

Acknowledgements

I wish to thank D. Milledge for carrying out the autopsy on M2. D. Purchase, D. Serventy, S. G. Lane and A. Leishman are thanked for their help and guidance. An apology must be given to all the people not mentioned specifically, especially my family, for whose help I am very grateful.

Reference

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Mixed Species Flocks in a Dry Sclerophyll Forest in Autumn and Winter

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Mixed species feeding flocks were studied in dry sclerophyll forest at Black Mountain Nature Reserve, Australian Capital Territory. Twenty-three species were observed in mixed flocks. Species are grouped according to foraging pattern and details of the composition of the flocks is given.

Mixed species flocks have been studied in many parts of the world e.g. Ceylon (Partridge and Ashcroft 1976), Sarawak (Croxall 1976), Kashmir (Macdonald and Henderson 1977), Patagonia (Vuilleumier 1967), Brazil (Davis 1946), Peru (Munn and Terborgh 1979) and Arizona (Austin and Linwood Smith 1972) and shown to occur in a wide range of habitats and to vary in the numbers, species and foraging behaviour of birds present. Macdonald and Henderson (1977) stated that this variation makes it difficult to devise a general hypothesis to explain the existence of mixed species flocks. Morse (1970) suggested that certain species within mixed species flocks reduce competition by feeding in different sites to the ones used by other species in the flock. Krebs, MacRoberts and

Cullen (1972) have shown in experimental studies that mixed species flocking may increase the amount of interspecific learning of potential food sources. Lack (1968) and Goss-Custard (1970) suggested an antipredator advantage to mixed species flocking behaviour.

In this study the aim was to determine the extent to which mixed species flocking occurred in Australian birds in a dry sclerophyll forest outside the breeding season. Also, it was hoped the study would indicate which species formed mixed species flocks and how these flocks were structured. There are few published records of this behaviour in Australian birds (Gannon 1934, Sedgwick 1949). Bell (in press) has examined mixed species flocking in the same location as this study.

Methods

The four study areas in the 521 hectare Black Mountain Nature Reserve in the Australian Capital Territory were located in the north and west of the reserve. They had northerly and westerly aspects. Their altitude ranged between 620-680 metres and the topography ranged from undulating to steep. The northern and western sides of the reserve were dominated by various age classes of *Eucalyptus rossii* with smaller areas of *E. polyanthemos* and *E. blakelyi*. The dominant tree species in the study areas was *E. rossii* although *E. macrorhyncha* and *Exocarpus cupressiformis* occurred in most plots.

Three different census methods were used: the transect method (where the observer moves at given speed recording all birds seen within a given distance from a track), the point quadrat method (where all birds observed by a stationary observer are recorded for a given time) and the searching quadrat method (in which the observer searches a marked area for a given time). These three census methods were being compared as of a wider study (Hermes 1977). The data for this study have been pooled from the three census techniques.

A mixed species flock was defined as four or more different species occurring within 50 metres of one another and moving together. When a mixed species flock was observed the number of birds of each species was recorded. The number for each species was the maximum seen at any one time together. The number recorded for any one species is therefore the minimum number present in the flock.

Results

During the fifteen week period from April to August 1977, 140 hours of censusing were completed, and 3 805 observations were made. An observation was each separate record of an individual or group of individuals of the same species. Thirty-nine species were observed of which twenty were known to be breeding residents. Scientific names of species are given in Appendix 1.

All summer migrants had left the study areas before the start of censusing except for the Leaden Flycatcher, which was only recorded in April, and the Fan-tailed Cuckoo, Black-faced Cuckoo-shrike and Grey Fantail. Small numbers of these species often over-winter in the Canberra area (Frith 1969). One passage migrant,

the Yellow-faced Honeyeater, was still moving through the area in April. The Golden Whistler, a winter migrant, was recorded in larger numbers in April than during the rest of the study. No birds of prey were observed during the study.

Of all the observations, 304 or about 8% were made of birds in 53 mixed species flocks. Twenty-three species were observed in mixed species

TABLE 1

The number of mixed species flocks observed listed against the number of species present.

Number of Species	Number of mixed species flocks
4	20
5	10
6	6
7	10
8	4
9	3

TABLE 2

The percentage of mixed species flocks in which each species was present and the mean number of individuals of each species observed in mixed species flocks. The mean was obtained by dividing the total number of individuals of a species observed by the number of flocks in which that species was present. Species are shown in order of percentage.

Species	Percentage of flocks	Mean number of individuals in flock
Buff-rumped Thornbill	77	5.7
White-throated Treecreeper	68	1.2
Golden Whistler	55	1.8
Scarlet Robin	47	1.5
Grey Fantail	42	1.9
Superb Fairy-Wren	40	3.2
Striated Pardalote	38	3.2
Striated Thornbill	30	4.1
Varied Sittella	28	6.3
Grey Shrike-thrush	28	1.1
Spotted Pardalote	21	4.4
Brown Thornbill	19	2.7
Eastern Yellow Robin	15	1.0
Speckled Warbler	11	2.0
Yellow-faced Honeyeater	9	—
White-eared Honeyeater	7	—
Eastern Spinebill	4	—
Silvereye	4	—
Crimson Rosella	4	—
Leaden Flycatcher	4	—
Australian Raven	2	—
White-naped Honeyeater	2	—
Pied Currawong	2	—
Unidentified	2	—

flocks although some of these may have only been coincidental. The average number of birds observed in each flock was 16.2. The range was 6-39 birds. The number of species present in each flock is shown in Table 1. The number of flocks in which each species was present and the average number of individuals of each species present is shown in Table 2. Species which did not occur in mixed species flocks are listed in Appendix 1.

The species occurring in mixed species flocks were arranged into groups based on their primary food preference and foraging patterns according to Frith (1969) (Table 3). These figures give a misleading indication of the regularity with which the aerially feeding species occurred in mixed species flocks since the Grey Fantail largely left the area during the middle of winter. Eighty-six percent of all mixed species flocks contained representatives of three or more of Groups A-E. Only on five occasions did more

than 75% of the composition of a flock come from only one group. The most common members of mixed species flocks are insectivorous.

Discussion

Mixed species flocks contained 8% of all observations made during this study and therefore are an important influence on the behaviour of many birds in the study area. It is possible that mixed species flocks may only have advantages for some species and perhaps, although there is no evidence for it here, only at certain times of the year. However, since some advantages may be subtle, these reasons may not yet be apparent.

The mean number of birds in each flock in this study (16.2) is similar to the figure of 14.6 found in post-breeding mixed insectivorous bird flocks in woodlands in Arizona (Austin and Lindwood Smith 1972). They state that these

TABLE 3

The composition of flocks by foraging pattern of species. The species are grouped according to foraging patterns given by Frith (1969).

Group	Foraging pattern	Species	No. of flocks in which group was present
A	Insectivorous species of the ground and low bushes.	{ Eastern Yellow Robin Superb Fairy-Wren Speckled Warbler Buff-rumped Thornbill	48 (91%)
B	Insectivorous species of tree trunks.	{ Varied Sittella White-throated Treecreeper	38 (72%)
C	Insectivorous species of outer tree foliage.	{ Striated Thornbill Spotted Pardalote Striated Pardalote	35 (66%)
D	Insectivorous species of shrubs and low bushes.	{ Golden Whistler Brown Thornbill	35 (66%)
E	Insectivorous species of the ground.	{ Scarlet Robin Grey Shrike-thrush	33 (62%)
F	Insectivorous aerial feeders.	{ Leaden Flycatcher Grey Fantail	22 (41%)
G	Other feeding types	{ Crimson Rosella Yellow-faced Honeyeater White-eared Honeyeater White-naped Honeyeater Eastern Spinebill Silvereye Pied Currawong Australian Raven	15 (28%)

types of flocks from temperate regions are remarkably similar in size and suggest there may be an optimum size for such flocks.

A pattern of vertical structuring of mixed species flocks was observed. This is shown by the fact that 86% of all the flocks had representatives of at least three of the foraging groups A to E (Table 3). In addition to the numbers of individuals or any one group only rarely constituted more than 75% of the total flock. It is possible that whatever the function of mixed species flocks the regular vertical structuring by its component species may be important. It may be that the function of the mixed species flock can only be achieved if a certain number of individual birds occupy at least a minimum number of feeding zones. Although the pattern of vertical structuring of the flock may be similar in forests of similar structure, the species occupying each foraging zone may change with distance and time.

In overseas studies, one species often stands out as the key species Austin and Lindwood Smith (1972) call this species the "flock leader" or "focal point species"; Winterbottom (1943) calls it the "nucleus species". This species is present in a large percentage of flocks. It is usually seen in numbers of six or more and can occur in small flocks outside mixed species flocks. It is generally a noisy species and is not necessarily a specialised forager.

One species in this study, the Buff-rumped Thornbill, had many of these characteristics. Although a clear horizontal structuring of all flocks was not obvious, the Buff-rumped Thornbills were certainly the "flock leaders" in many of the flocks observed in this study, and because of the frequency and large numbers in which they occurred in flocks, may have been important in the formation of the flocks.

It has been suggested (Austin and Lindwood Smith 1972, Partridge and Ashcroft 1976) that the composition of individuals in a mixed species flock changes as the flock moves through the home ranges of different birds. Although individual flocks were not specifically followed in this study, a restructuring of some of the mixed species flocks was observed. This occurred when the leading birds moved forward quickly such as across a steep gully. Under these conditions the species composition of the flock changed and so must have at least some of the individuals.

It was not clear whether this was due to the leading birds separating from the flock or due to new individuals joining the flock.

The adaptive significance of mixed species flocking behaviour has been considered by many authors (Crook 1965, Macdonald and Henderson 1977, Vuilleumier 1967, Partridge and Ashcroft 1976, Croxall 1976, Rubenstein *et. al.* 1977, and Morse 1970). In this study there was no evidence to indicate that increased protection from predators was a major advantage of flocking as postulated by some of these authors. Alternatively, it has been proposed that mixed species flocks increase the efficiency of foraging of individual birds by reducing individual competition (Morse 1970) or by enabling patchy food supplies to be more effectively utilised (Crook 1965). The latter explanation is supported by the finding of this study that there is a vertical structuring of the flocks. Such a flock would be more efficient in finding and exploiting scattered concentrations of insects than would be separate individuals of monospecific groups or groups of species which all forage in the same stratum.

Acknowledgements

This study formed part of an Honours course in 1977 at the Australian National University. It was supervised by Dr. J. Carstairs. I would like to thank the Conservation and Agriculture Branch of the Department of the Capital Territory for permission for me to conduct this study in the Black Mountain Nature Reserve. I would also like to thank D. Lunney and P. Smith for their useful comments on this manuscript and to S. Briggs and J. Hermes for help with earlier drafts.

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APPENDIX 1

List of species observed on study plots in the Black Mountain Nature Reserve during April to August 1977. Scientific and common names follow the 'Recommended English names for Australian birds' RAOU 1978.

Asterisk mark those species which were not recorded in mixed species flocks.

* Maned Duck	<i>Chenonetta jubata</i>	Striated Thornbill	<i>Acanthiza lineata</i>
* Painted Button-quail	<i>Turnix varia</i>	Varied Sittella	<i>Daphoenositta chrysoptera</i>
* Common Bronzewing	<i>Phaps chalcoptera</i>	White-throated	
* Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Treecreeper	<i>Climacteris leucophaea</i>
* Australian King-Parrot	<i>Alisterus scapularis</i>	* Red Wattlebird	<i>Anthochaera carunculata</i>
Crimson Rosella	<i>Platycercus elegans</i>	Yellow-faced	
* Eastern Rosella	<i>Platycercus eximius</i>	Honeyeater	<i>Lichenostomus chrysops</i>
* Fan-tailed Cuckoo	<i>Cuculus pyrrhophanus</i>	White-eared Honeyeater	<i>Lichenostomus leucotis</i>
* Laughing Kookaburra	<i>Dacelo novaeguineae</i>	* Brown-headed	
Black-faced		Honeyeater	<i>Melithreptus brevirostris</i>
Cuckoo-shrike	<i>Coracina novaehollandiae</i>	White-naped Honeyeater	<i>Melithreptus lunatus</i>
* Blackbird	<i>Turdus merula</i>	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>
Scarlet Robin	<i>Petroica multicolor</i>	Spotted Pardalote	<i>Pardalotus punctatus</i>
Eastern Yellow Robin	<i>Eopsaltria australis</i>	Striated Pardalote	<i>Pardalotus striatus</i>
Golden Whistler	<i>Pachycephala pectoralis</i>	Silvereye	<i>Zosterops lateralis</i>
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	* Common Starling	<i>Sturnus vulgaris</i>
Leaden Flycatcher	<i>Myiagra rubecula</i>	* White-winged Chough	<i>Corcorax melanorhamphos</i>
Grey Fantail	<i>Rhipidura fuliginosa</i>	* Australian Magpie	<i>Gymnorhina tibicen</i>
Superb Fairy-wren	<i>Malurus cyaneus</i>	Pied Currawong	<i>Strepera graculina</i>
Speckled Warbler	<i>Sericornis sagittatus</i>	* Grey Currawong	<i>Strepera versicolor</i>
Brown Thornbill	<i>Acanthiza pusilla</i>	Australian Raven	<i>Corvus coronoides</i>
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>		