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BREEDING BIOLOGY OF HOODED ROBINS *Melanodryas cucullata* IN NEW ENGLAND, NEW SOUTH WALES

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Hooded Robins were studied near Armidale in the 1991 and 1992 breeding seasons, when 26 nests were found. Nests were built from late August to late December and took from 4 to 10 days to build. They were placed in eucalypts from 0.2 metres to 9 metres above the ground. All clutches were of two eggs and were incubated for 15.2 days (6 nests), almost entirely by the female, who spent 65 per cent of her time on the nest. Males occasionally sat briefly on the nest when eggs were present, and fed the female before she laid the eggs and while she incubated. Both parents, and sometimes helpers, fed each nestling on average 5 times per hour. After fledging at about 12 to 13 days of age, the young were unable to fly, but hid in dense cover. Parents performed distraction displays if predators came near their young. Overall, only 22 per cent of nests were successful, with most failures probably being due to predation. Hooded Robins often re-nested after failure, but not after rearing young. Well-studied pairs made 2.75 nesting attempts during the 1991 season, and produced on average 0.7 fledglings. This level of annual productivity, if it is typical, seems inadequate to replace annual mortality. Therefore, high nest failure, which is mostly due to predation, could contribute to the ongoing decline of Hooded Robins in the region.

INTRODUCTION

The Australian robins (Petroicidae) are small ground and aerial feeding insectivores of woodlands and forests (Boles 1988). Several species, including the Hooded Robin *Melanodryas cucullata*, have experienced substantial declines in the agricultural regions of southern Australia (Saunders 1989; Robinson and Traill 1996; Reid 1999; Garnett and Crowley 2001). The causes of these declines are poorly understood, though they are presumably related to the loss, fragmentation and degradation of woodlands and other habitats (Ford *et al.* 2001). Studies of the biology of robins may help to understand what factors limit their populations and what management actions may allow local populations to be sustained or to recover.

There have been detailed studies of the breeding biology of several Australian robins, namely: Eastern Yellow Robin, *Eopsaltria australis* (Marchant 1984, 1985; Zanette and Jenkins 2000), White-breasted Robin, *E. georgiana* (Brown and Brown 1980), Red-capped Robin, *Petroica goodenovii* (Coventry 1988), Scarlet Robin, *P. multicolor* and Flame Robin, *P. phoenicea* (Coventry 1989; Robinson 1990) and Grey-headed Robin *Heteromyias albispecularis* (Frith and Frith 2000). The New Zealand Robin (*Petroica australis*) has also been studied in detail (Powlesland 1983; Armstrong *et al.* 2000; Powlesland *et al.* 2000). However, only a few short notes on the Hooded Robin's breeding biology have been published (Leach 1929; Chisholm 1960; Rogan 1964; Courtney and Marchant 1971; Bell 1984; Sullivan 1993). Rogan found two female Hooded Robins apparently laying in the same nest, suggesting polygamy. On the other hand, Bell proposed co-operative breeding in this species, after he found a pair, whose male offspring helped in nesting duties. In this paper, we describe the breeding biology of the Hooded Robin from a study near Armidale, on the Northern Tablelands, New South Wales.

METHODS

The study was carried out in three main study sites (Gara, Strathaven, Torryburn) and seven other sites east and west of Armidale (described in Fitri and Ford 1997). All consisted of patches or strips of eucalypt woodland with a sparse and patchy understorey. Study sites other than the main study sites are treated as one group and referred to as 'other' sites.

General

During the 1991 breeding season, we attempted to locate all nests begun by Hooded Robins on the three main study sites. Other sites were visited less often. During the 1992 breeding season, nests were found opportunistically on some study sites only. One breeding attempt was detected when a pair of Hooded Robins was seen inspecting a fork in which a nest was later built. Most nests were discovered while being built by following females as they collected nest material, or by following males that sang loudly and fed the female. Some nests were found after incubation had begun or after hatching. For some pairs the nest was not found but fledglings were seen with the adults. If nests were well hidden, they were marked with surveyors' tape within 10 metres; others that were located in more open areas were relocated by using natural landmarks. Where possible, nests were monitored every 1 to 3 days. Nests were watched for periods of 0.5 to 2 hours, from 20 to 30 metres distance. The time when nests were started was recorded to half a month or calculated by back-dating from egg-laying, hatching or fledging of young.

The nest and nest site characteristics

For some nests, the inside and outside diameter, outside height and inside depth were measured to the nearest millimetre. The height of the nest above the ground, the height of the nest tree or plant, the nest tree species, position in the supporting plant and concealment were also noted. The degree of concealment of each nest was estimated when viewing the nest from any direction at a distance of 1–2 metres. Concealment was graded from 1 to 3: grade 1 nests had cover between 0 and 25 per cent, grade 2 nests had cover between 25 and 50 per cent, and grade 3 nests 50 to 100 per cent cover.

Nest building behaviour of the female and mate guarding and courtship feeding by the male were also recorded. The hourly rate at which the male fed the female was recorded while females incubated.

Parental care

We recorded all aspects of parental care, such as incubation of eggs, nestling care, feeding of nestlings and feeding of fledglings. The incubation period was calculated from the time of laying the last egg to the hatching of the last egg. An incubation spell (minutes) was recorded as the time from when the focal bird sat on the eggs until it left. After hatching, feeding rate of nestlings was expressed as the number of feeds per hour per nestling. A few nestlings were colour-banded. After the young fledged, they could be followed for several days. However, their co-ordination developed quickly and they soon became difficult to find; therefore data on feeding rates of fledglings were collected opportunistically. Feeding rate was expressed as the number of feeding visits by an adult per hour per fledgling.

Breeding success

Nesting success was the percentage of nests from which at least one offspring fledged. Calculations did not include nests that were abandoned during construction but included all nests in which eggs were laid. We also calculated nesting success according to the daily probability of survival of nests that were found at any stage of the nesting cycle (Mayfield 1975). This was done by dividing the total number of nests that failed by the total number of days that all nests were monitored. Next, this was converted into a daily chance of survival (1 — chance of failure) and raised to the power 15 for the chance of survival through incubation, and to the power of 14 for chance of survival of nestlings to fledging.

Nest failure was assigned to one of three categories: predation (when eggs or nestlings disappeared), desertion (when eggs were left in the nest), and weather (when nests with eggs were destroyed by intense heavy rain or thunderstorms).

Statistical analysis

Unless otherwise stated, values included in the text represent mean values ± standard errors (s.e.). One-way ANOVA for unbalanced data was used to test variances in courtship feeding, incubation spells and feeding rates of nestlings and fledglings. Prior to analysis, data were log-transformed to increase homogeneity of variances. Where applicable, non-parametric tests were also used (Sokal and Rohlf 1981). Five per cent levels of significance were used for all statistical tests.

RESULTS

Breeding season

The breeding territories were defended by male Hooded Robins (see Fitri and Ford 1997) by either chasing intruders or singing loudly. Twenty-six nests and five fledglings from three broods were found during the 1991 and 1992 breeding seasons. The breeding season (from first nest building to last fledglings) of Hooded Robins encompassed four months of the year, from late August to late December or early January. However, 73 per cent of Hooded Robin nests (n = 19) were started between the beginning of September and mid-November (Fig. 1). Nesting commenced in late August at Gara (n = 7 nests) and Torryburn (n = 7) and the second week of September at Strathaven (n = 5). Repeat breeding attempts occurred after nest failure. Hooded Robins at the main sites made at least 2.8 ± 0.9 nesting attempts (range 1–5, n = 4 pairs), with some nests being missed at Gara and Torryburn.

Nest building

Only females built the nest, although males inspected the nest site prior to nest-building. Females chose the nest site by sitting in several forks, either in the same or in different trees. They inspected the site several times once they had chosen it and then started to collect nest material.

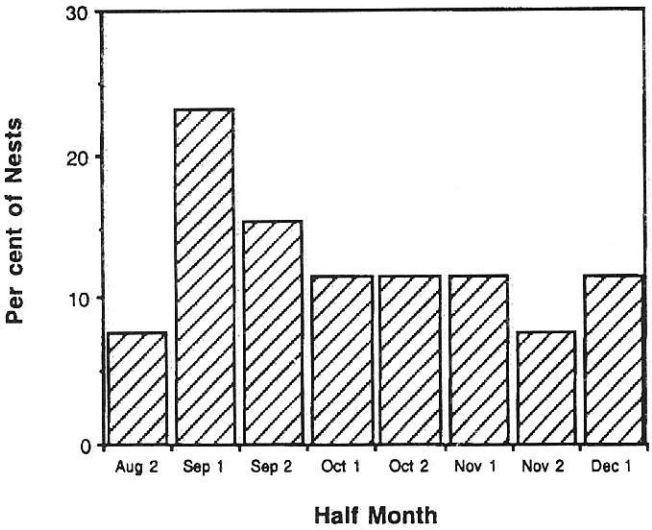

Figure 1. *The percentage of Hooded Robin nests started each half month in 1991 and 1992 (n = 26).*

Eighty-three building trips were counted at 5 nests, with an average of 20 ± 3.36 trips per hour. Robins took from four to ten days to construct the nests. The mean time between the commencement of building and laying of the first egg was 7.9 ± 1.1 days (range 4–10 days, n = 7 nests). There was no indication that a nest was used for more than one breeding attempt.

Males fed the females from the period when they started selecting a site to a few days prior to the eggs hatching. Pooling data from all study sites, males fed females at an average rate of 4.8 ± 0.7 feeds per hour (n = 7 pairs, total observation = 22 hours), and there was no significant difference in feeding rate between study sites (*ANOVA*, $F_{3,38} = 0.41$, $P > 0.10$).

Nests were open cups and were built from strips of bark (mostly stringybark), grasses, sometimes lichens and cobwebs. The inside of nests was neatly lined with narrow grass stems, fern fibres and sometimes feathers. Four characteristics were measured on five nests: inside diameter — 55.2 ± 0.6 millimetres (range 54–57 mm); outside diameter — 83.4 ± 0.9 millimetres (range 80–85 mm); outside height — 41.4 ± 1.2 millimetres (range 38–45 mm); and inside depth — 30.2 ± 1.5 millimetres (range 27–35 mm).

Nest sites

There was no significant difference in the distribution of nest heights between study sites (Kolmogorov-Smirnov one-sample test, $D = 0.116$, n = 26, $P > 0.05$). Nests were built between 0.2 and 9 metres above the ground (Fig. 2), with a mean of 3.2 ± 0.55 metres (n = 26). Sixteen nests (61.5%) were built at heights of 3 metres or less, with one nest almost on the ground in regrowth *Eucalyptus melliodora* at Strathaven.

The nest trees had a mean height of 8.4 ± 2.4 metres, and ranged from 1–20 metres (n = 26). Most nests were built in eucalypts, with ten in New England Stringybark *Eucalyptus caliginosa*, eight in Blakely's Red Gum *E. blakelyi* and two in Yellow Box *E. melliodora*. Four nests were in Native Apple *Angophora floribunda*.

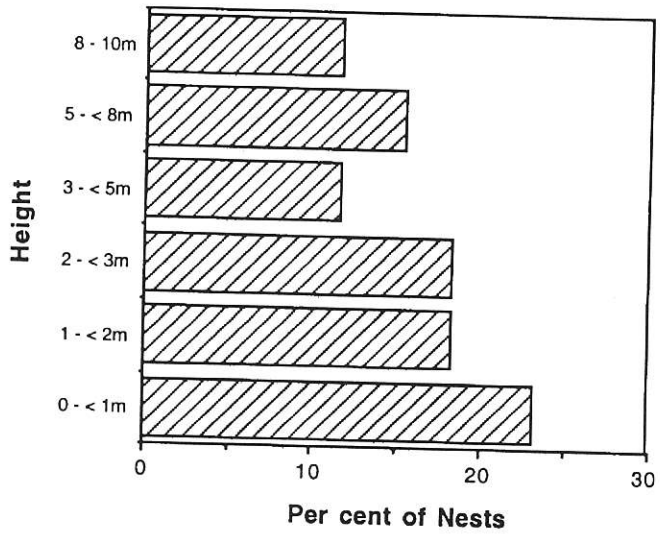

Figure 2. *The percentage of Hooded Robin nests at each height above the ground.*

Hooded Robin nests were most commonly built in horizontal (10 nests) or vertical forks (9), with two each in side branches, sloping branches and in hollows of stumps and one in dense regrowth. Nests on horizontal branches were often built between two forking branches and sometimes overhanging clumps of foliage covered these nests. Nine nests were conspicuous with <25 per cent cover, ten had 25–50 per cent cover and seven were well concealed (>50% cover).

Eggs

All of the Hooded Robin clutches found contained two eggs. For the first few days after laying, eggs were light olive-green but they gradually darkened to light brown over the larger end. Eggs were tapered oval and sometimes had white spots.

Eggs were laid at intervals of about 24 hours, and were incubated almost solely by the female, which incubated eggs for 65 per cent of the time in spells averaging 21.5 ± 3.12 minutes (n = 16 nests, total observation = 66 hours — Table 1). When females were off the nest, males at three nests were seen to cover the eggs occasionally for periods up to 90 seconds. The average incubation period was 15.2 ± 0.3 days (range 14–16 days, n = 6 nests).

Nestling care

After hatching, nestlings were black, naked and blind. Feathers appeared at 3–4 days of age and within a week nestlings were covered with contour feathers. When nestlings were about 12 days old, they were able to fledge.

Only two determinations of the nestling period were obtained. On 25 October, both eggs of a clutch at Church Gully had hatched and 13 days later (7 November) the second nestling had fledged. On 16 October 1991, two nestlings (one or two days old) were found in Gwydir Park. On 27 October, both young birds had fledged, giving a 12–13 day nestling period.

Nestlings were fed by both parents and in four cases by helpers. Only one nestling was fed on each feeding visit and only one item of food was brought each time. By combining data for all brood sizes and ages, including parents with and without helpers, the average feeding rate for each nestling was 5 ± 0.6 feeds per hour (n = 12 nestlings, total observation = 22 hours — Table 1). The difference in nestling feeding rates between study sites was not significant (*ANOVA*, $F_{3,14} = 0.91$, $P > 0.10$). There was no significant difference (*ANOVA*, $F_{1,14} = 0.11$, $P > 0.10$) in nestling feeding rates between pairs with helpers (mean of 5.1 ± 0.78 feeds/hour, n = 3 pairs) and pairs without helpers (mean of 4.7 ± 0.9 feeds/hour, n = 3 pairs).

Only large food items brought to nestlings could be identified and these included: cicadas (Hemiptera), spiders (Araneae), butterflies and moths (Lepidoptera), grasshoppers (Odonata) and worms (Annelida). Both males and females removed faecal sacs. Nestlings defaecated after being fed, and adults removed and dropped the faecal sac 10–20 metres away from the nest.

Fledgling care

For the first few days, fledglings were incapable of flying and perched on a branch or sat quietly among cover on the ground. They made their way by hopping or fluttering from branch to branch. If an observer or intruder came close to the young, the adults led the young high into the canopy or protected the young by feigning injury. Displaying birds crouched, then ran and tumbled along the ground until they perched on the side of a tree trunk, flapping their wings. Chisholm (1960) called the crouching and tumbling on the ground a 'rodent-run' display and the flapping of the wings an 'injury feigning' display. The

TABLE 1

Aspects of nesting cycle of Hooded Robins, with mean, standard error, range and number of hours of observation.

Site	Incubation Bout (minutes)	Nestling Feeding Rate (feeds per hour)	Fledgling Feeding Rate (feeds per hour)
Gara	19.8±3.8	5.6±0.8	
	2–63, 19	3.5–8.1, 7	
Strathaven	21.2±4.1	4.0±0.5	
	2–79, 20	3.1–4.7, 4	
Torryburn	26.5±4.9	6.8±2.6	3.4±0.5
	0–94, 24	4.2–9.5, 2	2.9–3.9, 1.5
Other	20.6±2.3	4.3±1.2	6.1±0.8
	5–44, 58	0.9–8.0, 9	3.2–10.7, 8

adults uttered agitated piping or chattering calls during these displays.

Recently fledged young had mottled dark greyish plumage and well-developed wings and feet, although their tails were not fully grown. Within three to four weeks of leaving the nest the plumage had become dark brown on the upperparts, with a dark brown, spotted upper breast, white bars on the wings and the tail was fully developed and black with a white tip underneath.

The time taken for fledglings to reach independence was not determined precisely. Six fledglings in three broods were observed when three to four weeks old. During this period, the fledglings obtained most of their food from their parents, although they had begun to catch prey. Observations on colour-banded nestlings indicated that each adult cared for a specific fledgling.

Overall (combining data for all fledgling ages), the average feeding rate of each fledgling by an adult (parents or helpers) was 5.6 ± 0.8 feeds per hour (n = 8 fledglings, total observation = 9.5 hours — Table 1). The feeding rates of fledglings were not significantly different between study sites (*ANOVA*, $F_{3,9} = 0.34$, $P > 0.10$). There was no significant difference (*ANOVA*, $F_{1,9} = 1.02$, $P > 0.05$) between feeding rates by pairs without (mean of 5 ± 1.3 feeds/hour, n = 5) and with helpers (mean of 6.7 ± 0.9 feeds/hour, n = 3).

The uninterrupted nesting cycle from nest-building to the young bird leaving the nesting area (e.g. a breeding pair at Church Gully in 1991) was about 70 days. If the cycle was interrupted by the loss of eggs or nestlings, the parents soon built a replacement nest. However, no repeat nestings occurred after fledging of young.

Breeding success

Three of 26 nests (12%) were abandoned while still under construction, 18 nests (69%) failed for other reasons, and 5 nests (19%) were successful. Twenty-two per cent of nests that received eggs were successful (Table 2). The productivity of Hooded Robin pairs was low, with an average of 0.75 ± 0.3 fledglings per pair per season (including those when the nest had not been found). Although some nests may have been missed, it is unlikely that fledglings were overlooked. The method of Mayfield (1975) gave the probability of success in rearing a brood as 28.7 per cent, based on a 15 day incubation period and 14 day nestling period.

Nine young fledged from 46 eggs, giving 20 per cent egg success (Table 2), which was similar to nest success. Thirty-seven per cent of eggs hatched and 53 per cent of nestlings fledged. Six pairs (40%) were helped by seven individual attendants, whereas nine pairs were unattended. Of these, four assisted pairs (66.6%) and four unassisted pairs (44.4%) nested successfully, a difference that is not significant ($\chi^2 = 0.71$, df = 1, $P > 0.10$). (Note that these data include pairs whose nests were not found.)

Eleven nests (42%) were preyed upon during incubation (including one which was deserted after one egg disappeared) and four nests (15%) were preyed upon during the nestling period. Although the identity of nest predators could not be determined, predation was inferred when the eggs or nestlings disappeared. Three nests (12%) were destroyed after becoming detached from the nest plant by strong winds or heavy rain. No cases of brood parasitism were seen, although Horsfield's Bronze-Cuckoos *Chrysococcyx basilis* and Pallid Cuckoos *Cuculus pallidus* occurred in the study sites.

DISCUSSION

The information presented in this paper is mostly from a single breeding season (1991), although some data were included from the next (1992) breeding season. Also, the sample size of most variables was small, so extrapolation of the findings to the species as a whole should be made with caution.

The breeding season of the Hooded Robin was quite long (4–5 months), and this is typical of other Australian robins, e.g. Eastern Yellow Robin (Marchant 1985), Scarlet and Flame Robins (Robinson 1990) and Grey-headed Robin (Frith and Frith 2000). The breeding season would be expected to occur during months when food is most abundant, as extra food is required when females are producing eggs and adults are raising young (Lack 1954). In eucalypt woodlands and forests in south-eastern Australia, insects tend to be most abundant during spring and early summer (September-December, Pyke 1983; Woinarski and Cullen 1984; Bell and Ford 1986; Recher *et al.* 1996), although seasonal variation of ground invertebrates is probably not great (Recher *et al.* 1983; Bell 1985; Ford *et al.* 1990).

In this study, Hooded Robins laid two-egg clutches, although Courtney and Marchant (1971) noted that they sometimes lay three eggs. This is slightly less than the mean clutch size of the similarly-sized Eastern Yellow Robin (mean = 2.4 eggs — Marchant 1985), and the larger New Zealand Robin (mean = 2.3-2.7 — Powlesland 1983; Powlesland *et al.* 2000) but more than the Grey-headed Robin (mean = 1.6 eggs — Frith and Frith 2000). Breeding pairs with helpers in Yellow Robins had a mean clutch size of 2.5 eggs, while pairs without helpers averaged 2.3 eggs.

TABLE 2

Breeding success and annual productivity of Hooded Robins at all study sites in 1991 and 1992.

Nest Success		Egg Success	
Number of pairs	12	Number of eggs	46
Number of nests with eggs	23	Number of nestlings	17
Number of nests with nestlings	9	Number of fledglings	9
Number of successful nests	5	% of successful eggs	19.6%
% of nests successful	22%		
Number of fledglings per pair per season	0.75 ± 0.26		

There was no indication that Hooded Robin pairs with helpers had larger clutches than unassisted pairs. Other Australian robins have clutches of two or three eggs (Beruldsen 1980), which is lower than the average clutch size of muscicapid robins and flycatchers in the temperate Northern Hemisphere (mean = 4.8; Woinarski 1985).

Hooded Robins made a mean of 2.8 nesting attempts, and up to five attempts, in a season. None of the five successful pairs of Hooded Robins re-nested; nest replacement occurred only after the loss of eggs or nestlings. However, the low breeding success provided few opportunities for double broods. Graham (1990), though, reported that a pair of Hooded Robins near Canberra had a second brood after the first fledgling disappeared. Scarlet Robins were not recorded as multi-brooded (Robinson 1990), though Coventry (1988) reported a pair renesting after a successful attempt. In contrast, Flame Robins are regularly multi-brooded (Robinson 1990). In study sites close to ours, Eastern Yellow Robins made 3.9 attempts per season and sometimes renested after rearing young (Zanette and Jenkins 2000). New Zealand Robins also make several attempts in a season and exceptionally, when predators are controlled, may rear three or four broods in a season (Etheridge and Powlesland 2001).

The incubation period of Hooded Robins found in this study (15 days) is similar to the 15.2 and 18 days estimated by Courtney and Marchant (1971) from two nests. The nestling period of 12–13 days agrees with Courtney and Marchant's (1971) values of 12.2, 12.5 and 14 days.

Hooded Robins showed facultative cooperative breeding, which has also been recorded in other Australian robins (Russell 1989), e.g. Eastern Yellow Robin (Courtney and Marchant 1971; Marchant 1984), White-breasted Robin (Brown and Brown 1980), but the *Petroica* robins do not breed co-operatively. Ford *et al.* (1988) listed four aspects of ecology that were frequent in Australian cooperatively breeding birds. Hooded Robins showed three of these traits, occupying eucalypt woodland and feeding on the ground and eating invertebrates. However, they employed a 'sit and wait' foraging strategy — pouncing, which is more typical of non-cooperative breeders.

Hooded Robins with helpers showed no better reproductive success than pairs without helpers, though the sample sizes were small. This could be because nest failure was mostly due to predation, which helpers cannot influence. Helpers could increase the survival of breeders, or may enhance their own fitness by delaying dispersal until vacancies are available in high quality territories. In Eastern Yellow Robins, pairs with helpers were more likely to have successful nests than unassisted pairs (Marchant 1985).

In this study, Hooded Robins appeared to be socially monogamous, in contrast to the finding of Rogan (1964) who, in a limited study, found that two females were incubating four eggs in the same nest. Although he proposed polygamy, it is unclear whether a single male was mated with both females. Armstrong *et al.* (2000) found that New Zealand Robins were socially and sexually monogamous, although a few females switched mates within a season.

Parental roles of Hooded Robins were similar to those of other robin species. The females built the nest alone, while the males fed the female before and during incubation. Males almost never incubated but did share in feeding the young. Courtship feeding of Hooded Robins was seen only during the breeding season and may be important to increase the female's reserves for eggs and minimize time off the nest during incubation. Female Hooded Robins spent less time incubating (65%) than did Eastern Yellow Robins (81% — Marchant 1985), even though they were fed 4.8 times per hour by males compared with 1.5 times in Eastern Yellow Robins. This suggests that they might experience less available food than robins in coastal forest.

The average feeding rate of 5 times per nestling per hour for Hooded Robins was slightly higher than for the Eastern Yellow Robin (mean of 3.5 times/nestling/hour — Marchant 1985; 3.75 times/nestling/hour — Zanette *et al.* 2000), but lower than for the Grey-headed Robin (9.7 times/nestling/hour — Frith and Frith 2000), Scarlet (9.3 times/nestling/hour) and Flame Robin (12.1 times/nestling/hour — Robinson 1989). Both sexes feed insects to the young and remove faecal sacs, as found in the Eastern Yellow Robin (Marchant 1985) and Scarlet Robin (Coventry 1989; Robinson 1992).

After fledging, the brood was divided between the parents in Hooded Robins. Similar brood division occurs in New Zealand Robins (Armstrong *et al.* 2000), and also in Rufous Whistlers (*Pachycephala rufiventris* — Bridges 1992) and Leaden Flycatchers (*Myiagra rubecula* — Trémont and Ford 2000).

Only 22 per cent of Hooded Robin nests with eggs were successful, which is very similar to the 19 per cent success rate for Eastern Yellow Robins in the same area (Zanette and Jenkins 2000). Low breeding success is shown by other Australian robins in eucalypt woodland and forest; Scarlet Robin (10%) and Flame Robin (25%) from two breeding seasons (Robinson 1990) and by other open-nesting passerines in New England (e.g. Rufous Whistlers — 13%, Bridges 1994; Leaden Flycatchers — 18%, Trémont and Ford 2000). Success is higher in the Eastern Yellow Robin in coastal forest (32% — Marchant 1985), and Grey-headed Robins in tropical rainforest (53% — Frith and Frith 2000).

Predation was the major cause of nesting failure in Hooded Robins. Nests were low (mean 3.2 m), not well concealed and could be easily reached by mammalian and avian nest predators. Hooded Robins show a number of possible adaptations to high nest predation. They lay multiple small clutches rather than a single large clutch per season (Slagsvold 1982). Adults may reduce their visitation rate to nestlings and fledglings by providing large food items, which may be advantageous if young are noisy during feeding. Hooded Robins use distraction displays, such as injury feigning, to attract potential predators away from the nest or young. Finally, recently fledged Hooded Robins have cryptic juvenile plumage that may help to camouflage them.

The importance of nest predators in limiting nest success has been shown clearly in New Zealand Robins. One site

on South Island and two on North Island, without predator control, had nest successes of 30 per cent, 11 per cent and 30 per cent (Powlesland 1983; Powlesland *et al.* 2000). Success in the two North Island sites was increased to 67 per cent and 72 per cent when mammalian predators were poisoned. A further study on South Island achieved a nest success of 89 per cent when predators were controlled (Etheridge and Powlesland 2001). An island population showed 51 per cent nest success in the absence of mammalian predators, but Common Mynahs *Acridotheres tristis*, Boobooks *Ninox novaeseelandiae* and Swamp Harriers *Circus approximans* were suspected of being nest predators (Armstrong *et al.* 2000).

The Hooded Robins' productivity of 0.75 fledglings per group per season was lower than that of Eastern Yellow Robins in the same area (1.76 fledglings/group/season — Zanette 2000), mainly because Yellow Robins made more attempts per season than Hooded Robins. Two of Zanette's sites produced fewer than 1.5 fledglings per group per year, which appeared to be inadequate to sustain these populations without immigration. Indeed, she found that these populations declined over two years. We have no data on survival rates of adult Hooded Robins, but other Australian robins show survival rates of 72–75 per cent per year (Marchant 1985; Brown *et al.* 1990; Robinson 1990; Zanette 2000). Mainland populations of New Zealand Robins produced 0.4–3 fledglings per pair per year, without predator control (Powlesland 1983; Powlesland *et al.* 2000). This increased to 3.7–5.9 fledglings per pair per year when mammalian predators were controlled (Powlesland *et al.* 2000; Etheridge and Powlesland 2001). A re-established island population of New Zealand Robins was able to increase when producing 2.5 fledglings per pair per year, and Armstrong *et al.* (2000) suggested that at least 0.8 fledglings per pair per year were necessary to sustain the population.

Hooded Robins have been identified as a declining species in the extensively cleared and modified agricultural regions across southern Australia (Saunders 1989; Robinson and Traill 1996; Reid 1999). Our brief study has shown that they have small clutches, repeated nesting attempts after failure, low breeding success and low annual productivity. These life history traits are typical of other open-nesting passerines in eucalypt woodland and forest (whether natural or modified). We suggest that Hooded Robin populations are barely able to sustain themselves in New England, unless they experience years when breeding productivity is higher than in the two years that we studied them or show higher annual survival than other robins. There is evidence that isolated pairs or groups have disappeared from some locations (Fitri and Ford 1997). Thinning of trees, suppression of regrowth and shrubs and dieback through insect defoliation may all have reduced the availability of concealed nest sites. Also, the Pied Currawong *Strepera graculina*, an important nest predator, has increased in abundance (Major *et al.* 1996). Furthermore, there is evidence that predation on open nests may be higher in narrow strips of vegetation (Major *et al.* 1999), though Taylor and Ford (1998) found limited support for this in New England.

Clearly, a longer term study on the Hooded Robin is desirable, to gain a better idea of annual changes in breeding productivity and to obtain values of adult and juvenile annual survival. Even if breeding productivity has not declined in rural landscapes relative to extensive woodland, it seems desirable to increase it for declining bird species, in order to replace adult mortality, which may have increased, and also to produce potential dispersers to rescue small sub-populations from extinction or to colonize new sites. It seems appropriate now to test the hypothesis that poor breeding success due to nest predation has contributed to the decline of Hooded Robins and other open-nesting woodland birds. This could be done by experiments that control the numbers of certain nest predators. Recent work on New Zealand Robins provides a valuable model for such experiments.

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