

FORAGING BEHAVIOUR OF HOODED ROBINS *Melanodryas cucullata* IN THE NORTHERN TABLELANDS OF NEW SOUTH WALES

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Received: 12 July 2002

Hooded Robins foraged mainly by pouncing or gleaning on the ground for invertebrates, with an increase in gleaning in winter. Less frequently they hawked for flying insects and gleaned or snatched prey from bark, both of which were more common in summer and autumn. Although branches were the most frequent perches from which foraging was initiated, Robins also foraged from trunks, stumps and logs and an array of artificial structures. Perches were typically close to the ground, though hawking, gleaning and snatching were usually carried out 3–8 metres above the ground. Foraging rates were more rapid in winter, partly due to the increase in ground-feeding, which employs more rapid foraging techniques, but also because the absolute foraging rates while ground gleaning and pouncing increased. The sexes did not differ in their foraging behaviour and there were only minor differences among study sites. Comparisons with other studies revealed that Hooded Robins forage in a similar way to the Eastern Yellow Robin *Eopsaltria australis*, though the latter occupies open forest rather than woodland. The smaller Scarlet *Petroica multicolor*, Flame *P. phoenicea* and Red-capped *P. goodenovii* Robins also forage in a similar way to Hooded Robins, especially in winter, when they forage more on the ground.

INTRODUCTION

Ground-foraging insectivores have been identified as a group of birds that have declined in southern Australia (Recher and Lim 1990; Robinson 1991; Lunney *et al.* 1997), for reasons that are not entirely clear. One hypothesis for their decline is that habitat loss, fragmentation and degradation have reduced the availability of their food. Zanette *et al.* (2000) provided some support for this hypothesis. They found a lower biomass of ground invertebrates in smaller than in larger remnants of eucalypt woodland. They also found that in small remnants incubating female Eastern Yellow Robins *Eopsaltria australis* were fed less frequently by their mates, and nestlings received less food. It is important, therefore, to collect detailed data on the feeding behaviour of declining woodland birds.

Hooded Robins, although widespread in Australia, are experiencing local disappearances and regional declines, to the extent that there is now concern about their conservation in southern Australia (Robinson and Traill 1996; Fitri and Ford 1997; Reid 1999; Garnett and Crowley 2001). The species has been described as a ground feeder by Brooker *et al.* (1990) and Gilmore (1985), and Graham (1990) suggested that it fed 70 per cent on the ground and 30 per cent in the air. The only quantitative foraging data on the species have been collected for short periods in mulga near Alice Springs (Recher and Davis 1997), and in acacia and wandoo woodland in Western Australia (Recher and Davis 1998; Recher *et al.*, in review). These confirmed that Hooded Robins mostly pounce on the ground, but display a small amount of hawking and snatching or gleaning from foliage and bark.

In this paper we present data on the foraging behaviour of the Hooded Robin, from an area in which it is declining

(Fitri and Ford 1997). A number of specific questions were asked:

- (i) Do the sexes differ in their foraging behaviour?
- (ii) Are there differences in foraging behaviour among sites?
- (iii) Are there seasonal changes in foraging behaviour?

METHODS

Study sites

Foraging behaviour of Hooded Robins was studied in three areas of eucalypt woodland near Armidale from April 1991 to April 1992. Gara and Strathaven are 15 kilometres and 10 kilometres east of Armidale, New South Wales and Torryburn is 45 kilometres west of Armidale. They are described in detail in Fitri and Ford (1997). The former two sites represent small, apparently isolated populations, whereas Hooded Robins are generally more widespread and common around Torryburn. Densities of Hooded Robins averaged about 0.06 birds per hectare. All sites contain a mixture of grassy woodland (13 to 83 large trees/ha) and open areas with only scattered trees. Open forest occurs at Strathaven (>100 trees/ha), but is generally not used by Hooded Robins. The woodland contained patches of regrowth eucalypts and shrubs (40–890 shrubs/ha), as did some of the treeless areas. Shrubs were less dense at Torryburn than at the other two sites.

Recording foraging behaviour

Foraging data were collected on 8–11 birds at Gara, 4 birds at Strathaven and 9–10 birds at Torryburn in each season. Most individuals were not colour-banded, but could be tentatively identified from their home ranges. Only one bout was recorded for each individual on any day, but several were collected in a season. The sex of each individual was determined by plumage. Sub-adult males were distinguished from females because they have darker grey upperparts and mottled underparts. Older males progressively develop a clear dark grey bib on the upper breast. L. Fitri (LLF) followed individual Hooded Robins for as long as possible and timed and dictated their activities into a cassette recorder. For each foraging move she recorded the foraging method, the substrate on which foraging occurred, and the type and height of perch from which foraging was initiated.

Foraging methods were:

- (i) Pouncing — dropping or flying to the ground to capture a food item.
- (ii) Gleaning — hopping on a substrate and taking prey from it.
- (iii) Hawking — flying from a perch to capture a flying insect.
- (iv) Hovering — remaining stationary in flight while taking an insect from a substrate.
- (v) Snatching — flying from a perch to grab prey from a substrate on the way past.

Substrates for prey capture and perching were:

- (i) Ground, including small dead branches, stones and animal dung.
- (ii) Stumps.
- (iii) Logs, larger dead branches on ground.
- (iv) Trunks of live or dead standing trees.
- (v) Branches, twigs or foliage of standing trees.
- (vi) Artificial objects — fence posts, sign posts, fence wire, electrical wires.

The height of the perch from which foraging was initiated was placed in the following categories: 0-<1 metre, 1-<2 metres, 2-<3 metres, 3-<5 metres, 5-<8 metres, 8-<10 metres, >10 metres. Foraging rates were calculated for each bout as the number of foraging acts per hour.

Statistical analysis

The percentages of each foraging method and substrate, perch substrate and height and foraging rates were calculated for each bout recorded for each individual. These were then arcsine square root-transformed, whereas foraging rates were log-transformed, as they were not normally distributed. The frequencies of different foraging methods, perch sites, perch heights and foraging rates were compared between sexes, sites and seasons using a Multivariate Analysis of Variance

(Cooley and Lohnes 1971). Where the MANOVA showed a significant difference in foraging in relation to one of the variables an ANOVA was carried out. Because more than one foraging bout was often recorded for an individual bird in the same season, there is a risk of pseudoreplication. Consequently, the more conservative level of significance of $p < 0.001$ was used.

RESULTS

A total of 345 hours of observations was made, with approximately equal time being spent in each site and in following birds of each sex (Table 1). There were no significant differences between males and females in foraging method and substrate, perch site and height or foraging rates (Table 2) and also no significant sex by site or sex by season interactions. Consequently, data are combined for both sexes.

Foraging method and substrate

The foraging method and substrate were combined into a small number of frequently used behaviours. Hooded Robins foraged mostly on the ground, either by pouncing from a low perch onto the ground or by hopping along the ground and gleaning prey from the surface (Fig. 1). Gleaning from bark and hawking were less common foraging methods and the few cases of foliage gleaning were combined with bark gleaning. Hovering (combined with hawking in Fig. 1) and snatching were used infrequently. Overall, the MANOVA showed no significant differences in foraging method between sites. Birds at Strathaven gleaned on the ground less frequently than birds from the other two sites (Fig. 1).

TABLE 1

Numbers of hours of observation of each sex at each site in each season; the figure in parentheses is the number of foraging records at each site in each season, sexes combined.

Season	Gara		Strathaven		Torryburn	
	Male	Female	Male	Female	Male	Female
Autumn	19.2	20.66	16.79	18.18	18.4	13.37
Winter	8.12	11.4	11.55	14.9	15.87	11.12
Spring	8.65	12.44	10.15	13.26	12.76	13.95
Summer	16.73	14.17	17.61	15.53	17.56	13.05
	(1 666)	(1 896)	(1 070)	(3 014)	(1 147)	(3 407)
	(1 132)	(788)	(851)	(749)	(1 240)	(835)

TABLE 2

Results of MANOVA tests for differences in foraging method, perch substrate and height and foraging rates between sexes, sites and seasons.

	Sex	Site	Season
Foraging Method	$F_{5,43} = 0.55$ $p = 0.74$	$F_{10,86} = 1.73$ $p = 0.08$	$F_{15,119} = 5.06$ $p < 0.0001$
Perch Site	$F_{6,42} = 0.11$ $p = 0.99$	$F_{12,84} = 3.92$ $p = 0.0001$	$F_{18,119} = 4.82$ $p < 0.0001$
Perch Height	$F_{7,41} = 0.42$ $p = 0.88$	$F_{14,82} = 9.29$ $p < 0.0001$	$F_{21,118} = 6.37$ $p < 0.0001$
Foraging rate	$F_{5,44} = 1.00$ $p = 0.43$	$F_{10,88} = 1.80$ $p = 0.07$	$F_{15,121} = 4.60$ $p < 0.0001$

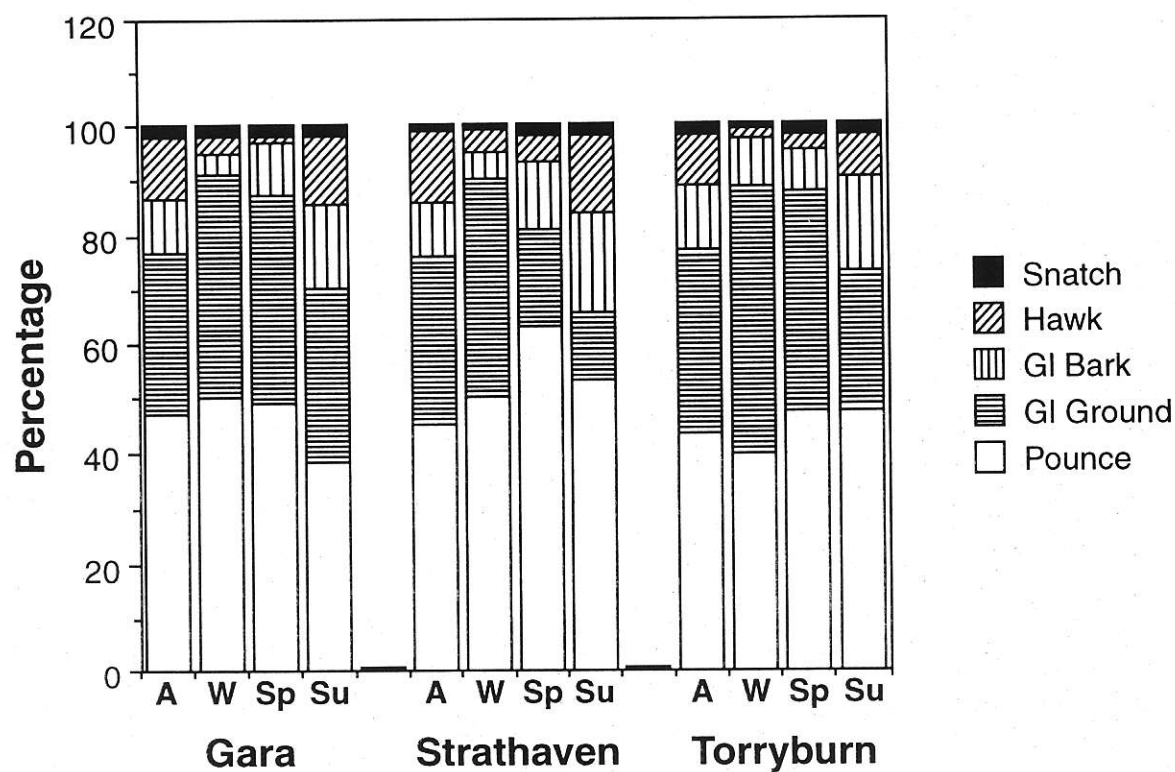


Figure 1. Foraging method and substrate of Hooded Robins at Gara, Strathaven and Torryburn in each season. A — autumn, W — winter, Sp — spring, Su — summer. GI — glean.

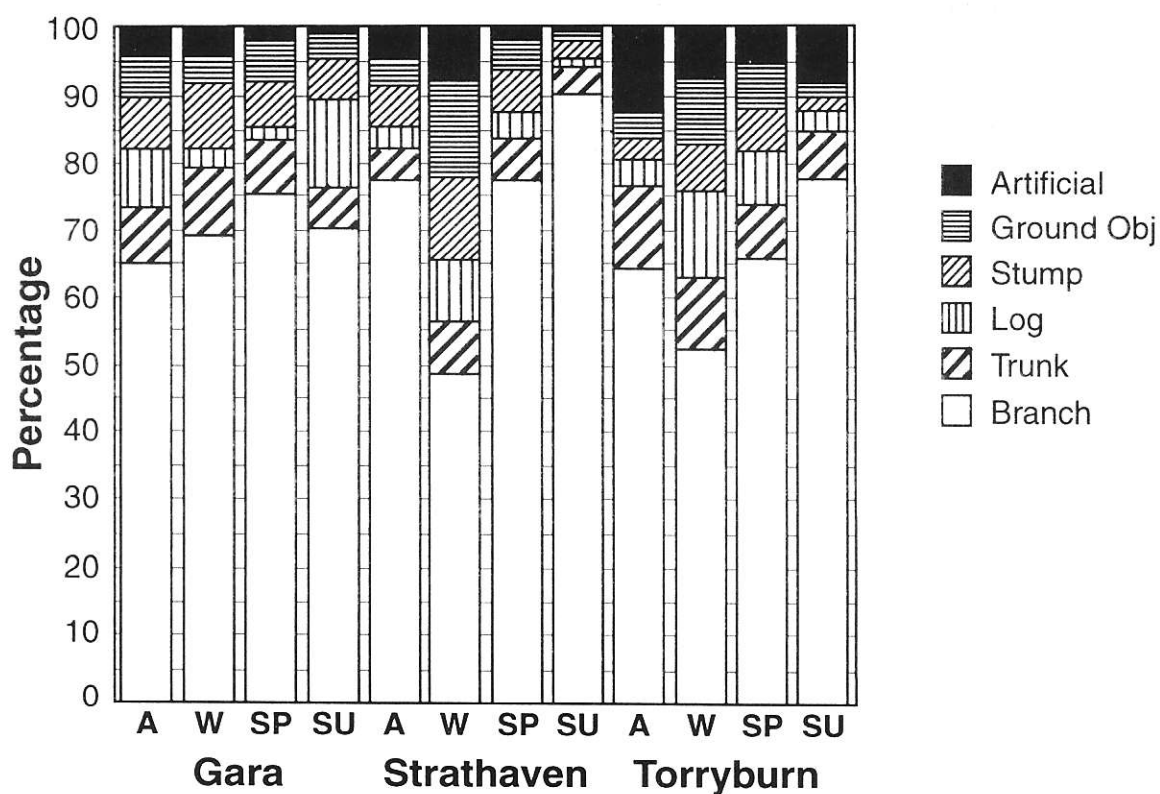


Figure 2. The percentage of each perch type used by Hooded Robins at Gara, Strathaven and Torryburn in each season.

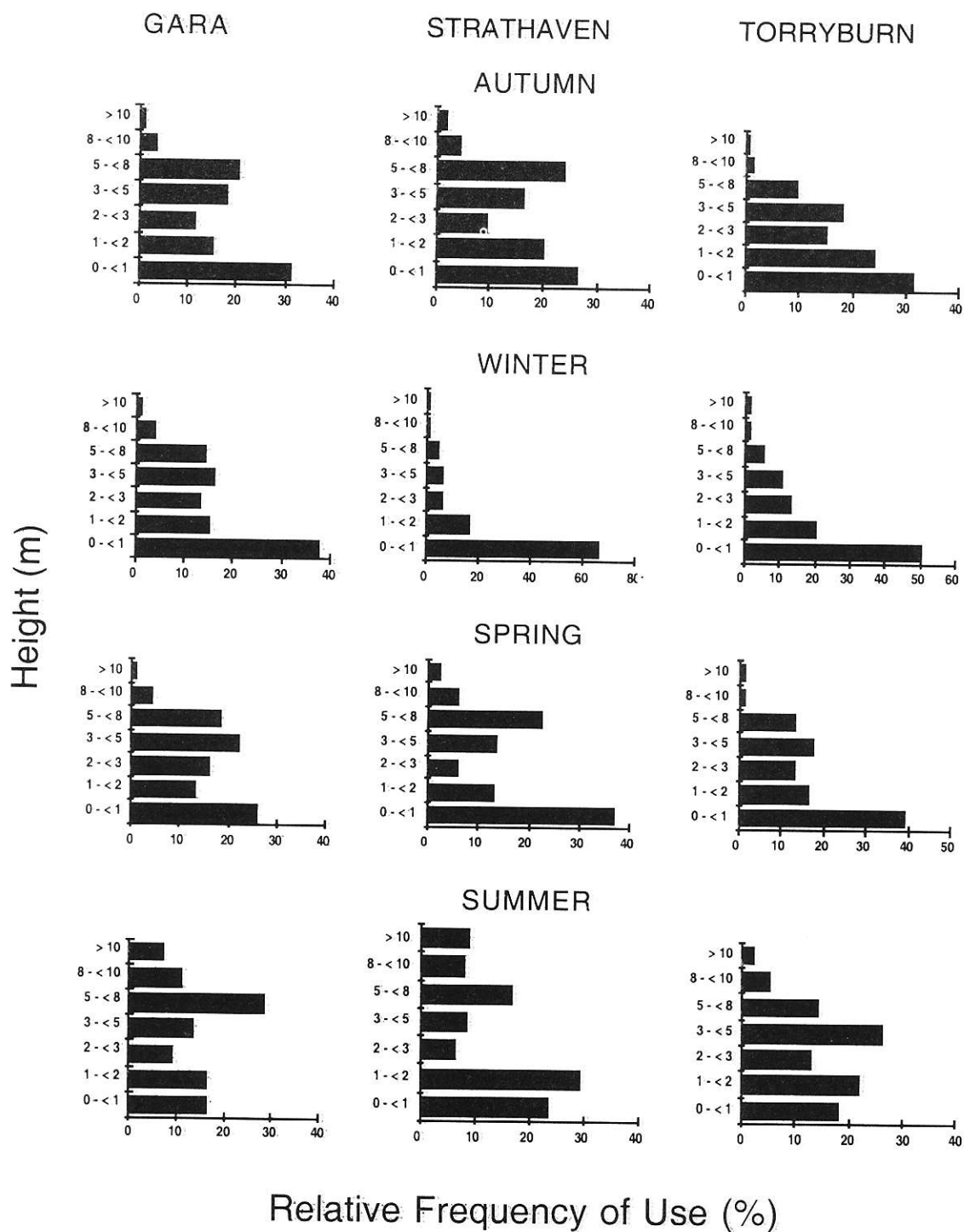


Figure 3. Heights of perches from which foraging was initiated by Hooded Robin in each site and season. (Samples sizes for Gara $n = 1\,837, 2\,176, 1\,411, 1\,004$ for autumn, winter, spring and summer, Strathaven $n = 1\,144, 3\,507, 1\,207, 1\,153$; Torryburn $n = 1\,164, 3\,031, 1\,404, 926$).

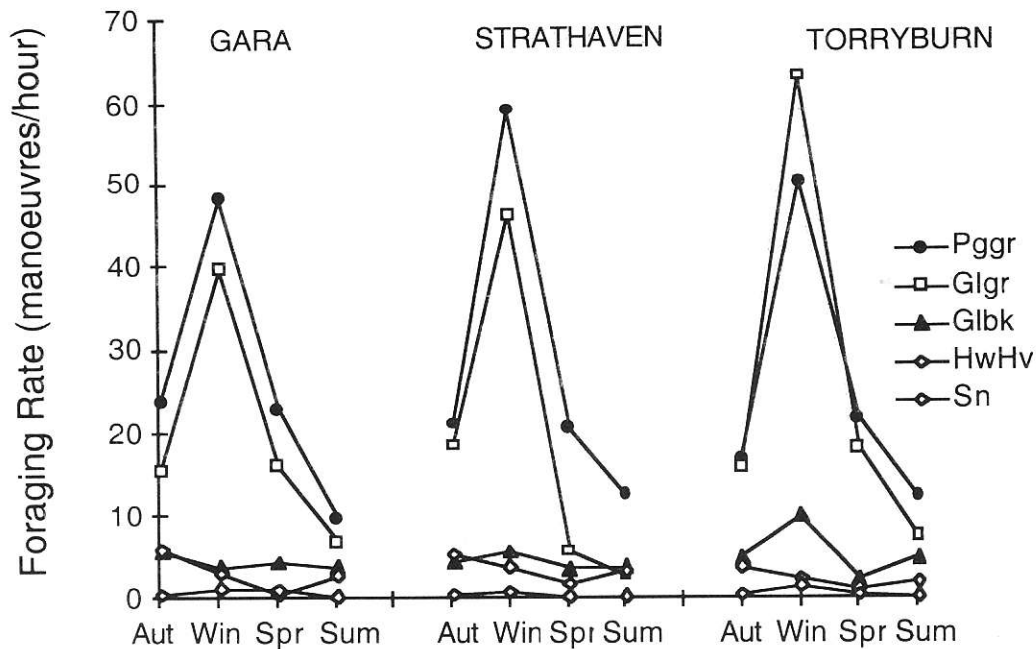


Figure 4. Foraging rate (attempts per hour) by Hooded Robins for each main foraging method at each site in each season. Pggr = pouncing on ground, Glgr = gleaning on ground, Glbk = gleaning on bark, HwHv = hawking and hovering, Sn = snatching.

The frequency of different foraging methods differed significantly among seasons. Hawking and hovering were more frequent in summer and autumn than in winter and spring at all sites (Fig. 1). Gleaning on the ground was most frequent in winter in all sites and gleaning from bark was most frequent in summer. Pouncing on the ground was most frequent in spring, mainly due to its very high frequency at Strathaven in this season. There were no interactions between season and site.

Perch sites

There were significant differences in perch sites among study sites and among seasons (Table 2), as well as interactions between these two variables ($F_{36,187} = 2.77$, $p = 0.0001$). There were relatively minor seasonal changes in perch site at Gara (Fig. 2). However, Hooded Robins at the other two sites showed a high use of branches in summer and a correspondingly lower use of perches close to the ground, such as stumps, logs and objects on the ground. There was a number of modest, though significant, differences among the sites. Hooded Robins used artificial perches more at Torryburn and stumps somewhat less.

Perch height

There were significant differences in the heights of perches used for foraging among sites and seasons (Table 2). Hooded Robins mostly perched on or near the ground, with a secondary peak at 3–5 metres or 5–8 metres above the ground in all seasons except for winter (Fig. 3). The latter heights correspond to bark-gleaning and hawking. The differences among sites were mainly due to differential use of the upper levels, with 3–5 metres being the favoured secondary height at Torryburn and 5–8 metres at the other two sites.

Foraging rates

There were highly significant seasonal differences in foraging rates (foraging attempts per hour) but no significant differences among sites (Table 2). Hooded Robins foraged at a higher rate in winter than in the other seasons and least rapidly in summer (Fig. 4). There are two components to these seasonal differences. First, gleaning on bark, hawking and hovering, all of which were used most in summer and least in winter, were performed at low rates compared with ground-feeding. Secondly, the main foraging behaviours, gleaning and pouncing on the ground, were performed at a greater rate in winter than in summer.

DISCUSSION

Hooded Robins are principally ground foragers, as found in other habitats from more limited data (Brooker *et al.* 1990; Recher and Davis 1997, 1998; Recher *et al.*, in review). We found that the species gleans as well as pounces on the ground. We defined the method as gleaning when the bird showed any hopping along the ground, even after flying down from a perch. In contrast, Recher (pers. comm.) included such behaviour as pouncing. Hooded Robins also display a small, though varying proportion of other foraging behaviours, such as gleaning from bark, hawking, hovering and snatching (as found by Gilmore 1985 and Graham 1990).

We found no significant differences in the foraging behaviour between male and female Hooded Robins. Other studies on foraging behaviour of Australian robins have looked for sexual differences. Wheeler and Calver (1996) found that male and female Red-capped Robins were very similar in their foraging method and use of substrates on Rottnest Island, Western Australia. Mac Nally (2000) found

no consistent differences in foraging behaviour between sexes in Rose Robins (*Petroica rosea*). Recher and Holmes (2000) found that female Scarlet Robins fed more on the ground than males, which fed more on bark and by hawking. Sexes of Flame Robins did not differ significantly. The general lack of sexual differences among robins contrasts with Golden *Pachycephala pectoralis* and Rufous Whistlers *P. rufiventris*, in which males foraged significantly higher than females (Bridges 1980, 1992; Bell 1986; Recher and Holmes 2000, but see Mac Nally 2000). Perhaps the fact that so much foraging is on the ground does not allow much opportunity for differential exploitation of sites by male and female Hooded Robins. Also, there may be subtle differences in food or the type of ground on which the sexes forage, which were not investigated in this study.

Seasonal changes in foraging, as shown by Hooded Robins, are a feature of smaller species of robins in south-eastern Australia. Scarlet Robins change from hawking, snatching, and gleaning from bark in summer to more ground-foraging in autumn and winter at Wollomombi (20 km east of Gara — Huddy 1979) and in the southern tablelands of New South Wales (Robinson 1992a). Flame Robins show this change even more markedly, with hawking being the most frequent activity in summer, whereas in winter they mostly glean on the ground (Robinson 1992a,b). However, this species is a migrant moving from woodland to more open habitat in the non-breeding season. Hooded Robins do not migrate, but expand their home ranges outside the breeding season to include open habitat with only scattered trees (Fitri and Ford 1997). Use of more open habitat is possibly the reason for an increase during winter of ground-gleaning, relative to ground-pouncing.

An increase in feeding rate in winter was also shown by Scarlet Robins and even more markedly in Flame Robins by Robinson (1992b). Flame Robins, like Hooded Robins, also increase the amount of ground-feeding in winter. Their maximum rate, of up to 250 pecks per hour, is about 5 times greater than the maximum rate for Hooded Robins. This is probably because they take smaller prey, mostly beetles and ants about 2.5 millimetres long (Robinson 1992b). The diet of Hooded Robins was not quantified but ants, moths, caterpillars, crane flies, butterflies, grasshoppers and skinks were seen being eaten.

Differences in foraging by Hooded Robins among sites were generally small and not very consistent through the year. They could have resulted from differences in the availability of perches, differences in where food was most available, or to idiosyncrasies of the individual Robins.

A number of other robin species may occur in similar habitat to Hooded Robins. There is a general gradation from mostly ground-foraging in the large Hooded and Eastern Yellow Robins to mostly hawking and snatching in the small Rose Robin (Fleming 1980; Recher *et al.*, 1985; Ford *et al.* 1986; Mac Nally 2000). As mentioned earlier, the intermediate-sized Scarlet and Flame Robin switch between more hawking and above-ground feeding in summer to predominantly ground-feeding in winter (Huddy 1979; Fleming 1980; Recher *et al.* 1985; Ford *et al.* 1990; Robinson 1992a). Data are only available on Red-capped Robins for late autumn to spring, from Western

Australia (Wheeler and Calver 1996; Recher *et al.*, in review) and Northern Territory (Recher and Davis 1997). They were mainly ground-feeders at this time, with some hawking, but it is possible that this species too may forage more above the ground in the warmer months.

Recher and Davis (1997) and Recher *et al.* (in review) found a very high overlap in behaviour and substrate between Red-capped and Hooded Robins (78–85%). They also noted that Red-capped Robins tended to forage nearer to shrubs than Hooded Robins did, which means that shrub encroachment in drier woodlands may favour the former species. Hooded Robins may also overlap closely with Eastern Yellow Robins, as well as Scarlet and Flame Robins in winter. Rose Robins tend to occupy wetter forests, though in winter they move into more open habitats, where they sometimes forage on the ground (9 out of 39 observations — Ford, unpublished). Two other birds occupy the same study sites as Hooded Robins and often interact aggressively with them: the Willy Wagtail *Rhipidura leucophrys* and the Jacky Winter *Microeca fascians* (Fitri and Ford 1998). Wagtails also fed predominantly from the ground, though most of their prey are captured in the air (62.5% hawking, 22% ground glean or pounce — Ford *et al.* 1986). Jacky Winters are also more aerial foragers than Hooded Robins (15–55% hawking, 29–64% ground pouncing from three sites — Recher *et al.*, in review; 7 hawk, 6 snatch leaves or bark, 2 pounce ground near Armidale — Ford, unpublished).

The finding of Zanette *et al.* (2000) that ground invertebrates are scarcer in small woodland remnants than in larger ones, and that this may alter the breeding behaviour of Eastern Yellow Robins, is relevant to the Hooded Robin. Changes to the quantity and quality of their habitat may influence both breeding success and adult survival in Hooded Robins. Additional measurements of the abundance of invertebrates on the ground and in the air in various habitats, and under various types of management, are required to indicate the extent to which availability of food may limit the distribution and abundance of ground-foraging insectivorous bird species. With particular respect to Hooded Robins, more information is required on diet and also on the abundance of favoured food in wooded and more open habitat throughout the year. We tentatively suggest that Hooded Robins may experience relative food shortage in winter. First, they are most dependent on ground invertebrates in winter, foraging less from other substrates. Secondly, their foraging rates are highest in winter, indicating that their energy demands are greatest then, or food items are small, or both. The influence of grazing, weed and exotic grass encroachment, removal of woody debris, disturbance of litter and microclimate on availability of ground invertebrates should be studied, especially in winter.

Long-term monitoring of sites in which Hooded Robins currently occur should record their survival as well as noting changes in the abundance of other ecologically similar species. It is possible that competition with other ground-foraging and aerial insectivores, due to habitat changes, has played a part in the decline of the Hooded Robin in southern Australia. This hypothesis is worthy of further exploration.

ACKNOWLEDGMENTS

We thank the Australian International Development Assistance Bureau for providing a scholarship for Lulu Lusianti Fitri and the University of New England and Worldwide Fund for Nature for research support. We are grateful to Stuart Cairns for assistance with statistics, to Harry Recher, Stephen Debus, Liana Zanette and Doug Robinson for commenting on the manuscript, and to Steve Ambrose for his useful comments on the thesis from which this manuscript is taken.

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