Radio-tracking Honeyeater Movements

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In heathland areas near Sydney honeyeaters (mostly New Holland Honeyeaters *Phylidonyris novaehollandiae* and White-cheeked Honeyeaters *P. nigra*) are either residents that can be observed repeatedly near the same location for at least two days or transients that are not seen again after initial capture and banding (Pyke & Recher, unpubl.). To understand what determines the distribution and abundance of resident honeyeaters it is necessary to know how and where individuals spend their time during the day. It is thus desirable to be able to follow their daily pattern of movements.

Radio-tracking is the best method for obtaining such movement data on these resident honeyeaters. It is not possible to follow individually colour-banded birds for more than a few minutes and birds that cannot be seen could be nearby in the vegetation or have flown some distance away. Packages consisting of radio transmitters and their batteries have been decreasing in size and weight and have recently been used in Australia to follow 9 g bats to roost sites (Lunney *et al.* 1985). The honeyeaters in the present study are twice the weight of these bats (average weights are 19.6 g for New Holland Honeyeater and 18.3 g for White-cheeked Honeyeater, Pyke & Recher unpubl. data). To date the techniques have not apparently been used in any published study of Australian birds. In this paper we describe the radio tracking methodology that we have developed for following the movements of honeyeaters. This study forms part of a program of research on honeyeater population biology (see Pyke 1983; Pyke & Recher 1986).

Methods

Study area, birds and observation periods

The study was carried out in heathland in Brisbane Water National Park, 30 km north of Sydney, N.S.W. The study site was a ten hectare grid that straddled the road connecting the Warrah trigonometric station and Patonga Road.

The subjects of the study were New Holland Honeyeaters or White-cheeked Honeyeaters that were resident in the sense that they had been seen regularly near the same place for at least the week before any radio-tracking. In all cases such birds had previously been colour banded with individual colour combinations.

Radio-tracking sessions were carried out during one or two week periods. Transmitters were attached to birds either near the beginning of any of these study periods or during the preceding week. This opportunistic procedure was adopted because it was not possible to reliably capture suitable birds on a given day and some birds either left the study area or lost their transmitters. We attempted to have four birds carrying transmitters at all times during the radio-tracking sessions.

Transmitters

The transmitters were Biotrack Model SS1 with an average current drain of 0.15 mA and a weight of 0.7 g. Each transmitter had an individual frequency between 150 and 151 MHz, was tuned for use with a 15 to 20 cm steel guitar string aerial (0.23 mm diameter) and was soldered to a 312 zinc air cell battery weighing 0.6 g. The antenna solder joint was protected using a drop of epoxy resin. The primary cloth (Raim 1978), a thin 1 cm x 2 cm chiffon cloth, was attached to the transmitter unit with cotton thread. The total weight of the transmitter package was 1.5 to 1.6 g, which was less than 10% of the body weights of the birds.

The batteries, which were soldered to the transmitters well in advance of attachment to the birds, were activated just before attachment by the removal of an adhesive tab from an air hole on the battery casing. In this way the maximum effective transmitter life (about 20 days) could be obtained.

Attachment of transmitters to birds

Transmitter packages were attached to each honeyeater using the following modification of Raim's (1978) method. Within an area of about 1.5 cm x 2.5 cm on the interscapular region of the back and immediately posterior to the neck, all feather shafts were cut using fine scissors to within 1 to 2 mm of their base. To this cleared area a piece of surgical gauze, the secondary cloth (Raim 1978), was glued using false eyelash cement (Lashfix (R) (Surgical) by Eyelure), which formed a flexible and hopefully non-irritant bond to the bird's back (Raim 1978). The transmitter package was mounted on the bird by gluing the primary cloth to this gauze using cyanoacrylate glue (Superglue-R). The transmitter package was carefully aligned along the body axis of the bird so that the whip aerial projected past the centre of the tail. This attachment procedure required two people, one of whom held the bird while the other cut the feathers and did the gluing. A sugar solution was offered to the birds before, during and after the procedure. Birds were held captive for between two and four hours and then released at their capture points.

The success of the attachment procedure depended on the time allowed for the eyelash cement to dry. The transmitter packages were initially attached to the surgical gauze after it had been attached to a bird for only about 15 min by which time the eyelash

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cement was still partly fluid and milky in appearance. Under these circumstances the transmitters often failed to remain on the birds (see below). Higher success was achieved when the drying time was extended to about 60 min by which time the cement had become transparent and fully set. On some occasions a pocket hair dryer was used to accelerate the drying rate (Raim 1978). While the cement was drying the birds were kept in a cotton holding bag in a shaded, well-ventilated position.

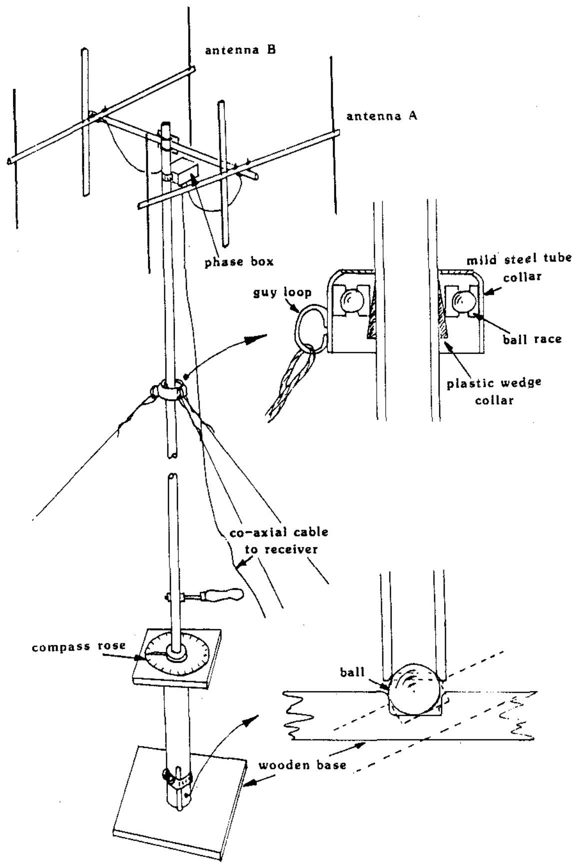

FIGURE 1 Antenna tower showing details of the top ball-race guying-collar and the lower single ball pivot on which the tower assembly rotates. The use of a single ball bearing as the lower support allows the bottom plate (a 40 cm^2 piece of 'form-ply'), to lie at an angle to the vertical axis of the mast, as for example when mounted on rocky ground, and still provide a secure pivot point (as indicated by the dotted lines). The upper ball race is anchored onto the mast tube by a wedge shaped piece of PVC conduit tubing, which is secured by cyanoacrylate cement to the mast. The steel cover is made from thin mild steel tubing, with the top swaged over to provide a rim which rests on the ball race. Three equally spaced loops are brazed to the cover (attempts to braze to the ball-race outer cage will result in destruction of the race). The race and the inside of the cover should be liberally packed with axle grease. Because the base plate can assume different angles to the mast, the length of PVC tubing to which the compass rose is attached is secured by 3 rods inserted into the base plate around the pivot hole and the tube is secured with a hose clamp once it has been aligned to due-north. Sizes of parts are not critical.

Antennae

The antennae were 3-element Yagis, constructed according to specifications in the *American Radio Relay League Handbook* (Woodward 1982). All antennae were matched and accurately tuned using a swept SWR bridge.

Receiving towers

The signals emitted by the transmitters were received at three fixed towers. Each tower consisted of the following components (see Fig. 1). Two vertically oriented antenna were spaced one wavelength (2 m) apart on a cross boom made of aluminium tubing. This structure was mounted on a 5.5 m, 32 mm diameter tubular aluminium mast. The tower was supported using three 2 mm wire rope guys attached to a ball race collar located three metres up the mast. This collar consisted of a steel ball race that wedged onto a thin (3 mm) tapered plastic collar cemented on the tower tube. A steel covering with three attached guying loops fitted over the ball race and wedged the race firmly onto the plastic collar. The mast rotated upon a stainless steel ball bearing (25 mm diameter) located on a wooden base plate, an arrangement allowing great ease of rotation. A sleeve with a compass rose at its top slid over the lower section of the mast and was secured in a fixed position to the base plate. A needle pointer, projecting at right angles from the mast just above the compass rose, enabled the direction of the antenna to be recorded. Also attached to the mast, just above the pointer, was a handle to enable the mast to be easily rotated. The system was light, uncomplicated and easily assembled on-site.

The signals received by the antenna pair were fed by two identical coaxial cables into a null/peak network phase box (described below), which was mounted on the mast just above the cross boom. More coaxial cable carried the signal from the null-peak box to a radio receiver positioned near the base of the mast. A remote control switch box (described below) was inserted in this cable just before the receiver to enable the observer to switch the antenna system between peak and null modes of operation (described below). Power for this switch box was supplied by a 12 volt battery. Two towers were equipped with Telonics TR2 receivers and the third tower with either an AVM LA 12 DS or a Biotrack RX-81 receiver. Headphones were used in conjunction with receivers.

In the peak mode the signals from both antennae were summed and the strength of the received signal was greatest when the antennae were pointing towards the signal source. In general, however, it was difficult to accurately determine the direction of this peak. In the null mode the signal from one antenna was subtracted from that of the other. Consequently the signal reaching the receiver vanished completely when the antennae were pointing directly towards the signal source. The angular range of directions through which no signal could be detected was usually small and so, by taking the midpoint of this range, an accurate estimate of the direction to the signal source could be obtained.

Null-peak network

The null/peak box (Fig. 2) consisted of a tuned coaxial bridge in which one of the four legs of the bridge was a half wavelength longer (0.652) than the other three (0.152) to provide a 180° signal phase inversion. The 0.152 legs provided a 50 ohm

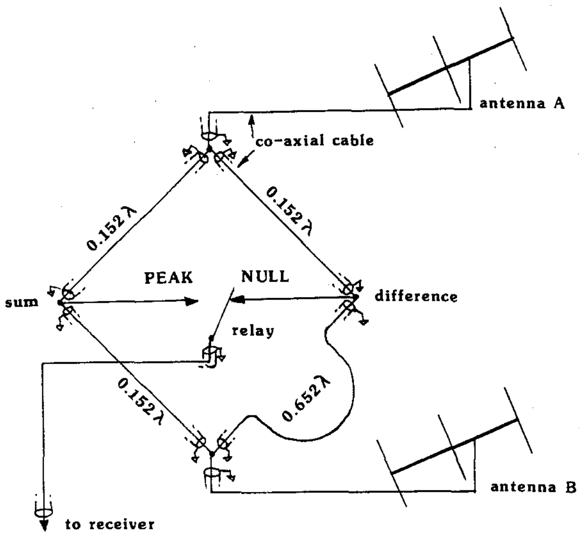

FIGURE 2 Essentials of the Null Peak Network. The details of the relay system and switch box have been omitted for clarity, (these are described in full detail in Spencer *et al.* 1987). The lengths of the coaxial cables connecting the antennas with the bridge must be identical, and all cables must be of 50 ohm impedance. The four phasing cables and relays comprising the bridge are mounted in a small weather-proof box, which is attached to the top of the mast.

impedance match to the antenna and receiver. A pair of reed relays served to connect the receiver to either the summing or difference (null) junctions, and to connect a 50 ohm load to the unused junction to preserve impedance symmetry. The relays were activated by a DC current supplied through the coaxial lead from the receiver. Hence the receiver could be remotely connected to the summing (PEAK) or difference (NULL) nodes on the bridge, by applying 12 V to the relays through a small switch box inserted in the antenna cable to the receiver. This switch box contained the necessary circuitry to isolate the DC and signal paths. This type of network is highly frequency dependent and success (in terms of narrowness of the null) depends on the care with which the bridge is constructed.

When properly made, such a network is stable, exhibits negligible signal loss and is exceedingly robust (Spencer *et al.* 1987).

Radio tracking procedure

With the phase box switched to peak mode, the observer rotated the mast until the approximate direction of the peak signal was determined. The observer then switched the system to null mode, and attempted to determine the direction corresponding to the centre of the null region (the width of which depended on signal strength). If the signal was too weak to use the null mode, the system was operated in peak mode.

To estimate the position of the radio-tagged bird it was necessary to calibrate the estimated direction of the bird from each tower with respect to a known direction. This was achieved by regularly measuring the directions from each tower to a fixed transmitter attached to the vegetation at a known location. It was also necessary to obtain in synchrony the directions from each tower to a bird. This was achieved by synchronising watches and determining the bearings as quickly as possible and as close as possible to predetermined times. Both the start and finish times of the procedure were recorded at each tower. Communication between towers was carried out using hand held C.B. transceivers.

Results

Behaviour of radio-tagged birds

When birds carrying transmitters were first released they usually flew to a perch and pecked at the transmitter. This behaviour was rarely seen later; birds were seen behaving normally and hawking insects, taking nectar from flowers, flying between perches and hopping amongst the vegetation. Thus the transmitters had no obvious lasting effect on their recipients. One bird successfully nested after carrying a transmitter for two weeks.

Duration of transmitter attachment

Of the 23 birds that have received transmitters, two left the study area, five lost their transmitters in less than one day and nine after from 1 day to 4 days (± = 2-3 days). The remaining eight birds carried their transmitters for an average of 12 days, the maximum duration of attachment being 23 days. In three of the five cases where attachments lasted less than one day the eyelash cement had not fully dried when the transmitter was attached.

We have so far been able to radio-track 15 birds for an average duration of 2.4 days (*s.e.* = 0.3, maximum = 5.3 days), which was sufficient for the purposes of this study.

Signal strength

Adequate signal strength was obtained as long as the distance from the transmitter to the tower did not exceed about 500 m line of sight and the bird was perched above the surrounding vegetation.

Conclusions

The present radio-tracking procedures enabled the movements of New Holland and White-cheeked Honeyeaters to be followed over an area of up to about 1 km^2, without any obvious affect on their behaviour. The method also worked well with Ground Parrots *Pezoporus wollicus* (R. Jordan pers. comm.) and with White-throated Tree-creeper *Climacteris leucophoea* (unpubl.). We therefore expect that it will be a worthwhile method for many birds weighing more than about 10 g. As technological advances lead to smaller transmitter-battery packages and more powerful transmitters it should also be possible to apply the method to smaller birds and to track birds over greater distances.

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