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Tree Species Preferences of Foraging Birds in Jarrah Forest in Western Australia

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Abstract

The foraging of ten species of birds on the five commonest tree species of the jarrah forest was studied in October 1982. *Acanthiza inornata* and *A. apicalis* were the least selective and *Anthochaera chrysoptera*, *Acanthorhynchus superciliosus* and *Purpureicephalus spurius* were the most selective. *Gerygone fusca*, *Pachycephala pectoralis*, *Melithreptus lunatus*, *Pardalotus striatus* and *P. punctatus* showed intermediate selectivity of tree species for foraging. Arthropod biomass in sapling crowns did not differ significantly among the tree species, but there were marked differences in taxonomic composition and the numbers captured. On the basis of these data, we speculate about the consequences of two types of forest logging on these bird species.

Introduction

Although the general ecology of bird species inhabiting the jarrah, *Eucalyptus marginata*, forest is well known (Kimber 1972, 1974; McCormick 1972; Christensen and Kimber 1975; Kimber and Christensen 1977; Nichols *et al.* 1981; Dell 1983; Nichols and Nichols 1984; Nichols and Watkins 1984), no quantitative information about their foraging niches is available. In this paper we examine whether bird species forage selectively on tree species present in the jarrah forest. Sapling crowns of each tree species were also sampled for arthropods, enabling us to consider whether biomass and taxonomic composition of the arthropod fauna could be an important basis of foraging preferences.

Methods

All observations pertain to a 125-ha subcatchment of jarrah forest, known as Yarragil 4L (32°51′S.,116°25′E.). Six tree species are present, typical of much of the upland jarrah forest. *E. marginata* and *E. calophylla* (marri) form the overstorey (30 m tall) and *Banksia grandis*, *Allocasuarina fraseriana*, *Persoonia longifolia* and *P. elliptica* are the understorey trees (maximum height 15 m). The forest was first cut over in 1933 for jarrah trees (selective logging). It has experienced typical prescribed low-intensity fires periodically from 1961 to 1973.

On 5, 6, 12, 13, 19, 20 and 26 October 1982 we recorded foraging of bird species on each tree species. We walked nonsystematically through the whole area and noted each foraging event and to which part of each tree species it was directed (flower, fruit, leaf, petiole or branchlet, bark on small branch, large branch or trunk). To avoid bias we did not concentrate on particular bird species or tree species, and each bird found foraging was watched until a maximum of five feeding actions was recorded.

The cross-hairs of a crownometer were used to record presence or absence of foliage of each tree species. A crownometer gives a vertical line of sight from the ground. It is similar to an instrument described by Montaña and Ezcurra (1980). The relative abundance of the crowns of each tree species

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was then calculated. An index of tree species preference by each bird species was calculated from the formula: $0{\cdot}5 \sum_{i=1}^{5} (|x_i - y_i|)/100$, where x_i is the relative abundance (percentage) of crowns of tree species i, and y_i is the percentage of foraging recorded on tree species i. Preference values range from 0 (no selectivity) to 1·0 (foraging only on the least abundant tree species). The above formula was derived by modifying an index of overlap commonly used in the literature (e.g. Schoener 1970). Because presence or absence of foliage and not the percentage crown cover was recorded, any differences in tree species architecture or foliage volume should have little effect on the index of tree species preference.

Arthropods present on foliage, petioles and small branchlets lacking flaky bark were sampled on 12, 19 and 20 October to a height of 4·4 m with a sweep net (48 cm diameter). Fifty sweeps were made on each of the crowns of 10 trees of five species. (Because we did not observe foraging on *P. elliptica*, we did not sample its arthropod fauna.) Samples were refrigerated and later weighed (at room temperature) and sorted into broad taxonomic categories (mostly Orders). We assume that the number and types of insects collected to a height of 4·4 m above ground level are not dissimilar to those occurring at greater heights.

The number of inflorescences of *B. grandis* produced during spring 1982 was counted on two randomly selected transects 6 m wide and 1·6–1·8 km long.

Results

Trees

Foliage of each tree species was present at the intersection of the cross-hairs of the crownometer as follows: *E. marginata*, 27·9% of 190 readings; *E. calophylla*, 3·7%; *B. grandis*, 11·6%; *A. fraseriana*, 17·9%; *P. longifolia*, 0·5%; *P. elliptica*, 0·0%. Thus the relative abundance of crowns of each tree species was: *E. marginata*, 45·3%; *A. fraseriana*, 29·1%; *B. grandis*, 18·8%; *E. calophylla*, 6·0%; *P. longifolia*, 0·8%; *P. elliptica*, 0%.

The numbers of inflorescences of *B. grandis* produced on the transects in spring 1982 were 66 and 142 per hectare, respectively.

Table 1. Relative abundance of tree species, relative foraging of bird species on tree species, and index of tree species preference for each bird species

E.m., Eucalyptus marginata; *E.c., E. calophylla*; *B.g., Banksia grandis*; *A.f., Allocasuarina fraseriana*; *P.l., Persoonia longifolia*

Bird species	No. of observations	Percentage of foraging on: *E.m.*	*E.c.*	*B.g.*	*A.f.*	*P.l.*	Index
Inland thornbill	161	23·0	11·2	30·4	35·4	0·0	0·23
Western thornbill	136	49·3	10·3	28·7	11·0	0·7	0·18
Western gerygone	68	36·8	16·2	36·8	7·4	2·9	0·30
Golden whistler	38	13·2	0·0	26·3	55·3	5·3	0·38
Striated pardalote	48	58·3	41·7	0·0	0·0	0·0	0·49
Spotted pardalote	43	41·9	58·1	0·0	0·0	0·0	0·52
Western spinebill	51	9·8	0·0	88·2	2·0	0·0	0·69
White-naped honeyeater	43	90·7	2·3	7·0	0·0	0·0	0·45
Little wattlebird	15	0·0	0·0	100·0	0·0	0·0	0·81
Red-capped parrot	19	10·5	10·5	79·0	0·0	0·0	0·65

Birds

Although we (two observers) gathered 690 foraging records of 20 bird species, 10 of the species were recorded foraging less than 15 times. We consider such small samples insufficient. The numbers of bird species recorded foraging on the six tree species were: 15 on *E. marginata*, 13 on *B. grandis*, 9 on *E. calophylla*, 8 on *A. fraseriana*, 3 on *P. longifolia* and none on *P. elliptica*.

Western thornbills *Acanthiza inornata* and inland thornbills *A. apicalis* were least selective in their use of tree species (Table 1), and little wattlebirds *Anthochaera chrysoptera*, western

spinebills *Acanthorhynchus superciliosus*, and red-capped parrots *Purpureicephalus spurius* were most selective (Table 1). Western gerygones *Gerygone fusca*, golden whistlers *Pachycephala pectoralis*, white-naped honeyeaters *Melithreptus lunatus*, striated pardalotes *Pardalotus striatus* and spotted pardalotes *P. punctatus* were intermediate in their choices of tree species for foraging (Table 1). Minimum and maximum values recorded were 0·18 and 0·81 (Table 1), indicating that no bird species showed complete lack of selectivity or complete specialization on only one uncommon tree species.

Bird species that foraged most on particular species include white-naped honeyeaters on *E. marginata*, spotted pardalotes on *E. calophylla*, little wattlebirds and western spinebills on *B. grandis*, and golden whistlers on *A. fraseriana*. Tree species to which the insectivorous species showed greatest aversion were golden whistlers on *E. marginata*, golden whistlers and white-naped honeyeaters on *E. calophylla*, striated pardalotes, spotted pardalotes and white-naped honeyeaters on *B. grandis*, and striated pardalotes, spotted pardalotes, white-naped honeyeaters and western gerygones on *A. fraseriana*. *Persoonia longifolia* was avoided by most species.

Three species (western spinebill, little wattlebird and red-capped parrot) foraged exclusively or almost so on inflorescences of *B. grandis* (Table 2). All other species foraged predominantly on leaves, petioles or the smooth branchlets. However, three species foraged to some extent in bark present on branches or the stem: inland thornbill (18% of foraging records; Table 2), western thornbill (21%) and golden whistler (26%).

Only one of the two congeneric pairs of species present in this study showed differential use of tree species. Inland thornbills foraged significantly more often on *A. fraseriana* and less often on *E. marginata* than did the western thornbill ($\chi^2_1 = 30{\cdot}8$, $P < 0{\cdot}001$). Striated pardalotes did not forage significantly more on *E. marginata* than *E. calophylla*, compared to spotted pardalotes ($\chi^2_1 = 1{\cdot}9$, $P > 0{\cdot}10$).

Table 2. Within-tree foraging preferences of bird species

'Leaf' includes petioles and small branchlets lacking bark

Bird species	No. of foraging records on:						Total records
	Flower	Fruit	Leaf	Bark, small branch	Bark, large branch	Bark, trunk	
Inland thornbill	0	2	130	15	14	0	161
Western thornbill	4	0	104	1	9	18	136
Western gerygone	2	0	61	5	0	0	68
Golden whistler	0	0	28	3	7	0	38
Striated pardalote	0	0	48	0	0	0	48
Spotted pardalote	0	0	43	0	0	0	43
Western spinebill	51	0	0	0	0	0	51
White-naped honeyeater	0	0	43	0	0	0	43
Little wattlebird	15	0	0	0	0	0	15
Red-capped parrot	19	0	0	0	0	0	19

Arthropods

Biomass of the arthropods sampled from each tree species did not differ significantly ($P = 0{\cdot}25$, one-way ANOVA). Means ± standard errors were as follows: *E. calophylla*, 0·416 ± 0·231 g; *E. marginata*, 0·222 ± 0·041 g; *A. fraseriana*, 0·162 ± 0·026 g; *B. grandis*, 0·117 ± 0·015 g; *P. longifolia*, 0·095 ± 0·018 g. In contrast, the number of arthropods captured per 50 sweeps differed significantly among tree species ($P = 0{\cdot}0003$, one-way ANOVA), as follows: *A. fraseriana*, $128{\cdot}6 \pm 16{\cdot}5^{A}$, *E. marginata*, $112{\cdot}8 \pm 11{\cdot}6^{A}$; *P. longifolia*, $70{\cdot}5 \pm 13{\cdot}5^{B}$, *B. grandis*, $68{\cdot}9 \pm 11{\cdot}6^{B}$ and *E. calophylla* $57{\cdot}0 \pm 5{\cdot}4^{B}$. (Means followed by the same letter are not significantly different ($P > 0{\cdot}05$) by Duncan's multiple range test.)

Although the number of taxa collected on each tree species was similar (12–15), taxonomic composition of the catches showed marked differences (Table 3). Predominant taxa were ants and bugs on *E. marginata*, ants, spiders and beetles on *E. calophylla*, spiders and flies on *B. grandis*, spiders, flies and beetles on *A. fraseriana* and bugs, spiders, beetles and flies on *P. longifolia*. Lerps (the tests of certain Hemiptera) were not common, being < 1% of arthropods captured except on *E. marginata* (5%).

Table 3. Taxonomic composition of the samples of arthropods collected on tree species

Tree species abbreviated as in Table 1. Asterisk, < 1%

Arthropod taxon	Percentage representation on tree species: *E.m.*	*E.c.*	*B.g.*	*A.f.*	*P.l.*
Diplopoda	0	0	0	*	0
Araneae	8·4	17·2	29·0	30·8	19·9
Ixodoidea	*	*	*	0	0
Blattodea	*	*	*	*	*
Mantodea	0	0	0	*	0
Orthoptera	0	*	0	*	0
Phasmatodea	*	0	0	0	0
Psocoptera	0	2·6	*	1·2	*
Hemiptera	19·6	14·9	13·8	11·5	25·7
Thysanoptera	*	*	0	*	0
Megaloptera	0	0	*	*	*
Neuroptera	*	*	*	*	*
Coleoptera	11·7	17·2	12·5	19·8	17·9
Mecoptera	*	0	0	0	0
Diptera	8·1	11·6	20·9	21·8	15·5
Trichoptera	*	0	*	0	1·3
Lepidoptera	*	1·0	*	1·4	1·8
Formicoidea	41·1	19·5	9·7	6·5	5·7
Other Hymenoptera	7·5	12·1	7·4	3·6	9·2
Unidentified	*	1·6	*	*	*
Total No. taxa	14	13	13	15	12
No. individuals	1128	570	689	1286	705

Discussion

Factors most relevant to insectivorous birds choosing to forage in certain tree species include the abundance, biomass and availability of arthropods and the relative abundance of the tree species in the forest. Before commencing our study, we knew that jarrah was the most abundant tree species, so we expected most of our feeding observations would be made on this species. In addition, Kimber (1974) had classified the avifauna of the jarrah forest in terms of four height strata: ground vegetation–lower understorey, inland thornbill, western thornbill; upper understorey–lower canopy, western spinebill and golden whistler; lower–mid canopy, western gerygone and white-naped honeyeater; and mid–upper canopy, striated pardalote and spotted pardalote. Our data are consistent with this interpretation, except that the western gerygone spent about one-third of foraging effort on *B. grandis*, part of the understorey.

Differential use of tree species by birds has been demonstrated in many studies (e.g. Hartley 1953; Franzreb 1978; Noske 1979; Holmes and Robinson 1981). In contrast, the food resources on different tree species have rarely been investigated but are thought not to be responsible for the great selectivity shown by some bird species (Holmes and Robinson 1981). Although we found no significant difference in biomass of arthropods on five tree species in jarrah forest, there were marked differences in numbers captured and in taxonomic composition. Furthermore, differing

behaviour, size, crypticity, etc., shown by the arthropod taxa may be important. Data from woodland and other forest in Western Australia indicate that there is high overlap among bird species in arthropods eaten (Calver and Wooller 1981; Wooller and Calver 1981; Tullis *et al.* 1982). Finally, differences between tree species in morphology and size of leaves could be relevant (Jackson 1979), as certain leaf types may be searched more easily by birds.

It would be valuable to extend this study by examining the gut contents and faeces of bird species in a similar stand of jarrah forest. We predict that the four most selective insectivorous species should have the following diets: spotted pardalote (ants, spiders and beetles); striated pardalote and white-naped honeyeater (ants and bugs); and golden whistler (spiders, flies and beetles).

It would also be useful to assess if forest management has any effect on those bird species showing preference for particular tree species (cf. Franzreb 1978; Loyn 1980; Recher *et al.* 1980). During the last 100 years, most of the jarrah forest has been cut over for large suitable jarrah trees. Our foraging data suggest that only white-naped honeyeaters would have been much affected by this kind of logging. Experiments indicate that the growth of jarrah can be improved by thinning and by removing noncommercial species such as *Banksia grandis*. It is proposed to apply such treatment to some of the more productive jarrah stands in the high rainfall zone. Our foraging data predict that the red-capped parrot, western spinebill, little wattlebird, golden whistler, inland thornbill, western thornbill and western gerygone may be disadvantaged.

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References

Calver, M. C., and Wooller, R. D. (1981). Seasonal differences in the diets of small birds in the karri forest understorey. *Aust. Wildl. Res.* **8**, 653–7.

Christensen, P. E., and Kimber, P. C. (1975). Effects of prescribed burning on the flora and fauna of South-west Australian forest. *Proc. Ecol. Soc. Aust.* **9**, 85–106.

Dell, J. (1983). The importance of the Darling Scarp to fauna. In 'Scarp Symposium'. (Ed. J. D. Majer.) pp. 17–27. (Western Australian Institute of Technology: Bentley, W.A.)

Franzreb, K. E. (1978). Tree species used by birds in logged and unlogged mixed-coniferous forests. *Wilson Bull.* **90**, 221–38.

Hartley, P. H. T. (1953). An ecological study of the feeding habits of the English titmice. *J. Anim. Ecol.* **22**, 261–88.

Holmes, R. T., and Robinson, S. K. (1981). Tree species preferences of foraging insectivorous birds in a northern hardwoods forest. *Oecologia (Berl.)* **48**, 31–5.

Jackson, J. A. (1979). Tree surfaces as foraging substrates for insectivorous birds. In 'The Role of Insectivorous Birds in Forest Ecosystems'. (Eds J. G. Dickson, R. N. Conner, R. R. Fleet, J. C. Kroll and J. A. Jackson.) pp. 69–93. (Academic Press: New York.)

Kimber, P. (1972). Birds of the jarrah forest. *For. Focus* No. 7, 5–7.

Kimber, P. C. (1974). Some effects of prescribed burning on jarrah forest birds. Proc. 3rd Fire Ecol. Symp., Monash University, pp. 49–57.

Kimber, P., and Christensen, P. (1977). Birds of Western Australian Forests. West. Aust. For. Dep. Inf. Sheet No. 12.

Loyn, R. H. (1980). Bird populations in a mixed eucalypt forest used for production of wood in Gippsland, Victoria. *Emu* **80**, 145–52.

McCormick, J. (1972). A post-burn fauna count in the northern jarrah forest. *West. Aust. For. Dep. For. Notes* **10**, 5–8.

Montaña, C., and Ezcurra, E. (1980). Simple instrument for quick measurement of crown projections. *J. For.* **78**, 699.

Nichols, O. G., Glossop, B. L., and Smurthwaite, A. J. (1981). A method for assessing the likely effects of bauxite mining on conservation of flora and fauna management priority areas. Alcoa Environ. Res. Bull. No. 12.

Nichols, O. G., and Nichols, F. M. (1984). The reptilian, avian and mammalian fauna of the Mount Saddleback State Forest, Western Australia. *West. Aust. Nat.* **15**, 179–89.
Nichols, O. G., and Watkins, D. (1984). Bird utilisation of rehabilitated bauxite minesites in Western Australia. *Biol. Conserv.* **30**, 109–31.
Noske, R. A. (1979). Coexistence of three species of treecreepers in north-eastern New South Wales. *Emu* **79**, 120–8.
Recher, H. F., Rohan-Jones, W., and Smith, P. (1980). Effects of the Eden woodchip industry on terrestrial vertebrates with recommendations for management. N.S.W. For. Comm. Res. Note No. 42.
Schoener, T. W. (1970). Nonsynchronous spatial overlap of lizards in patchy habitats. *Ecology* **51**, 408–18.
Tullis, K. J., Calver, M. C., and Wooller, R. D. (1982). The invertebrate diets of small birds in *Banksia* woodland near Perth, W.A., during winter. *Aust. Wildl. Res.* **9**, 303–9.
Wooller, R. D., and Calver, M. C. (1981). Feeding segregation within an assemblage of small birds in the karri forest understorey. *Aust. Wildl. Res.* **8**, 401–10.

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