OBSERVATIONS OF COEXISTENCE BETWEEN ADELAIDE AND EASTERN ROSELLAS (*PLATYCERCUS* SPP.) IN ADELAIDE

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SUMMARY

Behaviour, including nesting site, habitat use and activity budgets of the Adelaide Rosella *Platycercus elegans adelaidae* and the Eastern Rosella *Platycercus eximius* were investigated in the Adelaide metropolitan area. The results suggest that coexistence of Adelaide and Eastern rosellas in the Adelaide region occurs because the species occupy different niches in overlapping habitats: Eastern Rosellas are found in open grassy environments and preferentially forage on the ground; Adelaide Rosellas are found more often in wooded environments, and more frequently take food items from trees. Differences in habitat were similarly reflected in density of vegetation surrounding nesting trees: Adelaide Rosellas nests were most often surrounded by scrub whereas Eastern Rosella nesting trees were most often surrounded by grass. Adelaide Rosella nesting hollows were also significantly higher than those of Eastern Rosellas. Taken together, these factors would serve to minimise direct competition between these species, and are reflected in the small number of interspecific agonistic interactions which were observed.

INTRODUCTION

Several different Rosella *Platycercus* species are found together in a strip along the east coast of Australia, from southern Queensland to Tasmania, and extending into South Australia. In south-east Queensland where three species occur, the Crimson Rosella *P. elegans elegans* is found predominantly in forest, and the Eastern Rosella *P. eximius* and Pale-headed Rosella *P. adscitus* are more common in agricultural areas (Wyndham and Cannon 1985). Mixed species flocks of Eastern and Pale-headed rosellas are rare, and may relate to the different ranges and fact that Eastern Rosellas usually feed on the ground, while Pale-headed Rosellas usually feed from a perch above the ground, with more food items taken from trees (Cannon 1982, 1983; Wyndham and Cannon 1985). On the New England Tablelands, Crimson Rosellas mainly reside in forest, while Eastern Rosellas occupy agricultural and woodland areas (Brereton and Sourrey 1959). The two species occur together around Armidale, with some mixed species flocks (H. Ford pers comm).

The Adelaide Rosella *P. elegans adelaidae,* a subspecies of the Crimson Rosella, and the Eastern Rosella, both inhabit the Adelaide area. These species overlap in distribution, and can be found in sites where both species are present in equal numbers, or where one species predominates. The aims of this study were to establish whether there are behavioural and ecological differences facilitating coexistence between the two rosella species in the Adelaide region, or whether there is potential for competition between the species. Although behaviour and ecology of these species are documented for the eastern states, this study provides the first such information for the Adelaide region.

METHODS

The information presented here incorporates relevant aspects of two honours theses, the data for which were collected during February-September 1990 (Torcello 1990) and September 1991 - May 1992 (Penck 1992).

Five study sites (Table 1) were chosen for their differences in abundance of the two rosella species, facilitating behavioural comparisons between populations with mainly one species, or a mixture of the two species. The sites were within 10-12 km of Adelaide city centre, climbing from 70 m elevation and 500-600 mm annual rainfall at Shepherds Hill, through 240-330 m elevation and 680-760 mm mean annual rainfall at Wittunga, Craigburn and Belair, to 520 m elevation and 1190 mm mean annual rainfall at Mt Lofty.

Population estimates of rosellas at the study sites were made by walking 500-1000 m transects through the sites and counting all the birds 50 m either side of the transect.

Behavioural data examined activity budgets, habitat use and interactions between the two species, in order to see: whether the rosellas frequented different parts of the habitat; and whether there was evidence that one species was excluding the other from particular habitats. From February-September 1990 the observations focused on the behaviour of individual birds in flocks, with one or two individual birds from a flock being observed for up to 10 minutes and behaviour recorded every 20 seconds.

There was no distinction made between central and peripheral birds (cf. Westcott and Cockburn 1988).

From September-December 1991 observations were collected in a different way, by noting the behaviour of each individual bird once only (except those obviously disturbed by the observers) as it was first seen. The nature of agonistic interactions (i.e. inter- or intraspecific) were recorded in 1991 as part of the behavioural profiles.

Activity profiles of rosellas were recorded on flocks and individuals. Behaviour of individuals was observed with binoculars, usually from 20 to 30 m away. The behaviour of rosellas both in flocks and individually was classified into the following categories (after Magrath and Lill 1983, 1985): foraging, vigilance, resting, maintenance, climbing, flying, agonistic, reproductive behaviour and communication.

For each flock encountered, its size, the date, time of day, temperature, and location within the study site (plotted on 1:5000 topographic map) were recorded. The vegetation stratum (on the ground, in shrubs, small trees <10 m, or tall trees >10 m) in which birds were observed was also recorded. The sex of Eastern Rosellas, and juvenile or adult status of Adelaide Rosellas were recorded: juvenile Adelaide Rosellas are olive green in comparison to the red and blue adults, and female Eastern Rosellas are markedly duller in colour than males.

Feeding records were taken during 1990 from birds observed foraging, with one feeding record from each bird.

Nesting data including the timing of nesting, position of nest sites within the tree and its habitat were obtained during the 1991-92 breeding season (October-December). Systematic searches at Belair, Mt Lofty and Craigburn identified active nesting sites. The criteria to identify occupied nests were: observing young in the nest, seeing parents feeding the young in the nest cavity, hearing vocalisations of the young in the nest, or seeing birds frequently entering and leaving the hollow. The environmental surroundings, nest position within the tree (including height) were noted. Also recorded were distances between neighbouring rosella nests, and between nests and nearest unused suitable hollow.

RESULTS

Population estimates

In Shepherds Hill Reserve two counts of 500 m transects in October 1990 gave estimates of 27 Adelaide and 5 Eastern rosellas per 10 ha. Similar counts in Belair National Park in October 1990 gave estimates of 64 Adelaide and 55 Eastern rosellas per 10 ha. Transects (500-1000 m) through entire study sites in May 1992 gave population estimates (averaged from 2 counts, expressed as density per 10 ha ± standard deviation) of 48 ± 4 Adelaide

Table 1. Study sites where Adelaide and Eastern rosellas were observed

Study site	Rosella population	Habitat
Shepherds Hill Reserve (study area 50 ha)	both, with majority of Adelaide Rosellas	mainly dry sclerophyll forest
Wittunga Botanic Gardens (study area 20 ha)	mostly Eastern Rosellas, occasional Adelaide Rosellas	well-maintained lawns, many introduced plants intermingled with wide variety of Australian genera
Craigburn Agricultural Farm (study area 35 ha)	mostly Eastern Rosellas, small population of Adelaide Rosellas	open pastoral, patchily distributed eucalypts, small patches of *Olea europa*
Belair National Park (study area about 20 ha)	both species in abundance	well-maintained playing fields surrounded by dense native scrub, introduced trees and eucalypts
Mounty Lofty Botanic Gardens (study area about 25 ha)	Adelaide Rosellas only	eucalypts with sclerophyll understorey of native plants, variety of introduced trees and shrubs

Rosellas at Mt Lofty, 16 ± 2 Eastern and 4 ± 3 Adelaide rosellas at Craigburn, and 62 ± 8 Adelaide and 38 ± 6 Eastern rosellas at Belair.

Flock sizes

From February to September 1990 the most common flock size was two for both Adelaide Rosellas (74 of 161 flocks) and Eastern Rosellas (79 of 125 flocks). During the nesting season (October-December) solitary birds were more common, possibly indicative of breeding females on the nest. At Belair, where both species were common, the numbers of birds in 154 flocks were recorded (Fig.1): 58 flocks of Adelaide Rosellas (mean size 3.4 birds), 67 flocks of Eastern Rosellas (mean size 2.9 birds) and 29 mixed flocks (mean size 9.1 birds). The flock size distributions of Adelaide and Eastern rosellas in single-species flocks were not significantly different [χ^2 4df = 4.7: p > .05], whereas the flock size distributions of mixed flocks were significantly different from the single-species flocks [$\chi^2$8df = 71.4: p << .01]. The mixed flocks were almost all seen foraging on the grassed playing fields, and some had additional species such as Red-rumped Parrots *Psephotus haematonotus* (two occasions) and Galahs *Eolophus roseicapilla* (five occasions). Analysis of the composition of 26 mixed flocks where the numbers of Adelaide and Eastern rosellas had been counted showed approximately equal numbers of birds of the two species (mean 4.0 Adelaide Rosellas, 4.3 Eastern Rosellas), with the most common flock size for each species 2 birds (Adelaide Rosellas 9 cases, Eastern Rosellas 8 cases). The flock size distributions of Adelaide Rosellas in single-species flocks and mixed species flocks were not significantly different [$\chi^2$2df = 5: p > .05], whereas the flock size distributions of Eastern Rosellas in single-species and mixed flocks were significantly different [$\chi^2$2df = 8.2: p < .05], with slighty more Eastern Rosellas on average in a mixed flock than a single-species flock. The data can be interpreted as showing that at Belair, the composition of mixed flocks is equal to the composition of single-species flocks summed together, but with a slight increase in the numbers of Eastern Rosellas found in mixed flocks.

Behavioural profiles

Between February and September 1990 a total of 68. 7 hours (n = 538 sessions) was spent observing the behaviour of individual birds (mean 7.7 minutes per bird). Eastern Rosellas were observed for a total of 7.4 hours at Shepherds Hill, 5.4 hours at Wittunga (June-July only) and 20.6 hours at Belair. Adelaide Rosellas were observed for a total of 15 hours at Shepherds Hill, 16.2 hours at Belair and 4.1 hours at Mt Lofty (June-July only). Using the single-record method, the following data were collected between September and December 1991: 1204 individual observations of Adelaide Rosellas at Belair, and 1444 at Mt Lofty. 1277 individual observations for Eastern Rosellas were recorded at Belair, and 999 at Craigburn.

Statistical analyses of the 1991 data for foraging and vigilance levels showed significant variation monthly (Sept.-Dec.) at each site [Adelaide Rosellas at Belair χ^2 3df = 21.8: p < .01; Eastern Rosellas at Belair χ^2 3df = 28.1: p < .01; Adelaide Rosellas at Mt Lofty χ^2 3df = 30.2: p < .01; Eastern Rosellas at Craigburn χ^2 3df = 27.3: p < .01], between species at Belair [χ^2 1df = 154:

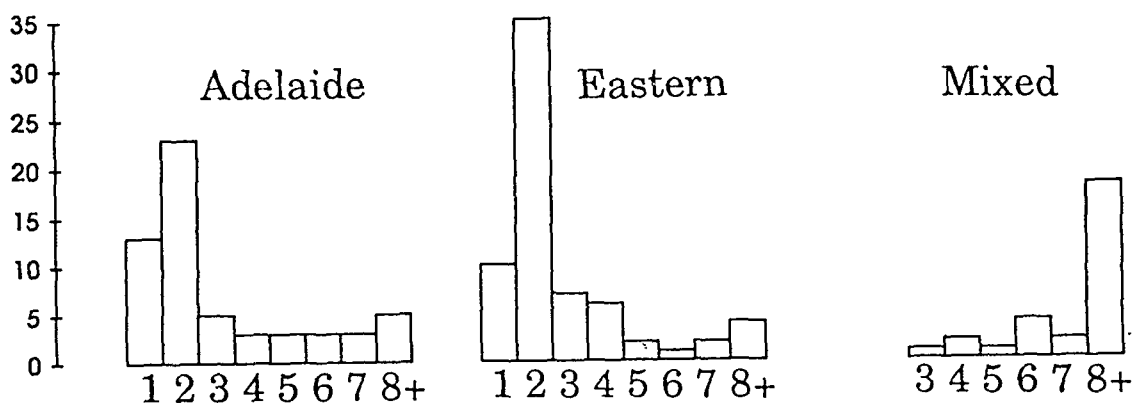

Figure 1. Histograms showing the flock sizes (1-8 + birds) of 58 Adelaide, 67 Eastern and 29 mixed rosella flocks at Belair, February-September 1990

$p << .01$, see Fig. 2], and between sites for Eastern Rosellas at Craigburn and Belair [χ^2 1df = 141: $p << .01$] and Adelaide Rosellas at Mt Lofty and Belair [χ^2 1df = 14: $p < .01$]. The 1990 data for foraging showed similar monthly, site-related and species-related variations, but were not analysed statistically because of the difficulties in handling samples which are not independent, there being an average of 24 consecutive observations taken from each individual bird. The levels of other behaviours recorded varied in similar ways.

Figure 2 contains four pie diagrams summarising the behavioural profiles of Adelaide and Eastern rosellas at Belair National Park in 1990 and 1991. The sampling methods used in 1990 and in 1991 bias data collection differently, accounting for large differences in behavioural profiles between the observation methods. One would expect the single record method to give higher values for flying, and the continuous observation method to give higher values for more sedentary activities such as foraging and vigilance, since flying birds often were sighted

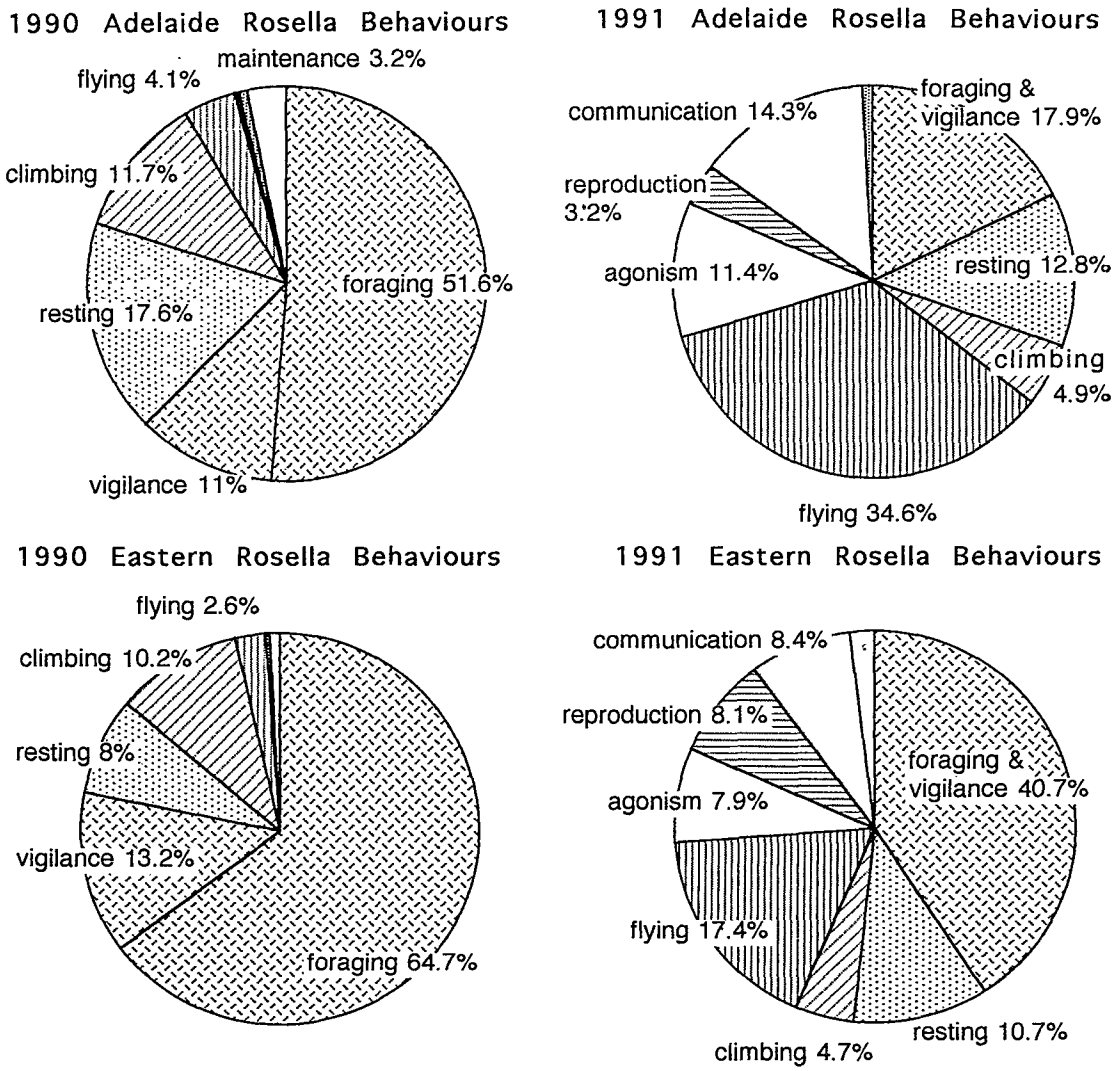

Figure 2. Pie charts showing the activity budgets of Adelaide and Eastern rosellas at Belair Feb-Sept 1990 (left) and Sept-Dec 1991 (right). The 1990 data were accumulated by watching individual birds (124 observations of Adelaide Rosellas, 151 of Eastern Rosellas) at 20 sec intervals for 2-10 mins and emphasised sedentary activities, particularly foraging and vigilance. The 1991 data comprised observations of the activity of each bird as it was first seen (1204 observations of Adelaide Rosellas, 1227 of Eastern Rosellas) and showed higher levels of flying, agonism, reproductive behaviour and communication than the 1990 data.

for less than one minute before they disappeared from view, and could not therefore be included in data which depend on being able to observe an individual bird for up to 10 minutes. Both methods of data collection are valuable: the single record method counts common behaviours such as flying, which are not well detected by the continuous observation method, but does not provide information about ongoing behaviour of individual rosellas; the continuous observation method provides information about the behaviour of individual birds which remain within sight for up to 10 minutes, but takes less account of behaviour of birds which are only briefly seen.

The two sets of data for Adelaide and Eastern rosellas at Belair (Fig. 1) confirm the expectations listed above. The 1990 data collected by continuous observation of individual birds gave much higher values for foraging + vigilance (62-78% of time during the day) than the 1991 data collected by single record observations of individual birds (18-41% of time), and much lower values for flying (3-4% of total activity) than the 1991 samples (17-35% of total activity). In addition communication, agonistic and reproductive behaviour were low in the 1990 samples (<1% of total activity) but together make 24-29% of total activity in the 1991 samples, probably because 1991 data were collected leading up to and during the breeding season. The data collected in 1990 and 1991 at Mt Lofty for Adelaide Rosellas show a similar trend, with values for flying and combined communication, agonistic and reproductive behaviour low in 1990 (4.5% and 1% of time, respectively) and high in 1991 (29.5% and 27% of time, respectively).

The data on agonistic interactions recorded in 1991 during the breeding season are presented in detail since they provide a measure of direct contact, and therefore possible inter-species competition. For Adelaide Rosellas agonistic interactions were 9% of activity at the single species site (Mt Lofty) and 11% at the dual species site (Belair), implying no great increase in agonistic behaviour derived from interspecific competition. Similarly, for Eastern Rosellas there was little evidence of increased agonistic interactions derived from interspecific competition, since agonistic interactions were 8% of activity in Belair, the dual species site, and 17% of recorded activity at Craigburn, which had few Adelaide Rosellas.

At Belair 110 agonistic interactions were recorded between rosellas, 54 Adelaide-Adelaide interactions, 38 Eastern-Eastern interactions and 18 Adelaide-Eastern interactions. The relative numbers of conspecific interactions, with slightly more Adelaide-Adelaide than Eastern-Eastern interactions, reflected the population densities of the two species at Belair, where there were slightly more Adelaide Rosellas than Eastern Rosellas, and suggest that the two species are similar in the levels of aggressive behaviour which they display. The number of intraspecific interactions (92) was much greater than the number of interspecific interactions (18). The number of interspecific interactions is significantly less than would be expected if it were assumed that encounter rates of birds is determined by the relative frequencies of Adelaide and Eastern rosellas [χ^2 1df = 49: $p << 0.01$], and suggested that interspecific competition is not an important factor at Belair.

Vegetation level/strata

Table 2 shows the distribution of birds among four strata levels at four study sites in 1990. When species data from all sites is pooled, a clear trend emerges, with the majority of Eastern Rosellas being observed at ground level (172/245), and (213/295) Adelaide Rosellas being observed in trees. For the dual species sites, the difference in the numbers of Adelaide and Eastern rosellas observed on the ground and in trees and shrubs was significant [for Shepherds Hill χ^2 1df = 26: $p << 0.01$; for Belair χ^2 1df = 63.9: $p << 0.01$]. These statistical tests confirm the differences apparent on site.

Table 2. Total numbers of birds observed in various vegetation strata

	Eastern Rosella			Adelaide Rosella		
	Belair	Wittunga	Shep. Hill	Belair	Mt. Lofty	Shep. Hill
Ground	129	29	14	57	18	1
Shrub	2	7	0	5	0	1
Sm tree	12	4	26	37	4	42
Lge tree	4	1	17	37	13	80

Table 3. Total numbers of birds observed feeding at ground or shrub/tree level

Feeding	Eastern Rosella			Adelaide Rosella		
Level	Belair	Wittunga	Shep. Hill	Belair	Mt. Lofty	Shep. Hill
Ground	120	28	21	77	10	0
Shrub/tree	13	8	16	31	10	37
Totals	133	36	37	108	20	37

Foraging level

Table 3 summarises results of feeding observations in 1990, with 165 feeding records from Adelaide Rosellas, and 206 from Eastern Rosellas. Eastern Rosellas fed predominantly on items obtained from the ground, taking grass seeds, and acorns when these were available at Belair. Adelaide Rosellas took more items from trees and shrubs, including eucalypts, oaks and olives, than did Eastern Rosellas. At Belair, Eastern Rosellas were observed more frequently foraging on the ground than in trees or shrubs, compared with Adelaide Rosellas [χ^2 1df = 13.1: $p << 0.01$]. These results are in accordance with the observations above of the preferred vegetation strata levels occupied by the two species.

Nesting data

In 1991 a total of 37 nest hollows were identified and characterised: for Eastern Rosellas nine at Craigburn and 11 at Belair; for Adelaide Rosellas 10 at Mt Lofty and seven at Belair. Table 4 shows vegetation density surrounding nesting trees. Adelaide Rosellas mainly selected nest holes in eucalypt trees more densely surrounded by shrub and trees, whereas Eastern Rosellas chose nest holes in eucalypt and willow trees located in more open areas, and at Belair did not nest in the sclerophyll forest.

Inspection of nest hollows by other pairs of parrots (including rosellas), was frequently observed, and as a consequence there were agonistic interactions in the vicinity of some of these nest holes. The most common agonistic interactions were between con-specifics, less common between hetero-specific rosellas, and least common between rosellas and other parrots such as Rainbow Lorikeets *Trichoglossus haematodus*.

Nest heights and inter-nest spacing are shown in Table 5. At Belair the mean distance from the nearest con-specific nest for both Eastern and Adelaide rosellas (34-45 m) was similar to the mean distance to the nearest nest of the other species (49-55 m), and similar to those for Eastern Rosellas around Armidale (Brereton and Sourry 1959). Distances to the nearest unused hollow were significantly lower than those between used nests, suggesting that spacing between rosella nests was enforced, or that nearby unused hollows were unsuitable as nest

Table 4. Total numbers of nests found and vegetation densities surrounding nesting trees

Vegetation around nest		Eastern Rosella		Adelaide Rosella	
		Belair N=11	Craigburn N=9	Belair N=7	Mt. Lofty N=10
Grass	dense	10	9	4	3
	medium	1	0	0	2
	sparse	0	0	3	5
Shrub	dense	0	0	3	5
	medium	5	3	2	4
	sparse	6	6	2	1
Trees	dense	0	0	0	0
	medium	2	2	6	7
	sparse	9	7	1	3

Table 5. Mean nest heights, ranges, inter-nest spacing and distances between nests and nearest unused hollow in 1991. All measurements given are in metres.

Nest site parameters	Eastern Rosella		Adelaide Rosella	
	Belair	Craigburn	Belair	Mt. Lofty
Total number of nests	11	9	7	10
Height range	3 - 7.5	2 - 10	4 - 12	0 - 15.5
Mean height ± S.D.	5 ± 1.5	4.5 ± 2.5	7.4 ± 2.7	7.7 ± 4.6
Dist. to con-specific nest	45 ± 37	44 ± 14	34 ± 15	37 ± 25
Dist. to hetero-specific nest	49 ± 23		55 ± 36	
Dist. to nearest hollow	8 ± 6	10 ± 10	7 ± 5	21 ± 12

hollows. However, less closely related birds appeared to be more tolerant of spacing between nests - the closest neighbouring psittaciform nests observed were a pair of Eastern Rosellas and a pair of Musk Lorikeets *Glossopsitta concinna* nesting approximately 3 m apart. Enforced spacing of nest sites by con-specifics is known in two cockatoo species, Carnaby's cockatoo *Calyptorhynchus funereus* (Saunders 1982) and the Pink or Major Mitchell's Cockatoo *Cacatua leadbeateri*, which is intolerant of breeding con-specifics within 2 km of an active nest (Rowley and Chapman 1991).

Statistically significant height differences were apparent between Adelaide and Eastern rosella nests, with Adelaide Rosellas consistently nesting in higher positions (pooled data $t = 3.04$, $p = .005$).

Taken together, the observations on inter-nest spacing, choice of nest site, and agonistic interactions at nest sites indicate some competition for nest sites, but that it was most often between con-specific rosellas.

DISCUSSION

Habitat use

The results of this study demonstrate slight differences in niches of overlapping habitats used by Adelaide and Eastern rosellas. Generally, Adelaide Rosellas were observed in higher strata, both nesting and feeding, and Eastern Rosellas were more frequently observed in the lower strata, especially at ground level. This is in agreement with the observations of Cannon (1982, 1983) and Wyndham and Cannon (1985). The dietary data, though rather limited, are in accordance with the more extensive data of Barker and Vestjens (1989), who listed 50 plant and 15 animal species consumed by Eastern Rosellas, including a large range of ground items, and 18 plant and five animal species consumed by Adelaide Rosellas.

The distribution of the two rosella species, and their nesting sites, may be influenced by human modification of the Adelaide landscape, and could favour the spread of Eastern Rosellas in the Adelaide region. Eastern Rosellas, which have increased their numbers dramatically from the original population during the 1930s (Parker 1987; Blakers *et al.* 1984), predominated at Wittunga and Craigburn, sites extensively modified by human activities into gardens with lawns, and pastureland. Eastern Rosellas are common also in other areas where maintained lawns predominate (e.g. golf courses, parklands). Adelaide Rosellas predominated at Shepherds Hill Reserve, a site with natural scrub invaded by exotic weeds and grasses, and at Mt Lofty Gardens, which has areas of natural scrub together with well maintained gardens and lawns. The gardens and lawns at Mt Lofty looked to be suitable habitat for Eastern Rosellas, but this species was not seen at Mt Lofty during 1990-2, possibly because the site is surrounded by thick bushland.

What evidence is there for direct competition between rosella species?

Evidence for competition might have been expected at Belair, where numbers of the two species are closest, there were some mixed feeding flocks, and there were opportunities to observe competition for nesting sites. Observations on the mixed feeding flocks provided little support for direct competition: mixed feeding flocks were common (18.8% of total), and with relatively little agonistic behaviour observed between the birds in these flocks. Competition for nest hollows was frequently observed, since agonistic behaviour often resulted from rosellas (and often other parrots) inspecting or being close to nest hollows which were already occupied. However, agonistic interactions were mostly between con-specifics, and the detailed observations on nest hole characteristics suggest that Adelaide and Eastern rosellas had different preferences for nest locations. This could be because: a) they naturally choose different sites; b) they have been forced to diverge or c) one species chooses the best sites, the other takes what is left.

Apparently suitable unoccupied nest holes were noted close to known rosella nest holes. There are at least three possibilities why the hollows were unoccupied: a) the hollow characteristics may not have been suitable, b) the hollows may have been suitable but too close to occupied hollows, or c) the hollows may have been suitable but not required. It is likely that each of these possibilities will apply in particular situations; one way to choose among the possibilities would be to observe the occupancy rate of a collection of artificial nest boxes or nest holes placed in a particular habitat.

In conclusion, the results of this study show that although there is considerable contact between Eastern and Adelaide rosellas, there is little evidence for direct competition between the two species. However, there is evidence for differences in environmental use: Adelaide Rosellas are found more often in trees in natural bushland; Eastern Rosellas are found more often on the ground in parks

and gardens. Where habitats overlap, long term studies will be required to see whether one species is gradually excluding the other from particular environments and nesting sites.

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