected from about 3 kilometres away across a valley. On 20 November, he was tracked to his location where he was found on the ground unable to fly after a heavy shower of rain. He was captured by hand, dried and placed on a sapling, and later flew away weakly. The bird was not seen, nor any signal detected on 22, 25 and 30 November, but was probably near the nest on 3 December, though his colour-bands were not seen clearly and there was no signal. He was seen clearly on 13 December. The radio-tag presumably had been lost between 20 and 22 November. His mate had laid three eggs by 26 November; the clutch declined to two eggs by 13 December and one egg on 17 December, which was long

after the eggs should have hatched. This bird returned every year up to the 1997/8 breeding season.

Noisy Friarbird 4 (female LG/W in Ford 1998) had bred since at least 1991 and had a radio-tag clipped onto her tail on 7 December 1995. She flew away strongly, preened for 8 minutes, then left. An hour later she was feeding young and swooping the observer. She was tracked on 21 days until 10 January 1996 and found readily on each day. She never touched the location of the radio-tag or otherwise indicated that she was aware of its presence. During this time her first nest failed; she built a second nest, was incubating by 20 December and had nestlings by 4 January. Although she was often detected on or near the nest, several times she travelled far from the nest. On 8 and 13 December, a signal was detected 1.3 kilometres south-west of the nest. On the second date, the tagged bird, recognized by her distinctive tail shape, flew across open land 200 metres south of Eastwood. There was a flowering *Grevillea* in a farm garden 2 kilometres south-west of the nest and she had possibly been visiting flowers there. On 13 January, her young were found dead below the nest. They were chewed, suggesting mammal predation or scavenging after death, and had large maggots, suggesting they had been dead for a day or two. There was no sign of the female, nor any signal from the transmitter. She has never again been detected at Eastwood.

Regent Honeyeaters

Regent Honeyeater 1, a male, was captured on 11 January 1996 at the Gwydir Park Travelling Stock Route, about 24 hours after his nest had failed. He was moulting his primaries (score $5^1 4^1 0^8$) and his tail feathers were worn. A radio-tag was clipped onto his tail. It pushed the outer four tail feathers on each side outwards, giving a distinctive three-pronged tail and making the bird easy to identify. For 80 minutes after release he perched in the crown of a small tree, occasionally moving through the foliage. He tugged at his bands but ignored the tail-clip and radio-tag. The radio-tag appeared to affect the bird's movements and when he flew, 35 minutes after release, his flight appeared laboured and he landed clumsily. The following day he was flying strongly and behaving normally. Regent 1 was tracked intensively until he lost his radio-tag 12 days later. The radio-tag was found with four tail feathers still in the clip. The radio-tag may have been lost because the tail feathers had been moulted or perhaps more likely the weight of the radio-tag had hastened their loss.

The home range of Regent 1 over 12 days covered about 24 hectares, calculated from the Minimum Convex Polygon. On most days the bird moved through only part of this home range, centring his foraging on a few trees, which had flowering mistletoe *Amyema miquelii* and abundant lerp. Over the 12 days of tracking, the bird gradually drifted eastwards. However, even 33 days after the radio-tag had been attached, Regent 1 was still feeding in mistletoes about 500 metres from the nest. On 17 January at 1750 hours, this bird moved in two stages to a position 1 500 metres east of the edge of his home range and about 3 kilometres east of the nest site. He stayed there from 1800 to 1840. After moving around an area of about 2 hectares and drinking from a creek, the bird fed on lerp in a patch of sapling Yellow Box *Eucalyptus melliodora*. At 1840 hours, he moved 1 kilometre west, paused in a tree for 15 minutes, then returned to the area where he was usually found. Regent 1 returned in 1996 and renested within 50 metres of his previous season's nest.

Regent Honeyeater 2, also a male, was captured on 16 January 1996 at Two Mile Creek, soon after the failure of his nest (possibly within 48 hours). He was moulting his primaries (score $5^2 4^1 0^7$) and his central two tail feathers had been shed; the left feather had almost fully regrown but the right feather was still absent. Because the tail was moulting, the tail-clip was attached to five tail feathers, the new central feather and four old feathers, leaving three feathers on each side outside the mount. This bird was released 30 minutes after capture and spent 45 minutes perched in the crown of a small tree, sometimes tugging at his bands. Over the next two days he was tracked in a home range of a few hectares, regularly foraging in an area of regrowth Yellow Box, 400 metres east of the nest tree. Regent 2 lost his tail mount and radio-tag two days after they had been attached. The transmitter was found and apparently the rubber backing plate of the mount had bowed, allowing the mount to slide off the tail feathers.

Two Regent Honeyeater nests, with nestlings, were found near Merrifield, 26 kilometres south of Bundarra, on 6 January 1997. Both females and one male were captured and colour-banded on 9 January. No transmitters were attached to the females as they had young in the nest. On 10 January, the other breeding male (Regent Honeyeater 3) was captured and tagged. The radio-tag, which was tied around the central tail feathers, was partly concealed by the upper tail coverts and sat firmly on the centre of the tail. The bird flew away strongly and pecked at its bands but ignored the radio-tag. It was feeding nestlings within 30 minutes.

Regent 3 was radio-tracked most days from 11 to 25 January and was easily detected by the signal from his transmitter and found. The radio-tag did not appear to inconvenience him and only the aerial was visible. His two young fledged at 1030 hours on 14 January and he continued feeding them at a higher rate than that of his mate. He spent much time feeding himself or collecting nectar for the fledglings from an ironbark 120 metres east of the nest. He also collected insects from a variety of sites. Occasionally, he went far north or south of the nest along the roadside vegetation and we only received a weak signal. However, when we followed we soon saw him returning to the nest, or detected a signal indicating that he was doing so. After fledging, the young moved towards the flowering ironbark and sat together, usually quietly. After 12 days they started to feed themselves on insects, nectar from New England Blackbutt *E. andrewsii*, Silver-leafed Stringybark *E. laevopinea* and mistletoe *Amyema miquelii*, and became more mobile and difficult to follow. Both parents continued to feed the young frequently (up to 98 times per hour, Oliver 1998). On 27 January, all four birds were 110 metres north of the nest, but the male had lost his transmitter, which was found on the ground 30 metres north-east of the nest. It was still attached to the two central tail feathers, which had been moulted or pulled out by the tag. None of the birds in this family was found on 29 or 30 January, or 2, 3, 5 or 8 February.

Regent Honeyeater 4, a male, was captured on 9 January and a radio-tag was tied to his tail. However, the superglue had made the dental floss stiff so that the knot was loose. Also, during attachment the bird lost three of his inner tail feathers. The radio-tag was removed and the bird released. Two days later he was recaptured and a radio-tag was glued around rectrix 2 of one side and rectrix 3 of the other, the intervening feathers having been lost. After release he sat still for 30 minutes, then left and was feeding his nestling within an hour. His tail was untidy, though this was mostly due to loss of feathers during the previous attempt to attach a radio-tag. The following day he was found and followed, by which time his single young had fledged. On 13 January, he had lost his radio-tag, which was found. He had lost no further rectrices, the radio-tag had apparently slipped off, with a few tail coverts attached, which had presumably been stuck to it with glue. He was seen regularly until 8 February.

DISCUSSION

The major aim of placing transmitters on to large honeyeaters and Regent Honeyeaters was to trial methods of attachment that would be reliable and would not harm the endangered Regent Honeyeater. Red Wattlebirds and Noisy Friarbirds weigh 90 to 140 grams (Higgins and Peter, in press), so our radio-tags added only about 3–4 per cent of weight to these large honeyeaters. However, tail-clips added 5.6–6.4 per cent to Regent Honeyeaters (mean male weight = 44.4 grams, mean female weight = 38.9 grams, D. Geering, pers. obs.). Tail gluing adds only about 2.4–2.7 per cent to the body weight of male and female Regents, using the small Holohil transmitters. Gluing radio-tags onto the back is tedious and time-consuming. Furthermore, they were lost 2 to 12 days after attachment onto a Wattlebird and three Friarbirds. In addition, we found one tagged Friarbird that was unable to fly after a rain shower, presumably at least partly due to the radio-tag. It could have died had it not been 'rescued'. Also, its mating efforts may have been handicapped, because its mate's eggs did not hatch. Male Friarbirds do not incubate (H. Ford, pers. obs.), so it seems unlikely that the eggs chilled through lack of attention. In contrast, the two female Friarbirds with glued transmitters and the one with a tail-clip continued with their breeding activities and even laid eggs. Therefore, from our experience with friarbirds and a wattlebird we decided not to glue radio-tags on to the backs of Regent Honeyeaters.

However, further experience in attaching radio-tags and holding the birds for some time before release might increase the attachment time of glued radio-tags. However, O'Connor *et al.* (1987) glued radio-tags to the backs of 23 New Holland and White-cheeked Honeyeaters and held the birds for 2–4 hours after attachment. Fourteen of their birds lost their radio-tags within four days, though others kept their radio-tags for up to 23 days. By contrast, only two of 14 Helmeted Honeyeaters lost their radio-tags within five days (Runciman *et al.* 1995) and only one out of 10 Noisy Miners lost a radio-tag (Clarke and Schedvin 1997). In both studies a gluing method similar to ours was used.

The tail-mounted radio-tags were easier and quicker to attach and birds do not need to be held after attachment. One Regent Honeyeater lost a tail-clip either because it had not been screwed on to the tail feathers tightly or because the rubber had bowed. A second Regent Honeyeater retained its tail-clip for 12 days, whereas the Friarbird retained its for at least 34 days. The Friarbird appeared unaffected by the radio-tag, whereas one of the Regent Honeyeaters was initially inconvenienced by its radio-tag. European Robins *Erithacus rubecula*, which are smaller than Regent Honeyeaters, showed no measurable changes in territorial behaviour, energetic condition or expenditure, or survival when carrying radio-tags on tail-clips (Johnstone 1998).

Tying and gluing radio-tags to the base of the tail feathers requires two, and preferably three, people, but it can be done quickly and efficiently. One Regent Honeyeater carried a tail-glued radio-tag for 16 days, during which it fed its nestlings and fledglings as assiduously as its mate did. The other bird looked dishevelled, mainly due to the loss of three tail feathers from an earlier attempt to attach a radio-tag, but was otherwise unaffected.

In terms of speed of attachment and inconvenience to the bird, tail-attached radio-tags appear preferable to those glued on to the back. However, they are inadequate for tracking post-breeding dispersal, which is one of the main deficiencies in our knowledge of Regent Honeyeaters, because they will be lost when the tail feathers are moulted naturally after breeding. Tail feathers can also be lost prematurely due to the weight of the tail-clip and tag. Whether tail-attached radio-tags are used for honeyeaters depends on the season and the aims of the study. They could be effective to track home ranges or local forays for food during either the breeding or non-breeding season. For long-term studies radio-tags are likely to be retained for the longest period if initially attached to newly-grown feathers. This would mean that birds could carry the radio-tags for a long time, even through the next breeding season. Harnesses may be a more appropriate method for attaching radio-tags and these should be tried on Regent Honeyeaters.

Whichever method of attachment is used, the detection range from the ground of current transmitters for birds the size of a Regent Honeyeater limits their usefulness for tracking post-breeding dispersal. Transmitters on Regent Honeyeaters were detectable up to nearly 1 kilometre in woodland from the ground and 7 kilometres from the air and those used on Friarbirds, up to 2 kilometres from the ground in favourable situations. Occasionally, both species went out of range of the receiver. The 3 kilometres movement made by Regent Honeyeater 1 was only followed because it was along a road. Runciman *et al.* (1995) were able to follow substantial exploratory movements (up to 3.1 kilometres) for two of their Helmeted Honeyeaters. However, this was in a relatively narrow, and very well known, strip of riparian forest.

Regent Honeyeaters sometimes stay close to their breeding area for several weeks, even after failure, apparently making short exploratory movements in search of new resources. It should be possible to follow radio-tagged birds if they move gradually away from their territories. This would be hard without transmitters, as Regent Honeyeaters are quiet and unobtrusive at this time.

More than one observer would make it easier to follow wandering birds. However, if Regent Honeyeaters travel tens of kilometres rapidly in post-breeding dispersal, locating radio-tagged birds from the ground would be very difficult. The chance of finding them would be higher if they could be tracked from the air.

Although the main aim was to trial methods of attaching radio-tags, this study has also provided some information on local movements of Noisy Friarbirds and Regent Honeyeaters. Both species will travel considerable distances from nests or young. Although Friarbirds spend much time near the nest perching or feeding, they also fly far from the nest (H. Ford, pers. obs.). Two of our tagged birds travelled at least 2 kilometres from their nests, possibly to feed on flowering *Grevillea* and Snow Gums and a third bird went out of range. One Regent Honeyeater travelled several hundred metres from his fledglings and the species will cross open areas to feed in Yellow Box blossom 800 metres to 1 kilometre from the nest (Geering, pers. obs.). These results indicate that even honeyeaters with parental responsibilities will use resources far from the nest. They may wander even further when they have finished breeding. Pyke and O'Connor (1993) found that New Holland and White-cheeked Honeyeaters left their heathland home ranges to forage on flowers in nearby open forest, even during the breeding season, when nectar was abundant in the heathland. These flights might involve monitoring of resources elsewhere, as well as using them if found. The full home range of honeyeaters may be far greater than the small area around the nest or some key resources.

Male Regent Honeyeaters may moult while breeding. Both males with nestlings in 1997 were in primary moult and one moulted its inner tail feathers (and lost the radio-tag) while it was still feeding fledglings. In 1996, one male shed its inner tail feathers (plus radio-tag) about 14 days after its nest had failed. This observation means that Regent Honeyeaters that are seen or captured in moult may still be breeding. The overlap of breeding and moult has also been found in Noisy Miners (Dow 1973) and Helmeted Honeyeaters (Franklin *et al.* 1999).

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