TABLE 2 Percentages of males and females giving different call types on release at Heron Island and Kobble. For abbreviations see Table 1.

Record	Sex	Call type VC	LC	SC	NC	No. of birds
Release	M	42.5	7.5	7.5	42.5	106
	F	0	38.4	5.8	55.8	52
Field and captivity	M	44.8	26.3	26.3	2.6	38
	F	0	52.9	41.2	5.9	17

captivity and in the field. On release, 42.5% of males gave the VC and 7.5% the LC, whereas in captivity and in the field 44.8% gave the VC and 26.3% the LC.

In the sexually monomorphic Silvereyes, behavioural discrimination of sexes must be important. Vocal discrimination of males is made possible by means of a contact call, namely, the male specific, VC. Although males also used the LC as part of their repertoire, only 7.5% gave this call on release after retention in isolation. The discrimination of these calls by a trained ear in the field can therefore lead to positive identification of males if they use the VC. Females gave the LC call on release more frequently than the males did, but neither the call structure nor the context in which it was given revealed the sex of the bird.

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Breeding Biology of the Brown-backed Honeyeater *Ramsayornis modestus* (Meliphagidae) in northern Queensland

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The Brown-backed Honeyeater is a small Meliphagid with an average adult weight of 12.1 g (Maher 1986). There is little published information about its life history and general ecology (Miller 1932; Maher 1986). I report on the nest, nest dispersion, breeding biology and nestling survival of the Brown-backed Honeyeater near Townsville, Queensland, latitude 19°15'S.

Study area and methods

The study was carried out in the Townsville Town Common Environmental Park, chiefly along the Forest Track, but with additional observations on nests along the Waterbird Circuit and the main road. The Forest Track (Fig. 1) is in open *Eucalyptus-Melaleuca* woodland adjacent to a shallow seasonal slough that is a swamp in the rainy season, but was a moist meadow during the study period. Principal woodland trees were paperbarks, primarily *Melaleuca dealbata*, in and along the edge of the slough and a mixed stand of *Eucalyptus* and *Acacias* on the higher ground. Among these the Stocking Gum or Moreton Bay Ash *Eucalyptus tesselaris*, Thick Pod Acacia *Acacia crassicarpus* and *Acacia holosericia* were most abundant. A dense understorey of tall shrubs was dominated by an introduced species, Chinee Apple *Zizyphus mauritania*, and also included White Currant *Securinega melanthesoides* and Sarsaparilla *Alphitonia excelsa*.

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The climate is monsoonal with contrasting rainy and dry seasons. Seventy percent of the rain (78.9 cm) falls from December through March. July, August and September usually have the least rain. The annual mean temperature is 24.1°C. Climatic details are given in Maher (1986). The climate during the study was near average.

The study area was visited daily from 20 August to 25 November except for 1 to 9 and 16 to 20 November. Visits were from 0630 to about 1030 h and often from 1500 to 1800 h. All active nests were visited each morning. I searched for new nests continually and I believe all nests on the Forest Track study area were found. Six nests with nestlings were observed for a total of 75 hours between 13 September and 28 October. Distances between nests were measured by pacing. The base map was from an aerial photograph. Supplementary (or additional) nest records were obtained from the Royal Australasian Ornithologists' Union Nest Record Scheme.

Results

Habitat The Brown-backed Honeyeater has been called the *Melaleuca* bird because of its dependence on the bark of *Melaleuca* spp. for nest material and its frequent use of those trees for nest sites and food. *Melaleuca* swamps and woodlands are its preferred habitat (Barnard 1914; Miller 1932; Gannon 1962 and Keast 1968) but it also occurs in mangroves, riverine vegetation, scrub along creeks in dry woodlands and sometimes in open country (Cayley 1959; Readers Digest 1979; Blakers *et al.* 1984). On the Forest Track study area, the Honeyeaters nested in a narrow band of *Eucalyptus-Melaleuca* woodland along the edge of a seasonal swamp. On average, the nests were 23 m from the slough edge (range 3 to 72 m, *s.d.* ± 19.9). The population was separated into four partly isolated groups by gaps in preferred habitat (Fig. 1). The habitat dividing the groups appeared to be unsuitable because the shrub layer was poorly developed or lacking or there was a gap in the tree canopy.

The population The number of pairs breeding between 10 and 20 September was 12 or 13 and the number between 10 and 20 October was 15 pairs (Fig. 1). A total of 41 nests in all stages of construction were found on the Forest Track study area. This is two to three times the number of nests active in mid-September and mid-October. Circumstances of timing and nest location suggested that, as with other honeyeaters (Dow 1978), some pairs renested when a nest was lost and after successfully fledging young; but without marked birds I could not determine how many did so. In view of these uncertainties, I estimate a minimum population of between 15 and 20 pairs.

Nesting season The Brown-backed Honeyeater arrives at Townsville in August and departs in April or May (Gill 1970; Blakers *et al.* 1984). It was present on the study area on 20 August when observations began.

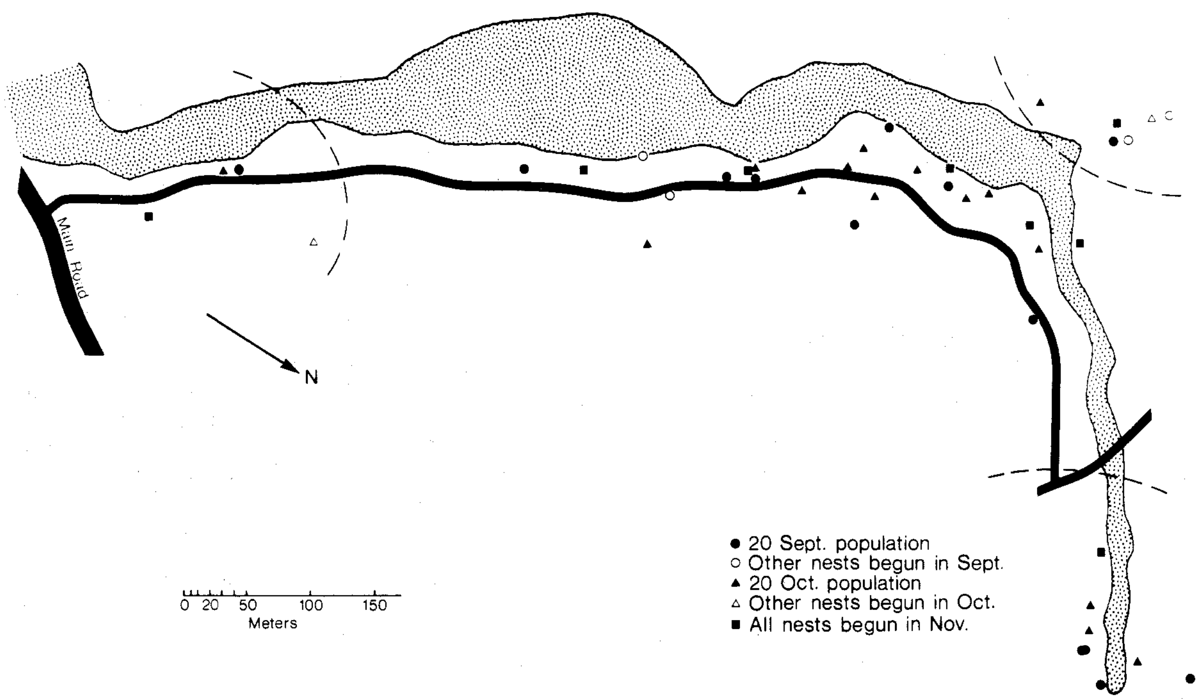

FIGURE 1 The Forest Track study area in the Townsville Town Common Environmental Park. A seasonal swamp is stippled. Dashed lines delineate groups of nests isolated from the central area by habitat.

Nesting began in the last week of August and peaked in the first half of October, when 28% of 40 nests that eventually had eggs in them were initiated. Only five nests were initiated between 1 and 16 November. On 25 November, the last day of observations, four new nests were found, three being built and one just finished.

Records of 18 nests from the RAOU show breeding over seven months from September through March. Nests, eggs and nestlings or fledglings were present from 14 September to 26 March, although most records were from October and November. Peak nesting was in November with almost 50% of the records. Breeding apparently declined during the rains in December and January and virtually ceased in February and March, although Macgillivray (1914), Cayley (1959) and Readers Digest (1979) report some breeding into April.

Egg laying Laying dates of 58 eggs from direct observation, extrapolation from hatching data or, in one instance, extrapolation from estimated age of nestlings, are in Figure 2. Egg laying began on 28 August and was ongoing when the study ended, as one clutch was completed between 23 and 25 November. Peak egg laying occurred in October when 53% of eggs were laid. Five clutches were laid in November although only two were dated (Fig. 2).

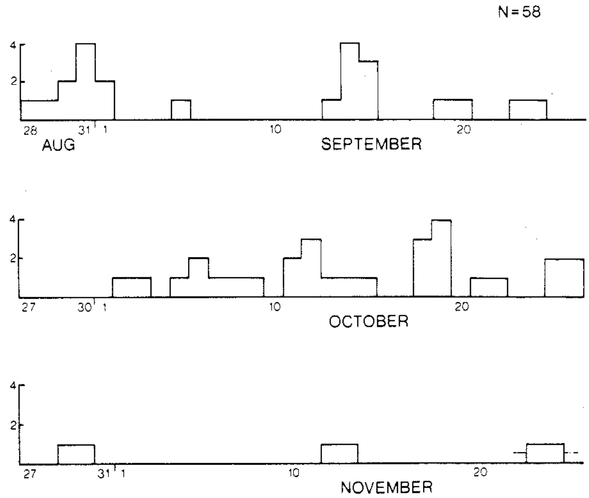

FIGURE 2 Temporal distribution of egg laying.

Population dispersion Brown-backed Honeyeater pairs are apparently territorial although I witnessed little territory defense. The nest site appeared to be the focus of the territory. Occasional strange honeyeaters that visited nests under observation were chased by either or both members of the pair. Claiming a nest site by a new pair involved intense interaction with nearby pairs. In two instances pairs were observed defending the particular branch on which they subsequently built their nest.

The distance between neighbouring nests of the 20 September population averaged 82 m (range 22 to 157 m, *s.d.* ± 41, *n* = 11). Nests were closer together in mid-October where 13 nests averaged 42 m apart (range 18 to 68 m, *s.d.* ± 15, *n* = 16). The distribution of these nests (Fig. 1) suggests that the early (September) breeders spaced themselves widely and that the later breeding honeyeaters inserted themselves among the established pairs. Assuming circular territories, in September Brown-backed Honeyeaters occupied about 5000 m^2 and in October about 1500 m^2.

The central part of the Forest Track study area (Fig. 1) was about 3.3 ha, estimated for an area 20 m or one average territory radius outside of the peripheral nests. In September density was two pairs per hectare and in October density was three pairs per hectare.

Nest The Brown-backed Honeyeater builds a domed or roofed pensile nest of *Melaleuca* bark bound together with spider webbing. The nest is 19.2 cm long on the back or longest side (range 16.5 - 24.0 cm, *n* = 14) and 8.5 cm wide at the widest point (range 7.1 - 9.5 cm, *n* = 14). Internally the nest cup is 6.2 cm deep below the entrance rim (range 5.0 -7.5 cm, *n* = 12). These measurements are similar to those reported by Miller (1932). Both sexes build the nest.

The nests were situated between 1 and 8 m in height near the end of branches of trees or shrubs. The median height of 57 nests was 2.4 m with a mean height of 2.7 m (*s.d.* ± 1.1). Fifteen RAOU nest records had a similar height distribution with a median of 1.8 m (range 0.78 to 8, *s.d.* ± 2.5 m) and an average height of 2.9 m. Miller (1932) reported nests situated from 2 to 16 m above the ground.

In this study 65% of 58 nests were in Chinee Apple shrubs, 14% were in thick pod acacia and only 10% were in *Melaleuca*. White Current, Sarsaparilla and *Terminalia* spp. were also used. Most authors comment on this species' virtually exclusive use of *Melaleuca* trees for nesting. Miller (1932) reported all of 39 nests were in papergums and Barnard (1914) reported the same for nests seen at Cape York. Nests are often suspended over water (Barnard 1911, 1926; Cayley 1959; Readers Digest 1979; Pizzey 1980; Garnett 1983); but none was over water in this study.

Clutch Twelve of 14 nests found during construction survived until the first egg was laid. The final stage in nest construction is the addition of a lining of loose fragments of *Melaleuca* bark 2.5 to 4 cm deep to the bottom of the nest cup. In six nests the first egg was laid one to two days after the addition of the lining, but the mean for all 12 was 3.8 days and the range was from one to nine days.

Thirty-two of 35 clutches had two eggs and three had one, giving an average clutch of 1.9. Two of the three one egg clutches were lost in three days and no adults were ever seen near either nest. These may have been uncompleted clutches or inexperienced pairs. One nest was found with two eggs, one of which hatched 13 days later. The second egg, weighed two days after the first one hatched, was intact and completely desiccated. It weighed 0.3 g compared with 1.75 g for two other eggs at hatch. The egg was old and this observation suggests a one egg clutch and that the nest was being used for a second time. However, there was no feather sheath residue suggesting that young had been raised in the nest previously.

RAOU nest records provided information on eight nests, four with two eggs and four with two young; again suggesting a normal clutch of about two eggs. Most recent authors (Cayley 1959; Readers Digest 1979; Beruldsen 1980) also give the clutch as two or three eggs. They are apparently following Miller (1932) who reported that six of ten nests with eggs had clutches of three eggs and the remainder had two eggs for a mean of 2.6 eggs. The observation of an old egg in an active nest suggests that some of Miller's (1932) three egg clutches were two egg clutches plus an old egg. Three egg clutches may be very infrequent or absent in this species.

Incubation and nestling period I (Maher, 1986) calculated the incubation period as 15 days (n = 5, range = 14-16 days) and the nestling period as 12.7 days (n = 9, range = 12-15 days).

Nest, egg and nestling survival Thirty percent of 23 nests with complete clutches produced at least one fledgling. Eggs hatched in 56% of nests and young fledged from 54% of nests with nestlings.

The daily rate of loss and survival of nests during the several stages of the nesting cycle were calculated using the method of Mayfield (1961, 1975). Rate of loss was calculated for four different periods in the nesting cycle: (1) from discovery of the nest to the laying of the second egg; (2) nest completion, as defined above, to laying of the second egg; (3) the incubation period from laying of the second egg; and (4) the nestling period. Records of 21, 21, 23 and 13 nests respectively were used. The results (Table 1) show the highest daily survival rate during nest building and egg laying (0.96) and the lowest daily survival rate (0.95) during the nestling period. The overall probability of surviving incubation and nestling periods is 27% and the probability of survival for those periods plus egg laying is 22%.

Twenty-one active nests failed during this study. Most commonly, nests were torn open and the contents were gone. Less frequently the contents simply disappeared from the intact nest. These two types of destruction accounted for nine (43%) and six (29%) respectively of the nests lost. Accidents accounted for three (15%) losses. One nest was apparently blown off its support intact, one was destroyed in a heavy rain storm and the bottom of one nest ruptured from the weight of the nestlings. Finally, two nests (10%) were abandoned and one nest simply disappeared.

Partial contents of nests were lost only twice. One egg disappeared from a nest that was destroyed later and one nestling died on the day of hatch from bites of a larval *Passeromiyia stenii* Port (Muscidae).

Predation No act of predation was observed. However, during 75 h of observation at nests, adult Brown-backed Honeyeaters stopped feeding visits when Corvids were in the area. Four instances involved the Pied Currawong *Strepera graculina* and one the Torresian Crow *Corvus orru*. Feeding was halted for an average of 30 min (range 15 to 39) and resumed when the intruders left. The Honeyeaters did not respond similarly to the presence of the Black Kite *Milvus migrans*.

Discussion

Pairs are apparently territorial and appear to establish a territory by claiming a nest site. Neighboring pairs challenge intruding pairs but if the intruders persist they are able to remain. The relatively uniform spacing of pairs (Fig. 1) is probably accomplished in this way.

TABLE 1 Survival of Brown-backed Honeyeater nests during the nesting cycle.

Nesting Stage	Nest days	Nests lost	Loss per day	Survival per day	Survival per period (days)
Building & laying[1]	147	6	0.041	0.959	0.688 (8.9)
Egg laying[2]	88	4	0.045	0.954	0.813 (4.4)
Incubation period[3]	216	10	0.046	0.954	0.493 (15)
Nestling period	122	6	0.049	0.951	0.547 (12)

[1] Discovery to laying of second egg. [2] From nest completion to laying of second egg. [3] From laying of second egg.

Miller (1932) commented on the habit of the Brown-backed Honeyeaters of aggregating into groups when breeding. He reported clusters of 21, 10 and 8 nests, each group confined to an area of about 0.7 ha within more extensive tracts of similar habitat.

The clustering of the Brown-backed Honeyeater nests at Townsville was evidently related to patchy habitat. A few isolated nests were found on the Forest Track study area and on other parts of the Town Common. The aggregation of pairs on the Forest Track study area was clearly related to the seasonal swamp and its associated papergums. Whether or not the Honeyeater is truly colonial requires further information from areas of more extensive *Melaleuca* swamps.

The nest success of tropical birds is low compared with the success of birds in temperate and arctic regions (Ricklefs, 1969). The 22% probability of success calculated from the data in this study is higher than that of a communal Meliphagid, the Noisy Miner, with a success of 16.7% (Dow 1978) but lower than two other communally breeding Australian species, the Yellow-tailed Thornbill, 63%, (Ford 1963) and the Grey-crowned Babbler, 32% (Councilman, *in* Dow 1978). The nest success of the Brown-backed Honeyeater is consistent with data from Central America where success in open or roofed nests (30 species) in forests was 23.1% (Skutch 1966).

Predation is generally the greatest cause of mortality of birds, eggs and young (Ricklefs 1969) and accounted for 72% of losses in this study. Predation was not witnessed but the reaction of the resting adults to the presence of Corvids suggests that they are important nest predators. Rowley & Vestjens (1973) report egg shells in 7.4% of stomachs of *Corvus orru* and that Australian Cracticids and Corvids are adept at finding nests and spend much time searching for them. Most of the 66% of nests lost that were torn open were probably lost to Cracticids and Corvids. Snakes remove nest contents without disturbing the nest and are the most important cause of nest loss in Central America (Skutch 1966, 1985). I saw several snakes in trees and shrubs while watching nests and I suggest that they were probably a major cause of the disappearance of eggs and young.

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