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## Observations on the Breeding of White-browed Woodswallows

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White-browed Woodswallows *Artamus leucorhynchus* invaded the Southern Tablelands of New South Wales during the summer of 1980. The invasion was correlated with drought conditions further west and a nesting colony was established on one of our study plots near the Bondi State Forest. The success of this colony was affected by predators, storms and possibly by the number of birds in the colony.

The White-browed Woodswallow *Artamus leucorhynchus* is most abundant in eastern Australia, tending to winter north of the Tropic of Capricorn and migrating south to nest in the drier inland during the spring and summer (Keast 1958; Reader's Digest 1976; Pizzey 1980). Movements of this species are not always predictable and from time to time large numbers appear on the coast of southeastern Australia where they then nest (D'Ombra 1934; Keast 1950; Sharland 1972).

The appearance of White-browed Woodswallows on the coast is correlated with dry conditions in the interior (Keast 1958). During 1979 and 1980 southeastern Australia was affected by drought (Recher *et al.* ms) and in the summer of 1980-81 White-browed Woodswallows invaded much of eastern New South Wales (Lindsey 1981) including the Southern Tablelands. Although this is within their normal range (Pizzey 1980), we had not recorded them during six years of faunal survey in that part of the state (Recher *et al.* 1980). The birds settled on one of our study areas (Woodlot 2) at the Bondi State Forest (37°07'S., 149°08'E.) near Bombala. In this paper we present our observations on the breeding of this colony.

### Results

#### Arrival

The first woodswallows were recorded flying overhead on 11 November 1980 and a few individuals were observed foraging on Woodlot 2 on 12 November. They did not settle on the plot in numbers until 20 November and over the next few weeks as many as 150 individuals were recorded during censuses. Flocks and nesting colonies of woodswallows were also found at a number of places in the Bondi and Coolangubra State Forests east of Bombala and in the drier country southwest of Bombala near the Delegate River. At about the same time S. Marchant (*in litt.*) recorded White-browed Woodswallows near Moruya (35°55'S., 150°05'E.) on the New South Wales coast and inland at Braidwood (35°27'S., 149°48'E.). This is Marchant's only record of White-browed Woodswallows at Moruya in observations spanning 18 years from 1963 to 1982. The birds did not nest at Moruya, but did nest in the town of Braidwood during November and December. Marchant had previously recorded woodswallows nesting not far from Braidwood near the Shoalhaven River on one or two occasions

in the 1960's. From these observations it is clear that White-browed Woodswallows invaded a large part of southeastern New South Wales during 1980, but relatively few birds penetrated to the coast and these probably did not nest.

Ten of 31 woodswallows caught on 23 and 24 November on Woodlot 2 had well-developed brood patches. Perhaps these birds had recently nested but were unsuccessful. Sharland (1972) commented that White-browed Woodswallows sometimes desert nests and eggs before breeding is complete. All the birds caught were adults and no immature or young birds were observed among the flocks near Woodlot 2.

### Nesting

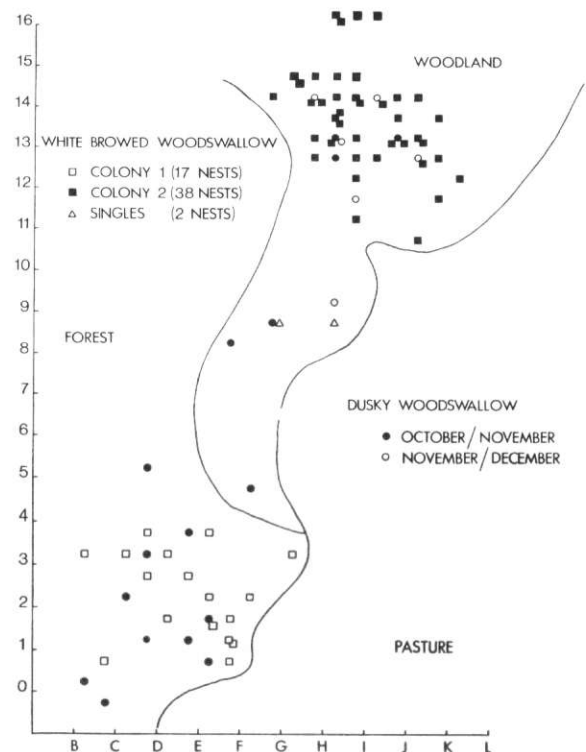
By 22 November the woodswallows on Woodlot 2 were building nests. Gwynne (1932), D'Ombra (1934), Keast (1950) and Sharland (1972) reported that nesting began almost immediately after a flock had settled on an area. As we observed at Bondi, the establishment of a nesting colony is commonly preceded by flocks of birds flying overhead and perhaps landing for brief periods (Keast 1950; Lowe and Lowe 1972). Other than this flocking there was no social or courtship behaviour other than pre-copulatory displays and the feeding of females by males which preceded nest building. Obviously the birds were paired before settling.

Females solicited copulation when perched. The tail was lowered, spread and wagged from side to side. Males may also have displayed in this fashion. The display is similar to that used by Dusky Woodswallows *A. cyanopterus* (HFR, pers. obs.). Within a colony reproductive activities were synchronized. Of nine nests for which we recorded the date the first egg hatched, three hatched on 9 December, two on 10 December and four on 11 December. By 27 December all young had fledged.

White-browed Woodswallows nest in loose colonies (Austin 1972; Reader's Digest 1976) and on Woodlot 2 there were two groups of nests (Fig. 1). One contained 17 and the other 38 nests. Two isolated nests were built.

The plot on which the woodswallows nested is bounded on one side by a road and on two sides by pasture. The edge of the pasture is dominated by sapling Snow Gum *Eucalyptus pauciflora* and Black Sally *E. stellulata*. Away from the edge the woodlot is dominated by

Narrow-leaved Peppermint *E. radiata* and Mountain Gum *E. dalrympleana*. The two groups of nests were about 200 m apart along the edge of the pasture. The larger group was in a mixture of young Manna or Ribbon Gum *E. viminalis*, large Snow Gum and Black Sally with about half the nests in the Snow Gum woodland and half in the second-growth forest of Manna Gum. Of the 38 nests, three were built in shallow cavities where the trunk of the tree had broken off, 14 were behind loose bark on the tree trunk and 21 were in forks where the trunk branched. The smaller colony was centered on a group of Peppermints which had been burnt in 1979. The burnt trees had developed a dense epicormic growth. Ten of the



● Figure 1. The position of woodswallow nests on Woodlot 2 during late November and December, 1980.

17 nests were located in this growth and the others in shallow cavities where trunks or branches had broken off. The height of the the canopy in both colonies was between 12 and 18 metres.

Dusky Woodswallows nest on Woodlot 2 each year and five nests were active when White-browed Woodswallows were nesting. The two species nested in about the same parts of the Woodlot (Fig. 1), but chose slightly different nest sites. Based upon data from 1976 through 1981, Dusky Woodswallows tend to build their nests higher above the ground than White-browed Woodswallows and nest in taller trees (Table 1). Both species nested in the most common trees, but Dusky Woodswallows nested more often in Peppermints and Manna Gums, probably because they selected taller trees. Both woodswallows weave a loose nest of twigs, roots and grass (Reader's Digest 1976) and the most important feature of a nest site for these birds appears to be a solid base on which or against which a nest can be positioned.

In addition to nesting on Woodlot 2, White-browed Woodswallows nested in nearby Monterey Pine *Pinus radiata* plantations. A colony with 44 nests was found two kilometres west of our study area in pine which had been planted on pasture in 1974. The pines averaged 2.3 m in height. There was a dense, grassy ground cover. The nests in this colony averaged 1.5 m above the ground, but were as low as

90 cm and as high as three metres. We have not recorded Dusky Woodswallows nesting in young pines, but they nest in tall pines at the edge of mature plantations.

Nests were completed in two to three days. D'Ombra (1934) reported that five of six nests which he observed closely were completed in two days and the sixth in three days. Both sexes constructed the nest, but D'Ombra thought that the male put more effort into building than the female. Our observations are inadequate on this point.

#### Clutch Size and Incubation

Eggs were laid soon after the nest was completed and the first eggs were found on 29 November. We were able to count the number of eggs or young in 34 nests. However, we did not visit nests daily and so some eggs or young may have been lost without having been recorded. In 12 nests the clutch size was three, in 20 it was two and in two it was one. Such data cannot be used to calculate average clutch size (Marchant *in litt.*). Courtney and Marchant (1971) accepted clutches as complete if the same number of eggs was recorded on two visits more than 24 hours apart. Using this criterion clutch size may still be underestimated, but it is more reliable than estimates based on single visits. We recorded the same number of eggs at intervals of 24 to 72 hours in 16 woodswallow nests. Five had clutches of three, 10 had clutches of two and one had a single egg. The average for these nests was  $2.3 \pm 0.1$  eggs. Three is the maximum clutch size recorded in the literature or reported in the RAOU Nest Record Scheme. Courtney and Marchant (1971) reported the average clutch size of 12 nests from the ACT, Riverina and Victoria as  $2.3 \pm 0.1$  and of 14 nests from Swan Vale and Armidale as  $1.9 \pm 0.1$ .

D'Ombra (1934) reported that the first two eggs were laid on successive days, but if a third egg was laid, this was several days after the second. An observation from South Australia in the RAOU Nest Record Scheme shows two eggs on 25 through 29 October 1978, but three eggs on 1 November. Possibly the third egg had been overlooked, but if not, it means that at least three days elapsed between the laying of the second and third eggs. It is not clear when incubation begins. The birds sit on the eggs as soon as they are laid and in nests with

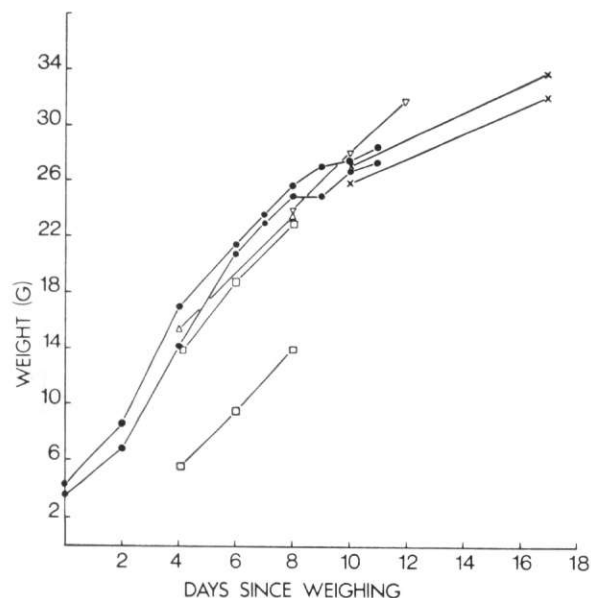
TABLE 1

Nest site selection by woodswallows

	White-browed Woodswallow	Dusky Woodswallow
	(n = 57) $\bar{x} \pm \text{SE}$	(n = 31) $\bar{x} \pm \text{SE}$
Nest Height (m)	$7.8 \pm 0.7$	$9.8 \pm 1.0$
Tree Height (m)	$11.2 \pm 0.8$	$13.9 \pm 0.9$
Tree Species (%)		
<i>Eucalyptus pauciflora</i>	43.1	33.3
<i>E. radiata</i>	27.6	33.3
<i>E. stellulata</i>	12.1	3.0
<i>E. viminalis</i>	17.2	30.3

White-browed Woodswallow nests recorded late November-December, 1980. Dusky Woodswallow nests recorded between 1976 and 1980.

two eggs, it appears that the young hatch within 24 hours of each other. In nests with three eggs, incubation may be delayed. D'Ombain (1934) found that in nests with three eggs the young were ready to leave together. Close to the time they were ready to fledge, we weighed the young of two nests with three nestlings. In one the smallest chick was 3.5 g (12% of body weight) lighter than the largest; in the other the difference was 1.5 g. The differences in weight were not greater than between nestlings in nests with two young (Fig. 2). In one clutch of two, there was an 8.5 g difference between the chicks when first weighed, but one egg or young may have been taken by predators before we found the nest. Both chicks increased in weight at about the same rate and despite the disparity in size, left the nest together.



● Figure 2. The growth rate of nestling and fledgling White-browed Woodswallows. Only two birds were weighed from the day they hatched and the position of other nestlings on the graph has been fitted to the growth curve of these two individuals. The same symbols have been used to illustrate nestlings from the same nest.

Both sexes incubated, but we recorded females on the nest more often than males. Of 112 observations of incubating birds made during the day, females were on the nest on 64 occasions and males on 48 occasions. The difference is not significant ( $\chi^2 = 2.286$ ;  $p > 0.1$ ). D'Ombain (1934) reported that in most cases it was the male which incubated at night. However, we made observations on 11 nests throughout the night on three different nights and each time the female was on the nest. Only once was a male found on a nest after sunset, but this was at 19:10 hours when it was still quite light.

### Growth Rates

Just before hatching eggs weighed from 3.5 to 4.5 g ( $n = 5$ ). As illustrated in Figure 2, nestlings grow rapidly and are ready to leave the nest 13 to 15 days after hatching. At this time they weigh between 28 and 32 g. Adults weigh an average of 38 g (unpubl. data;  $n = 38$ ). Nestlings 9 or 10 days old remained in the nest when handled, but older birds tried to desert. We prevented premature departure by returning chicks to the nest and covering them firmly with a cloth for about 30 minutes.

After fledging the young remain on the the ground near the nest for about two or three days. At an age of 16 to 18 days these young birds weigh 32 to 34 g (Fig. 2). Fledglings gain weight less rapidly than nestlings, but develop flight feathers and can fly short distances by 18 to 20 days of age. We could not locate fledglings older than about 21 days and concluded that within four weeks of hatching young birds join their parents and leave the nesting area. During January we observed juveniles flocking with and being fed by adults which suggests that young birds depend on their parents from some weeks after fledging.

### Reproductive Success

None of the birds in the smaller colony on Woodlot 2 reared young. All except three of these nests failed by 6 December and these three were lost on 9 December. Predators accounted for all nest losses in this group. A female Pied Currawong *Strepera graculina* regularly foraged on the plot and was quick to discover the woodswallow nests. On the morning of 29 November we watched her searching for nests and taking eggs. She moved through the canopy and scanned the vegetation below her. In this way

she was able to look down into nests which are quite conspicuous from above. Pairs of woodswallows attempted to defend their nest, but there was no group mobbing behaviour.

Eggs were laid in all of the 33 nests in the larger colony that we could check. Nine nests failed before the eggs hatched and six failed before the young were fledged. Five nests fledged one young and 13 fledged two young. None of the woodswallows on Woodlot 2 managed to rear three nestlings to fledging, but some nests in the pine plantation did produce three fledglings. Predation was also responsible for most nest losses in the second colony. Several nests, for example, were either pushed to the ground or pulled apart. The predator was probably a Brush-tailed Possum *Trichosurus vulpecula* which was resident in this part of the study area. At least two nests and several young in other nests were lost during 36 hours of cold rainy weather. In contrast to the smaller group, the woodswallows in this colony actively mobbed and pursued predators. Laughing Kookaburras *Dacelo novaeguineae*, Brown Goshawks *Accipiter fasciatus* and Pied Currawongs were attacked whenever they approached the colony.

The pattern of nests success in the pine plantation was similar. We did not visit this colony until 24 December, but it appeared that nesting began about one week later than on Woodlot 2. Between 24 and 29 December we found 44 nests of which 27 were empty, two had eggs and 15 had young. All of the young birds were fledged successfully. In the nests with eggs, one clutch was infertile and the second hatched eggs on 27 and 28 December. The two young left the nest on 7 January after weighing. Their departure was probably premature. The contents of at least three of the empty nests had been taken by predators and at two the incubating female had been killed and eaten. Cats *Felis catus* and Foxes *Vulpes vulpes* were common and either could have reached the nests.

#### *Foods and Feeding*

Nestlings were fed grasshoppers, cicadas and large flying insects. Insects were hawked from the air or snatched from vegetation. Grasshoppers (which were particularly abundant) were commonly caught on the ground by birds

pouncing from a low perch. Although White-browed Woodswallows nested in the same places as Dusky Woodswallows, the two fed in different ways. White-browed Woodswallows foraged mostly on open fields and along the edge of roads. Dusky Woodswallows hunted more often among the trees at the edge of the forest or hawked for insects above the canopy. White-browed Woodswallows also did a great deal of aerial foraging, but tended to fly much higher than the Dusky Woodswallows.

#### **Discussion**

White-browed Woodswallows move north during the winter and return south in spring and summer, but Keast (1958) called them 'inland nomads'. The main feature of nomadism is to 'bring the population where living conditions are good' (Keast 1980). A successful nomad must also be able to exploit favourable conditions to its maximum advantage.

We interpret our observations of White-browed Woodswallows in the following way. Drought in southeastern Australia during 1980 forced flocks of woodswallows to move further south and east than normal. Wherever birds encountered favourable conditions, they attempted to nest. Reproductive success depended on the birds finding sufficient food and on weather. Predation of nests is a secondary factor affecting reproduction and is strongly affected by the size of the colony, kinds of predators and security of nest sites. Diurnal predators can be driven away if the colony is large, but protection from nocturnal predators depends on the height and location of the nest. If the two groups on Woodlot 2 are a fair indication, colonies must be larger than 20 pairs for successful mobbing behaviour.

White-browed Woodswallows are opportunists. The ability of the birds to rapidly move long distances enables them to sample a wide range of conditions in a fairly short time. The flocking behaviour reported before nesting colonies are established may be part of the process through which birds locate and (to be anthropomorphic) assess conditions. It appears that birds within a flock are paired and capable of immediate reproduction. If food is abundant, nest construction and the laying of eggs begins at once. The birds exploit a wide range of foods (including nectar) (Lowe and Lowe 1972) and will use a



wide range of nest sites. Their flexibility in this regard enhances the ability of the birds to exploit locally abundant resources.

Saving time may be critical when food resources may be only temporally abundant. The quick construction of nests and laying of eggs saves time. If nesting fails, the birds move on and attempt to nest somewhere else. In view of the well developed brood patches on several birds when they arrived on Woodlot 2, it is likely that they had already attempted nesting and failed at another place. The delay in laying a third egg is interesting. It may be that the females require extra time to accumulate the reserves to form a third egg. Alternatively it may be produced in response to especially favourable conditions.

The rapid growth of the young and their ability to travel with the adults within four weeks of hatching is not substantially different from some other birds (e.g. New Holland and White-cheeked Honeyeaters *Phylidonyris novaehollandiae* and *P. niger*; D. Paton pers. comm.; Recher unpubl. data). It means that the woodswallows can move away from an area if food resources are not sustained. The desertion of nests reported by Sharland (1972) probably also occurs in response to changes in food abundance or to storms which interfere with foraging (e.g. D'Ombra 1934).

Nomadism is a feature of the Australian avifauna. Keast (1961) estimated that 26% of the avifauna was nomadic. The high degree of nomadism is related to Australia's erratic climate and there is a correlation between the movements of birds and patterns of rainfall and vegetative growth (Nix 1976). Our observations show that nomadism is characterized by a suite of ecological, behavioural and physiological adaptations which permit birds to locate and exploit temporarily favourable environments.

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