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Article *in* Emu · September 1996

DOI: 10.1071/MU9960209

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Roosting of the Sulphur-Crested Cockatoo *Cacatua galerita*

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EMU Vol. 96, 209-212, 1996. Received 25-2-1996, accepted 1-3-1996

Sulphur-Crested Cockatoos *Cacatua galerita* may move considerable distances between night-time roosting sites and other areas where foraging takes place. Flocks may maintain a permanent roosting site and may occupy it for many years (Lamm & Calaby 1970; Frith 1976; Taylor & COG 1992). In south-eastern Australia they roost in various trees including eucalypts, casuarinas, melaleucas and leptospermums (Lamm & Calaby 1970; Cooper 1975). We describe the night-time roosting behaviour of *C. galerita*, the species of trees used and the characteristics of the remnant habitat patches occupied.

Methods

During September and October 1995, night-time spotlighting surveys were undertaken within 40 patches of remnant eucalypt forest located within an extensive area of exotic *Pinus radiata* plantation in the Buccleuch State Forest near Tumut, southern New South Wales (148°40′E, 35°10′S). The remnant patches were dominated by either Narrow-leaved Peppermint *Eucalyptus radiata*, Mountain Swamp Gum *E. camphora*, Red Stringybark *E. macrorhynca* or Ribbon Gum *E. viminalis*; other common species of eucalypts included Long-leaved Box *E. goniocalyx* and Broad-leaved Peppermint *E. dives*. The patches often also supported relatively tall understorey trees (up to 10 m in height) such as Silver Wattle *Acacia dealbata*, Broad-leaved Hickory Wattle *A. falciformis*, Blackwood *A. melanoxylon* and Cherry Ballart *Exocarpus cupressiformis*, as well as *P. radiata* that had invaded the remnants. These patches of eucalypt forest varied from approximately 0.4-40.4 ha and have been surrounded by *P. radiata* forest for 15-40 years. For each remnant patch, data gathered included: topographic position (i.e. gully, midslope, ridge or flat); dominant tree species; slope of the site, patch shape; geology (volcanic or granite); and the type of site (rocky area, steep hilltop, swamp or streamside reserve).

A series of transects, each 50 m apart and marked with coloured flagging tape, was used to ensure that all areas of eucalypt forest within each of the 40 patches was surveyed. A total of 436.7 ha of eucalypt forest was surveyed in which 69.9 km of transects were walked; spotlighting time was approximately 65 hours. The primary aim was to survey populations of arboreal marsupials but observations of roosting by *C. galerita* were also made; we recorded the species of tree and the number of birds observed roosting. Most birds were not disturbed by spotlighting and remained in the tree where they were first observed; very few individuals moved so the risk of counting the same bird twice was minimal.

Results

Tree level results

Ninety-six per cent of 173 observations of *C. galerita* were in large *E.viminalis* trees; only seven birds were recorded roosting in *E. radiata*. No *C. galerita* were observed in any other species of tree during our extensive spotlighting surveys. *C. galerita* were never observed roosting in *P. radiata* trees either within the plantation, or in wildlings that had become established in the remnant eucalypt patches.

Patch level results

The total number of birds found roosting in each patch is shown in Table 1. The number of birds observed per patch varied from zero to 28; we usually observed a solitary bird or a pair of birds in any tree; more than two per tree were uncommon. *C. galerita* were absent from almost half of the survey sites (n = 18). Relationships between the presence and abundance of *C. galerita* and attributes of patches (e.g. size, dominant tree species, topographic position, etc.) were examined using generalised linear modelling (McCullagh & Nelder 1983). No variables were found to significantly influence the presence or absence of birds in a patch. However, given the presence of *C. galerita* in a patch, significant relationships were found between the abundance of birds and patch size, dominant tree species and whether the site contained a stream. More birds were

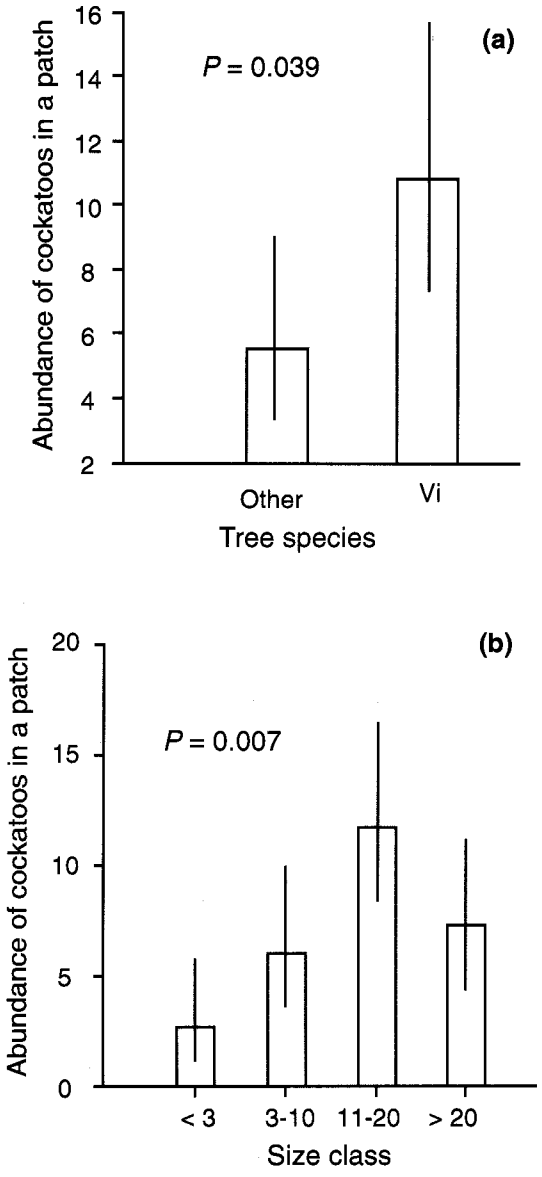

Figure 1 The relationships between measured attributes of remnant eucalypt patches and the abundance of Sulphur-Crested Cockatoos *C. galerita*. Note that the count data used in the analysis have been conditioned on the presence of one or more individuals in a patch (see text). Results are presented for the two of the three significant explanatory variables derived from generalised linear modelling: **(a)** the dominant species of trees (showing *E. viminalis* (Vi) and all other species of trees combined [other¹); and **(b)** the size of patch. The vertical bars are the 95% confidence limits associated with predictions from the analysis.

observed on sites dominated by *E. viminalis* than by other species of eucalypt (Fig. 1a) and that did not contain a watercourse. There was also a non-linear relationship between the abundance of *C. galerita* and the size of remnant patches (Fig. 1b). For each significant variable, an effect was identified by ignoring all other parameters. Thus, we identified three alternate models from our analyses, each with a single significant explanatory variable, which highlighted the existence of some dependence between the three significant factors.

Discussion

Our observations indicated that *C. galerita* exhibited a strong preference for *E. viminalis* trees as roosting sites, with only a small proportion of records from other typically much more common tree species in our study region. In several instances, birds used *E. viminalis* trees even when the species was represented by five or fewer individual stems within patches that supported several hundred other eucalypts. The reasons for this are not clear. It is possible that factors such as the branching angles and patterns, stem height and/or the density of foliage (each of which varies markedly between tree species), may have influenced the selection. Conversely, other reasons may account for our findings. For example, we gathered a number of records of *C. galerita* using hollows in *E. viminalis* (n = 8) but none from other species of trees although they often contained large cavities (particularly *E. radiata* and *E. goniocalyx*). Eucalypts vary markedly in patterns of cavity development (Lindenmayer et al. 1993) and the differences in the types of hollow that form may make some tree species unsuitable as nest sites (Gibbons & Lindenmayer 1996). It is possible that the apparent suitability of *E. viminalis* trees as potential nest sites for *C. galerita* may also influence their use as places to roost. Finally, our findings could be associated with differences in the colour of the bark of trees. The various species of eucalypts and understorey trees in our study areas have dark-coloured bark except *E. viminalis*, which is characterised by smooth, white bark that extends over most of the trunk and the branches. The colour of the bark may provide camouflage for *C. galerita* when they are roosting. One possible predator could be the Powerful Owl *Ninox strenua* which has been recorded in the more extensive areas of woodland and forest at the margins of our study area (DBL unpubl. data) and is known to prey on a range of relatively large birds (Tilley 1982; Lavazanian et al. 1994). However, we are unaware of

Table 1 Information on the abundance of the Sulphur-Crested Cockatoo *C. galerita* derived from surveys in the Tumut *P. radiata* plantation. Data in Part A highlight those patches where *C. galerita* was observed and values are the numbers of birds recorded in *E. viminalis* and *E. radiata* trees within each patch. Characteristics of patches where no birds were recorded are shown in Part B. The single letter codes in the column for the dominant tree species in each patch are: r = *E. radiata*; v = *E. viminalis*; c = *E. camphora*; and m = *E. macrorhynca*. Two or more species are listed where they are co-dominant in a given patch.

PART A: PATCHES OCCUPIED BY *C. GALERITA*

Patch	Size (ha)	Dominant species	Eucalypt roosted in: *E. viminalis*	*E. radiata*
D3	8.7	v	10	0
I2	5.0	v, r	5	1
198	40.4	c, v, r	10	0
449	9.0	v, r	5	0
433	22.1	c, v, r	3	0
E3	13.5	v	5	0
I1	9.1	c, v, r	7	0
C3	20.1	r	13	2
102	6.6	r	2	0
335	2.4	r	3	0
U3	20.5	r	5	0
419	1.6	c, r	2	0
599	16.2	v, r	7	1
490	1.6	r	1	0
276b	20.5	v,r	14	2
276a	20.7	v, r	28	0
446	30.1	r	11	0
353	12.7	v	10	0
B3	0.8	r	4	0
569	2.3	r	2	1
T3	18.7	v	16	0
Totals	282.6		166	7

PART B: PATCHES WHERE *C. GALERITA* WAS ABSENT

Patch	Size (ha)*	Dominant trees
389	0.4	r
369	18.9	r
114	0.6	m, r
422	38.0	c, v, r
V3	9.0	v
700	5.6	r
567	0.7	r
115	0.7	m, r
K1	4.1	r
365	1.7	r
I4	2.0	r
325	1.0	r
235	15.1	c, r, v
S3	10.6	c
632	4.9	r, v
310	18.8	v, r
661	4.4	r
258	15.1	c, r

* The total area of forest in the patches where *C. galerita* was not observed (i.e. in Part B of Table 1) was 154.1 ha.

any records of *C. galerita* as a prey item of *N. strenua*.

The prevalence of *C. galerita* roosting in *E. viminalis* was consistent with the larger number of birds recorded from remnant patches dominated by this tree species. The larger number of *C. galerita* observed in patches of *E. viminalis* may have been related to existence of more suitable roosting sites in these areas. Fewer birds were recorded from the smaller patches of remnant forest, although this relationship was not linear because more animals were recorded in patches 11-20 ha than those > 20 ha in area (Figure 1b). This finding highlights some confounding between our explanatory variables as most of the patches in the 11-20 ha size class were dominated by *E. viminalis* that was potentially where more roosting sites were likely to occur.

Our studies indicated that many remnant patches of eucalypt forest near Tumut provide roosting and nesting places for *C. galerita*. The species is able to locate these sites even though some are within extensive areas of *P. radiata* plantation and several kilometres from more extensive stands of unfragmented native vegetation or grazed pastures. *C. galerita* were often seen flying over the *P. radiata* plantation late in the afternoon, presumably seeking a patch in which to roost. *C. galerita* is known to maintain a long-term affinity with particular roosting sites (Lamm & Calaby 1950; Taylor

& COG 1992) and it is possible that groups of birds have maintained traditional use of some habitat patches as roosting sites despite the major changes in the landscape that have occurred as a result of the establishment of the *P. radiata* plantation over the past few decades.

Acknowledgements

Field studies at Tumut are supported by The Land and Water Resources Research and Development Corporation, N.S.W. National Parks and Wildlife Service, State Forests of N.S.W., Canberra Ornithologists Group and Brookfield Zoo, Chicago, U.S.A. We are most grateful for the assistance provided by these organisations. Peter Higgins from the RAOU provided the draft text on the Sulphur-crested Cockatoo from presently unpublished Volume 4 of the *Handbook of Australian, New Zealand and Antarctic Birds*. Comments by Bruce Lindenmayer, McComas Taylor and Karen Viggers improved earlier versions of the manuscript.

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