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RADIO-TAGGING THE EASTERN BRISTLEBIRD: METHODOLOGY AND EFFECTS

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Eastern Bristlebirds *Dasyornis brachypterus* were captured at Jervis Bay by two people using up to 168 m of mist-net, open for 145 hours over 29 days. Twenty-two birds were radio-tagged and useful data were obtained for 19 birds at 3 sites in Booderee National Park and for one bird in NSW Jervis Bay National Park. The radio-tags weighed 1.6 g which averaged 3.8 per cent of the birds' weights. The routine time taken from trapping to the release of a radio-tagged bird averaged 45 minutes. The radio-tags were attached to the inter-scapular using Supa Glue Gel. The radio-tags remained attached for a median time of 5.5 days (range 1–41 days). The effect of tagging on the birds was noticeable during processing but appeared to diminish to a negligible level within the first day. A review of 23 studies across 31 avian taxa weighing 7–180 g, carrying radio-tags 0.4–6.9 g which were 1.6–16 per cent of their weight, suggested that for small to medium-sized birds, small radio-tags glued to the inter-scapular have minimal effect and the acclimation period is less than a day.

INTRODUCTION

Management planning for threatened species should be based on valid scientific studies. Information about each population, particularly where the individuals live, is fundamental to ecology (Andrewartha and Birch 1954; Southwood 1977) and planning (Goldingay and Kavanagh 1993; North and Reynolds 1996). However, the threatened Eastern Bristlebird *Dasyornis brachypterus* is cryptic by nature and all the past studies have relied on detecting individuals by their loud, distinctive calls and an occasional fleeting glimpse. A study of colour-banded Eastern Bristlebirds at Barren Grounds (J. Baker, unpubl. data) yielded few useful data about the population and its habitat utilization. Hence, there has been little opportunity to assess the validity of the previous Eastern Bristlebird studies. Radio-tracking, although expensive and time-consuming, can answer otherwise unassailable questions (Macdonald and Amlaner 1980) and it seemed to be an appropriate method to 'see' and thereby study Eastern Bristlebirds in their habitat.

Studying the Eastern Bristlebird is problematic because it is a small, brown, ground-dwelling inhabitant of very dense vegetation and it is also shy and elusive. In considering a radio-tacking study of the Eastern Bristlebird, further problems arise. The species is difficult to trap and sensitive to disturbance, characteristics shared with the Rufous (J. Seymour, pers. comm.) and the Western (Murphy 1994) Bristlebirds.

There was no apparent easy solution to the problem of catching Eastern Bristlebirds, so the present study was planned to include a considerable trapping effort. All three species of bristlebirds are recognized as being sensitive to disturbance during breeding (Baker 1997). This problem was overcome by planning the study in autumn, outside the breeding season. There are other examples of the sensitivity of bristlebirds to disturbance. For instance, at Barren Grounds, in the 12 years to the end of 1994, 42 Eastern Bristlebirds were trapped and there were four retraps. Two of these birds (one was a retrap) died suddenly and unexpectedly during processing. This rate of mortality is extremely high compared to all other species which are trapped and banded at Barren Grounds. At Two Peoples Bay, Western Australia, Murphy (1994) fitted radio-tags to three Western Bristlebirds. Two of the birds had no apparent difficulties and were tracked for six and 14 days respectively. The third bird was fitted with a radio-tag and released in the late afternoon, tracked successfully on the second day but found dead on the morning of the third day. Although the prevailing cold and wet weather may have contributed to the bird's death (A. H. Burbidge, pers. comm.) there may also have been deleterious effects from tagging. Hence, in designing the present radio-tracking study of Eastern Bristlebirds, extreme caution was planned for handling and tracking the birds.

General information about methods and the effects of radio-tags on birds may be useful in the future, particularly if translocation is contemplated as a species recovery action for bristlebirds or similar threatened species. There has not been a review of radio-tracking studies which assesses the effects of small radio-tags on small to medium-sized birds. Studies involving radio-tagging of small to medium-sized birds generally invoke some modification of the methods of Raim (1978) and may be reported in the unpublished (or 'grey') literature (e.g. Murphy 1994). The method of transmitter attachment utilized in the present study was sufficiently different to Raim (1978) and Murphy (1994) to warrant detailed description. The tracking data obtained in the present study were used to investigate home-range, population density and habitat utilization and that part of the study is reported elsewhere (Baker 1998a, 1998b).

The aim of this paper is to use the case study of radio-tracking the Eastern Bristlebird at Jervis Bay to investigate the methodology and effects of radio-tagging in regard to (i) trapping, (ii) processing, (iii) the radio-tags and tracking and (iv) the movements of radio-tagged birds.

STUDY AREA

The close network of trails in the Booderee National Park (Booderee) and New South Wales Jervis Bay National Park, Jervis Bay, made the area ideal for netting and tracking. The study was undertaken at three sites (A, B and C) in Booderee and two sites (D and E) in Jervis Bay National Park. Each site had trails suitable for the erection of lines of mist-nets and for the subsequent ease of radio-tracking and mapping, but the trails were away from areas of high public visitation. The sites were also known to support relatively high densities of Eastern Bristlebirds.

METHODS

Trapping

Trapping was conducted from 26 March to 20 May 1997. Combinations of 18, 12, 9, and 6 m mist-nets were used with up to 168 m of net used at one time. The net size was 31 mm (stretched diagonal). Nets were either set in continuous walls, an *en masse* catching tactic, or placed individually near places of Eastern Bristlebird activity. All vegetation under the nets was clipped to ground level and the ground was raked to prevent snags. The bottom shelf-string was set at ground level and, where necessary, held down with small rocks. The second shelf-string was placed approximately 300 mm above the ground at the net-ends. Eastern Bristlebirds were not expected to be caught above the second shelf because of their poor flying ability and tendency to run across tracks. Hence, the higher shelves were stretched fully opened which minimized the by-catch of non-target species because most birds bounced away from the nets rather than becoming entangled in the pockets. The nets were used between sunrise and 15 minutes pre-sunset but were not used during excessively windy or hot periods or during rain. Two experienced mist-netters checked the nets continuously during trapping periods. Birds other than Eastern Bristlebirds were quickly released without being banded or measured. All nets were closed as soon as an Eastern Bristlebird was trapped and they remained closed while the bird was being processed.

Taped call replay was used in anticipation that it would attract Eastern Bristlebirds to the nets. The most commonly heard calls at Barren Grounds and Jervis Bay are variations of the A-call, 'pretty birdie', and the strident 'prist' of the B-call. The tape recordings were made at Barren Grounds Nature Reserve and replayed on a one-minute loop tape using a portable tape player. The main recording used contained A–B duetting sequences from two different 'pairs' of birds. The success of the call replay was difficult to assess. A second recording, a continuous squawking Eastern Bristlebird distress call, was tried but it did not seem to attract Eastern Bristlebirds.

Call replay was either a loud broadcast for one minute at approximately 30 minute intervals in the general vicinity of the nets or was more specific if a bird approached the nets. This latter technique, which was relatively successful, required one person hidden with the tape player in vegetation on the opposite side of the mist-nets to the bird. The tape was played at varying volumes using the A–B duetting sequences or the A or B parts of the sequences, depending on how the bird seemed to react. A second person hid near the track on the bird's side of the net and watched for the bird's movements. If the bird went into the net, this person was able to rush toward it, thereby discouraging it from doubling back and escaping if it was not tangled, and secure the bird in a net-pocket by lifting the net off the ground. An alternative strategy of moving noisily behind a bird which was within 10 m of a net, in the hope of flushing it into the net, failed on all ten attempts.

Processing

The processing of each bird was organized to minimize handling and holding time and to maximize the chance of a successful radio-tag attachment. When a bird was trapped it was removed from the net and held in a calico bag while all of the nets were closed. Each bird was weighed in its bag, then removed and banded with a standard size 5 aluminium band issued by the Australian Bird Banding Scheme. The band number was used to name the bird. The bag was weighed and stored for later inspection. The bird was held over a work-sheet of blotting paper and care was taken to prevent it from touching its feet on anything because Eastern Bristlebirds have a tendency to jump if they can push off with their legs. Standard measurements of head-bill (HB), bill (BK) and tarsus with foot (TZ) lengths were taken (Low 1989). Eye colour was noted because in some species this can be used to distinguish between adults and immature birds (Low 1989). In four cases, to hasten processing time, not all morphometric measurements were taken.

Preparation for radio-tagging required one person to hold the bird and a second person to perform the following tasks:

(i) The bird's head was enclosed in a hood which was a draw-string bag 80 mm × 100 mm made from black, open-weave cotton. Eastern Bristlebirds are very wriggly when being handled and the hood had a noticeable calming effect on most of them.

(ii) The feathers in the interscapular area were trimmed to 1 mm over an area approximately 10 mm wide and 20 mm long using round-nosed scissors and an artist's size-4 pure bristle paint brush wet with 70 per cent ethanol. This was the most time consuming part of the processing. Wet feathers were easier to snip than dry ones and the ethanol was intended to clean dirt and oil from the radio-tag attachment area. Because of the likelihood of the bird making a sudden movement, round-nosed scissors were considered less likely to accidentally damage the bird than pointed scissors. The birds were moulting and when the emerging pin feathers were trimmed they bled which may have hindered radio-tag attachment. Hence, whenever possible, the pin feathers were plucked using tweezers or they were left unsnipped.

(iii) When the attachment area was clean and dry, a fresh smear of Supa Glue Gel (Selleys) was applied to the radio-tag which was then held firmly to the bird for 5 minutes, aligned with the bird's dorsal axis.

(iv) The hooded bird was then placed in a 100 mm × 200 mm × 300 mm holding box for 10 minutes to allow additional time for the adhesive to strengthen.

(v) When the bird was taken from the box, the hood was removed and the bird was released into thick vegetation close to the point of trapping.

The Supa Glue is a cyanoacrylate which Perry *et al.* (1981) found the most successful type of adhesive to use with birds and which Johnson *et al.* (1991) found to be safe for use with 128 birds from four passerine species. Acetone was kept handy as a solvent in case of accidental gluing with Supa Glue. Forthane, an anaesthetic, was kept handy for the euthanasia of injured birds, as specified by the Animal Ethics Approval.

From each bird, between two to six pin feathers which had been removed with tweezers were stored in 70 per cent ethanol for subsequent DNA analysis. The calico bag, work-sheet and holding box were checked for faecal samples which were collected and stored in 70 per cent ethanol for subsequent dietary analysis. These data and the morphometric data will be analysed and published in the future.

Radio-tags and tracking

The radio-tags were supplied by Titley Electronics at $145 each. They consisted of a single-stage, miniature transmitter (Model LTM), a 388 Varta 1.35 V mercury battery and a magnetically operated reed switch, all hermetically encapsulated in heat-shrunk plastic tubing with a whip style transmitting aerial attached. The mean dimensions of the radio-tags were 21 mm × 9.4 mm × 3.5 mm and each weighed approximately 1.6 g. The aerials were 250 mm long, nylon-covered multi-strand stainless steel fishing trace wire. The expected battery life was 6–8 weeks. The radio-transmitters pulsed at approximately 1 Hz and each had unique frequencies ±2 kHz in the 151 MHz band. Signals were detected using hand-held three-element Yagi antennae and Telonics TR-2 and TR-4 portable receivers.

Before the radio-tags were used and again immediately prior to attachment, each was checked for transmitter signal frequency and strength. Prior to catching each bird, a piece of gauze (cotton T-shirt material approximately 0.5 mm thick) was attached to the radio-tag using Supa Glue Gel and trimmed to overlap the radio-tag by 1 mm. This was intended to enhance the adhesion of the radio-tag to the bird. Direct attachment of radio-tags to birds without using the gauze was attempted thrice with attachment lasting five days, nine hours and six hours respectively, after which this method was not used again.

A detached radio-tag was recognized by its constant signal strength, constant source location and occasionally by having a strong signal when the receiving antenna was held vertically. Detached radio-tags were generally easy to find. This was achieved by finding the approximate location to within a few square metres then folding away the elements of the Yagi antenna and using it as a probe every 250 mm and progressively reducing the receiver gain (volume).

Ten radio-tags were used. When retrieved, the radio-tags were cleaned and reused or returned to the supplier for new batteries which were fitted for a minimal cost.

Twenty-two birds were radio-tracked during 77 days between 26 March and 26 June. The initial intention to have an approximately even tracking effort across all sites was not achieved because few Eastern Bristlebirds were trapped at sites C, D and E (Table 1). During the first 50 days of the project, a median of three birds (range 1–5) were tracked simultaneously and for the remainder of the project, only one bird was tracked. Some birds were not tracked on every day that they were tagged.

Movements of radio-tagged birds

The average weight of the radio-tags was compared to the weight of the birds trapped during the study (n = 26 including a retrap).

Tracking of birds was commenced from the day of radio-tagging and their movements and behaviour were studied for any indications of acclimation or exceptional movements.

The initial activity of the radio-tagged Eastern Bristlebirds was compared to their activity on subsequent days. A trend of increasing movement over time would indicate that radio-tagging initially inhibited birds and a trend of decreasing movement over time would indicate that radio-tagging initially aggravated birds. The greatest distance between any two locations of a bird during a day was taken as an index of activity and the first full day of tracking was compared to the mean of the subsequent two days using the Wilcoxon paired-sample test (Zar 1984).

RESULTS

Trapping

Twenty-six Eastern Bristlebirds were trapped (including a retrap) during 29 days (145 hours) of mist-netting (Table 1). There were approximately 1 000 captures of birds which were not Eastern Bristlebirds and all of these were released unharmed. For the 26 successful trappings, six were considered to be directly attributable to the tape because the birds called and/or were seen nearby within a few minutes, ten occurred in conjunction with tape playing, although the influence of the tape in these cases was not known, and the remaining ten occurred without the tape being played.

TABLE 1

Trapping results. *Number of mist-nets (based on a standard 18 m net) × number of hours of netting. JBNP: Jervis Bay National Park.

Site and park	Trapping days	Trapping *mist-net.hours	Trapping birds trapped	Birds tagged
A1 — Booderee	5	157	6	6
A2 — Booderee	4	138	5	3
A3 — Booderee	3	122.5	5	5
B — Booderee	6	167	8	6
C — Booderee	3	88.5	1	1
D — JBNP	3	136	0	0
E — JBNP	5	153	1	1
Total	29	962	26	22

Processing

Nineteen of the 26 birds were processed routinely, as described above, in an average time of 45 minutes, with holding time in the calico bag averaging 17 minutes (range 2–38 min) and processing time, including time in the holding box, averaging 28 minutes (range 23–34 min). The seven exceptions to the processing routine were as follows:

Bird #52 was recaptured 12 days after first capture and 9 days after its radio-tag became detached. It was assessed to be in good condition. In the interscapular area, there was no sign of glue or skin damage and approximately 20 new pin feathers had sprouted to a length of 8 mm. Morphometrics were taken and the bird was released.

Bird #57 was captured 35 minutes before sunset, held in a calico bag for 2 minutes then processed very quickly (20 minutes). However, the air temperature dropped suddenly and when the bird was released it was reluctant to move. It was cold to touch and presumably was hypothermic. It was immediately placed in a calico bag and warmed by a researcher's body heat. It was kept warm and held overnight in the bag and released the following morning after a drink of warm sugary water from an eye-dropper. The bird was then successfully tracked for 11 days before the radio-tag became detached and was retrieved.

A bird was captured as the nets were being closed, 15 minutes before sunset. It was released immediately without being measured, banded or radio-tagged because there was insufficient time pre-dusk for processing. Holding birds overnight was considered to be an emergency not a routine procedure.

Bird #60 was captured in the early morning. The weather was cool but the bird was warm and dry so it was held in a bag for one hour and then it was processed quickly (20 minutes) and released.

Bird #68 was captured accidentally in a partly furled net, as a line of nets were being erected on a warm afternoon in late April. The bird appeared to be normal and healthy, although it may have been trapped for up to 30 minutes, from 90 minutes pre-sunset. The bird was processed immediately and quickly. However, 13 minutes into the processing, after the radio-tag had been held in place for three minutes, the bird's heart gave several very strong beats and stopped. Attempts to revive the bird with artificial respiration and external cardiac massage failed. The body was frozen and held for later examination, after which it will be lodged with the Australian Museum, Sydney.

A bird was captured in the early morning as the nets were being opened. The bird was cold and wet from dew and so it was held and warmed in a bag for an hour until it was dry. It was then photographed and, although it appeared to be normal and healthy, it was released without being measured, banded or radio-tagged because it was considered that the additional time required for processing could have been excessively stressful to the bird.

Bird #72 was held in a bag for only 10 minutes prior to processing. However, for no apparent reason it became droopy while the radio-tag was being held in position. It was given some sugary water with an eye-dropper and released without being placed in the holding box. When released it remained still for approximately 30 seconds then suddenly retreated into the cover of the vegetation. The bird was then successfully tracked for five days before the radio-tag became detached and was retrieved.

Of the 25 individuals captured during the present study at Jervis Bay, only one (trapped in late April) had a pale iris. However, a brief examination showed no particular pattern of plumage or soft parts which was noticeably different from the other birds and we were uncertain whether it was a young bird.

Radio-tags and tracking

The radio-tags averaged 3.8 per cent (range 3.3–4.7%) of the birds' weights (range 34–49 g). Once attached, the radio-tag fitted neatly between the bird's scapulae and was covered by body feathers with the aerial lying along the back and projecting approximately 120 mm beyond the tail. The transmitter axis was parallel to the bird's anterior-posterior axis. When the radio-tags became detached from the birds, they were retrieved and they showed varying degrees of bending and scraping along the aerial, indicative of the birds' attempts to preen or remove the radio-tags.

The detached radio-tags had the stubs of the snipped feathers and up to 13 whole body feathers glued to the gauze. During search and retrieval of radio-tags, no indication of injury to the birds was found except in one case, bird #69, which is noted below. This was taken to indicate that the birds were unaffected by the temporary attachment of the radio-tag.

The most serviceable radio-tags included one which was used on five different birds for a total of 19 days and another used on three birds for a total of 18 days then fitted with a new battery and used on another bird for 41 days.

In three cases, there were problems with receiving signals. A radio-tag was fitted to bird #59 but the following day the signal could not be detected within a radius of approximately 1 km. Despite frequent checking, the signal was not detected again during the remaining 6 weeks of the study. A radio-tag was fitted to bird #64 and it transmitted without problems for two days. However, the signal became increasingly variable in strength and pulse rate with few data being obtained after the sixth day of tracking. No signal was detected for several days but the detached radio-tag was retrieved when it transmitted briefly on the fourteenth day.

A radio-tag was fitted to bird #69 and it transmitted without problems for four days. On the fifth day the signal became weak and ceased. On the ninth day, when a faint signal was detected, the detached radio-tag was found. It was punctured with several blunt tooth-like marks and was located with some Eastern Bristlebird feathers (approximately 20 body feathers and three wing primaries) but no other bird remains were found. Presumably, this bird was predated by a fox because within 50 m there were piles of feathers from a ground parrot and a crimson rosella and some chewed kangaroo bones; within 100 m, in thick scrub on the eighth day, a fox-sized mammal was flushed, although not sighted; and a fox was seen 200 m from the location 5 months previously.

Generally, signal detection was easily achieved within 200 m of the radio-tagged birds. The maximum distance at which each transmitter signal was received averaged 330 m (n = 9; range 200–500 m). The median radio-tag attachment time was 5.5 days and the mean was 8.4 days (Fig. 1).

Movements of radio-tagged birds

The only retrapped bird had a weight change of 10 per cent (+4 g) in a period of 12 days. The 1.6 g radio-tags averaged 3.8 per cent (range 3.3–4.7%) of the Eastern Bristlebirds' weights (range 34–49 g).

When radio-tagged birds were released, they quickly disappeared into thick vegetation. However, often their movements seemed to be conservative in the first few hours after release. Movements of less than 60 m from the point of release were recorded for 16 birds in their first 20–220 minutes of tracking, including four birds released

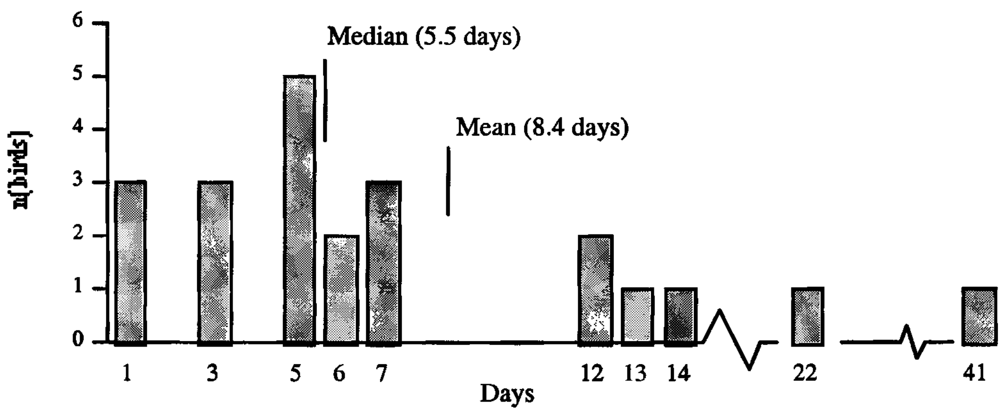

Figure 1. *Period of radio-tag attachment (days or part thereof) for 22 birds.*

late in the afternoon which did not move beyond 60 m until the following morning. In nine cases of longer movements, including five of the birds which were initially conservative in their movement, birds moved 70–260 m in their first 80–225 minutes of tracking. For example, bird #55 was released late in the afternoon and moved only 25 m in 20 minutes before roosting for the night but then it moved at least 300 m in the first hour of light the next morning.

There was no difference between the index of activity on the first full day of tracking (mean distance 145 m; range 75–230 m) and the subsequent two days (170 m; 100–325 m) ($T_{0.05,(2),16} = 29$; $T = 54.5$, $P = 0.5$).

The above results are taken to indicate that radio-tagged Eastern Bristlebirds may take a few hours before they begin to move about normally but they recover within the first day of tagging.

Occasionally, radio-tagged birds seemed to react when they were approached to within 25 m by an observer. On 28 occasions, birds (14 different individuals) evaded by moving perpendicularly to the direction of the approaching observer. On 10 occasions, birds (9) retreated rapidly in the direction opposite to the approaching observer. On three occasions, birds (2) approached to within 2 m of the observer. On three occasions, birds (2) remained still, silent and hidden, even when the observer approached to within one metre. Two radio-tagged birds were flushed from cover and seen flying approximately 20 m and 10 m respectively. Rapid movements of 35–80 m within 10 seconds were recorded for 13 individuals moving through thick vegetation.

There were a number of notable movements by radio-tagged birds. After it was radio-tagged, bird #51 accidentally escaped 295 m from the point of trapping. It moved 20–50 m into thick vegetation and remained there for at least 30 minutes. Three and a half hours after release, it had returned to within 90 m of the point of trapping. Rapid movements by five radio-tagged individuals were: 110 m in one minute, 140 m in one minute, 165 m in less than 20 minutes, 190 m in less than 10 minutes, 320 m in less than 20 minutes and 330 m in less than 60 minutes. The furthest daily movement between two fixes was 525 m by bird #55. Bird #73 was the most intensively tracked bird and during 5 days, for 8–11 hours per day and 9–18 fixes per day, it moved 830–1 540 m per day at an average of 115 m per hour.

DISCUSSION

Trapping to tracking

The materials and procedures used to trap, process, radio-tag and track Eastern Bristlebirds in this project were generally considered to be satisfactory. Trapping took a large proportion of the field work time and this reduced the time available for tracking. In future, this situation could be overcome with additional field workers or by increasing the trapping success rate. Other studies have reported similar variable and short times of radio-tag attachment (Sykes *et al.* 1990; Johnson *et al.* 1991; Murphy 1994). Nevertheless, the short time of attachment in the present study was disappointing and it may have been exacerbated because the birds were undergoing their annual moult. Trapping in early spring would possibly increase the trapping rate if the birds were more responsive to taped call replay and should avoid the problems of moulting feathers and bleeding pin feathers. However, there may be a strong risk of disrupting breeding if Eastern Bristlebirds are disturbed in spring. Future similar radio-tracking projects will need to anticipate this dilemma.

Alternative, more secure methods of radio-tag attachment using a thread harness (Sykes *et al.* 1990), collar (Marcstrom *et al.* 1989) or leg band (Morris and Burness 1992) were considered unsuitable for the Eastern Bristlebird because of the possibility of becoming snagged in their dense habitat. Surgical implanting of radio-tags was also considered inappropriate because of the problematic nature of the Eastern Bristlebird and the numerous potential difficulties associated with the method (Perry *et al.* 1981). In the future, tail mounting could be attempted but we expect that Eastern Bristlebirds would quickly remove the radio-tags with or without their tail feathers.

The effects of the radio-tags on the birds

Radio-tags must be small, relative to the animals being studied. From 5 886 retrapped birds (6–80 g) of 40 species, Naef-Daenzer (1993) calculated that within 8 days, 49 per cent changed weight by more than 5 per cent and 18 per cent changed weight by more than 10 per cent and he considered that all of these species were capable of carrying tags which were 5–7 per cent of their body weight. From flight aerodynamics calculations, Caccamise and Hedin (1985) considered that radio-tag loads of 5 per cent of a bird's weight were generally acceptable, although this is probably conservative for the Eastern Bristlebird because it is semi-flightless. In their review of 187 papers, Calvo and Furness (1992) utilized categories such as 'weight loss' and 'breeding ecology' to list studies which reported an effect or no effect of radio-tagging on birds. The most commonly reported effect was 'initial discomfit' which was reported in 28 of the studies. Generally, our review of radio-tagging studies (Appendix 1) suggests that for small to medium-sized birds, small radio-tags glued to the interscapular have minimal effect and the acclimation period is less than a day.

Processing was traumatic for the birds (and nerve-racking for the researchers). One bird died and two became temporarily stressed. When released, all of the birds disappeared quickly but then seemed to take a few hours before they began to move about normally. They appeared to recover within the first day and were then capable of rapid and extensive movements and typical short flights. When the detached radio-tags were found there was no sign of injury to the birds. The effects of trimming the feathers was temporary. Bird #52 had begun to regrow feathers 9 days after radio-tag detachment. Sykes *et al.* (1990) found that feather replacement in small passerines, independent of the moult cycle, occurred within 17–24 days. The radio-tags used in the present study were considered to be sufficiently small to cause minimal deleterious effects and minimal changes in behaviour to the birds being studied. Future studies would benefit from more rapid attachment techniques aimed at reducing the trauma of processing. Captive experimental animals (e.g. Common Starling *Sturnus vulgaris*) could be used to investigate rapid glues such as 10 second Supa Glue (Selleys) and refinement or omission of the feather-trimming process.

To minimize handling time, in the present study few morphometrics were taken and in four cases none were taken. Collecting faecal samples was incidental and caused no delays during the processing. Plucking pin feathers was preferable to snipping because snipped pin feathers bled which necessitated cleaning the radio-tag attachment area. Therefore, collecting the faecal material and the pin feathers caused no unnecessary delay in processing the birds. When researching a threatened species it is sensible to take opportunities to collect data which may assist with the future conservation of the species. Nevertheless, future studies will need to consider the balance between minimizing handling time and maximizing the opportunities for data collection.

Evidence indicated that one radio-tagged bird was killed by a fox but this did not suggest a particularly vulnerable bird. There has been evidence of similar instances of untagged Eastern Bristlebirds being predated at Barren Grounds and Nadgee Nature Reserves (Baker 1998a).

Radio-tagging may be better tolerated by some species than others. Johnson *et al.* (1991) found that of four similarly small species, only one, a cardinal, displayed little tolerance for an interscapular radio-tag. The cardinals worked at the tag until they removed it. In the present study, the scraping and bending of the aerials and the generally short attachment times suggested that Eastern Bristlebirds may have little tolerance to wearing an interscapular radio-tag.

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APPENDIX 1

Radio-tags glued to the inter-scapular of small to medium-sized birds: their relative size and effect

The Table shows a total of 23 studies across 31 avian taxa weighing 7–180 g, carrying radio-tags 0.4–6.9 g which were 1.6–16 per cent of their weight. Five of the studies did not mention the effect of the radio-tags on the birds. Nine studies reported no effects on the birds. Six of the studies reported generally minor effects associated with radio-tagging and tracking, mainly on the first day, although in two of these studies a bird died. In two studies, radio-tagging was implicated in reduced breeding success. In the remaining study, (Hooge 1991) found that acorn woodpeckers reduced their amount of flying with radio-tags >5 per cent of their body weight but behaved normally with radio-tags weighing <4 per cent.

Australian studies

Species (sample size)	Bird weight (g)	Radio-tag weight (g)	Tag : Bird %	Effect of tag (source reference)
Gouldian Finch *Erythrura gouldiae* (4)	*approx. 14	0.9–1.0	7	No effect reported (1).
Red-browed Finch *Neochmia temporalis* (3)	approx. 10	0.7	7	No effect reported (2).
Helmeted Honeyeater *Lichenostomus melanops cassidix* (14)	approx. 17–27	1.7 and 2.3	4.5–8	Laboured flight for first few hours (3). Possible minor change in foraging strategy: less flying (4).
New Holland Honeyeater *Phylidonris novaehollandiae* and White-cheeked Honeyeater *P. nigra* (23)	20 (NHHE) 18 (WCHE)	1.5–1.6	7.5–8.9	Initially, some pecking at tag but then no obvious affect on behaviour (5).
Western Bristlebird *Dasyornis longirostris* (3)	approx. 30	2	6.7	One died within 40 hours of release. Two avoided observers when they were tracking close to the bird (6).
Noisy Scrub-bird *Atrichornis clamosus* (?)	f: (31.5–39.2); m: (47–57)	f and m 2; m 1.2	2–6.3	No effect reported (7).
Plains-wanderer *Pedionomus torquatus* (captive bird trials + 7)	approx. 40–95	1.5	1.6–3.8	No discomfort or behaviour changes were discernible (8).
Ground Parrot *Pezoporus wallicus* (4)	70–94	4.8–5.6	5–8	Birds appeared unaffected (9).
(18)	mean 78	4.7–5	6–6.4	No effect reported (10).
(13)	84–108	4.5–5	4.2–6	Birds flew away strongly (11).

*Approximate weights are given where the given reference did not indicate bird weight

(1) Woinarski and Tidemann (1992); (2) Todd (1997); (3) Runciman *et al.* (1995); (4) Runciman (1996); (5) O'Connor *et al.* (1987); (6) Murphy (1994); (7) A Burbidge, CALM WA, (pers. comm.); (8) Baker-Gabb *et al.* (1990) (9) Jordan (1988); (10) McFarland (1991); (11) Burbidge *et al.* (1989).

Studies outside Australia

Species (sample size)	Bird weight (g)	Radio-tag weight (g)	Tag : Bird %	Effect of tag (source reference)
Common Yellowthroat (8)	7.6–15.5	1.1	7–14.5	One died due to capture stress. Remaining seven had excellent physical health. No effect on the number of flights or weight (12).
Tits (46): Blue, Great, Crested and Coal; Garden Warbler (39)	9–18	0.4 (on lighter birds) 0.9 (on heavier birds)	4–5	Normal behaviour resumed within 0.5–24 hours. Possible adverse effects due to handling of 3/150 birds (13).
California Black Quail (36)	33	2	6	No effect reported (14).
Interior Least Tern (20) and Western Snowy Plover (18)	approx. 35	2–2.6	5.6–7.4	No adverse reaction. No effect on reproductive success rates (15).
Brown-headed Cowbird (60)	approx. 44	1.7–1.8	3–5	30 per cent ignored the radio-tag. The remainder pecked and preened the tag for up to several hours, with two birds persisting for many hours until they removed their tags. Otherwise, all behaviour was normal (16).
Blue Jay, American Robin, Brown Thrasher, Northern Cardinal	approx. 50	1.4	generally <3	No apparently abnormal behaviour (17).
California Least Tern (7)	60	1.8	3	Affected breeding success (18).
Acorn Woodpecker (25)	76–84	3 4.5	3.5–3.6 5.1–5.4	No effects. Reduced time in high energy activities (19).
Robin (1), House Sparrow (1), Common Starling (?), Common Grackle (?)	76.6 (robin) 30 (sparrow) approx. 95 (starling) 100 (grackle)	5.7 4.7 6.4 4.7–6.9	7.4 15.7 6.7 4.7–6.9	No effects (20).
Common Starling (8)	95.5	3.2	3.4	Some birds moved more slowly on the first day. Otherwise no effect (21).
American Wood-cock (8); (177)	approx. 120–170	4 3.5–5	approx. 3 ≤3	Three hens abandoned broods (22); no effect reported (23).
Great Snipe (52)	180 (female) 140 (male)	3.2 4.3	1.8 3	A detailed study showing no significant differences for clutch size or volume, egg-fertilization, physical condition or territorial behaviour (24).

(12) Sykes *et al.* (1990); (13) Naef-Daenzer (1993); (14) Flores and Eddleman (1995); (15) Hill and Talent (1990); (16) Raim (1978); (17) Johnson *et al.* (1991); (18) Massey *et al.* (1988); (19) Hooge (1991); (20) Graber and Wunderle (1966); (21) Bray *et al.* (1975); (22) Horton and Causey (1984); (23) Krementz and Pendleton (1994); (24) Kalas *et al.* (1989).

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RECOVERY OF CURLEW SANDPIPER FROM CHINA

There is nothing unusual in the reporting of a Curlew Sandpiper banded in Australia and recovered in China, though not a very common occurrence. However, a 'Report of Recovery to Bander' received recently is very unusual.

I banded a Curlew Sandpiper *Calidris ferruginea* at Stockton, New South Wales on 12 November 1977. The Report of its recovery was received by me on 29 March 1999! No, the bird was not over 22 years old. The report from the National Bird Banding Centre of China stated that the bird (band number 040-91835) had been recovered on '6/12/79', 8 967 km NNW. The bird was dead (probably 'hunted').

According to the report, which was partly in Chinese, from the National Bird Banding Centre of China, the bird had been reported to them in November 1998 by Tan Yaokuang! However, it seems that the bird bands were submitted to 'one old scientific worker' who had kept them in his draw. They were located when the worker's desk was cleaned up.

This is possibly 'a record' for the longest time between 'recovery and reporting date' so far! — some 19 years later.

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(For the details of the recovery see Recovery Round-up in this issue, page 51.)