

## CHAPTER 5

## SOCIAL ORGANIZATION AND DAILY ROUTINE

## 5.1 POPULATION SIZE AND ORGANIZATION

At both field areas there appeared to be distinct populations of White Cockatoos (Fig. 10 and 11). The maximum range of the Swan Vale population was approximately 4,500 ha (45 sq. km), although activity by the majority during much of the year occurred within a smaller area of about 2,000 ha. At Wallangra the range of the population at Site A was 3,000 ha and at Site B was 2,500 ha. These Wallangra areas are probably underestimated since there may have been isolated nests which were not found in the areas between the Sites, where no White Cockatoos were observed.

The number of White Cockatoos in each of these populations fluctuated considerably over the study period of 33 months. Populations increased during autumn or immediately after the breeding season, and declined prior to the breeding season in both years, at both field areas (Fig. 12).

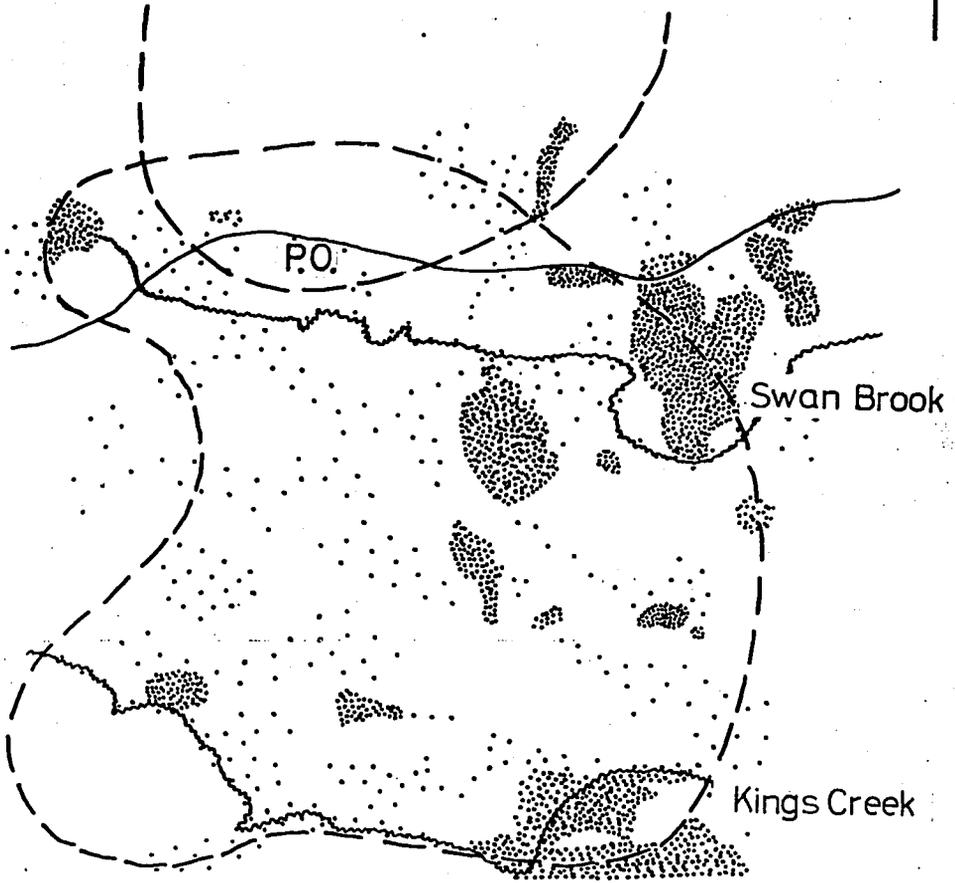
## a. SWAN VALE

The population fluctuated between 50 and 210 at Swan Vale (Fig.12a). The April to July increase in numbers coincided with the ripening of sunflowers which constituted the major food source in these months each year. The decrease in numbers from July to September coincided with the decline in sunflower availability as well as with the arrival of the breeding season. The remaining Cockatoos included those which bred from August to January as well as some apparently non-breeding birds. The latter could be found in flocks in resting, roosting or feeding areas during the day, and did not split up into pairs to

FIGURE 10RANGE OF THE  
WHITE COCKATOO POPULATION AT SWAN VALE

-  Gwydir Highway
-  Main creeks
-  "Home" range boundary
-  Forest
-  Woodland
- P.O. Post Office - Swan Vale

SWAN VALE



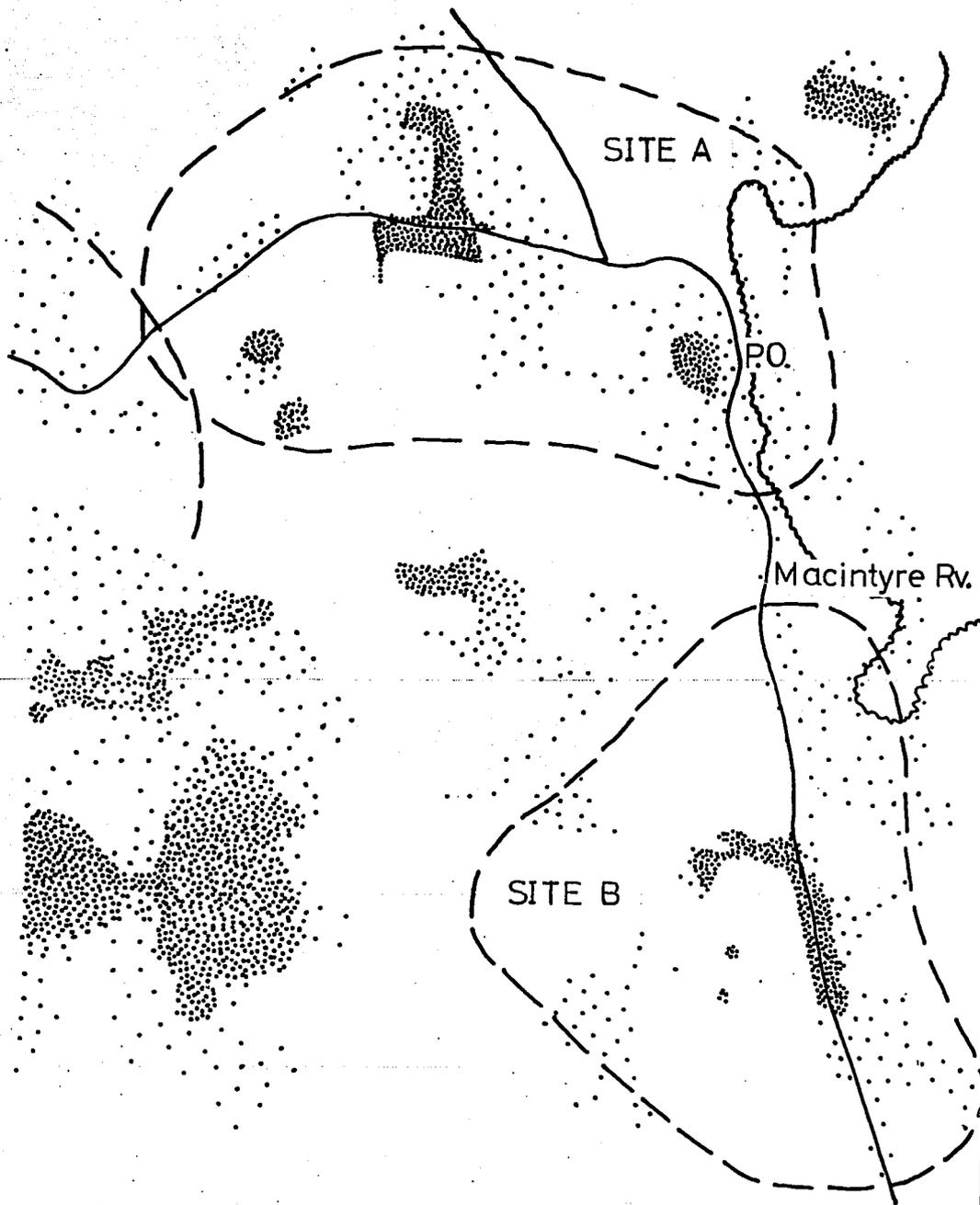
0 1 2 km

FIGURE 11

RANGE OF THE  
WHITE COCKATOO POPULATIONS AT WALLANGRA  
SITE A AND B

- \_\_\_\_\_ Main road  
~~~~~ Macintyre River  
\_\_\_\_\_ "Home" range boundary  
▒▒▒▒ Forest  
••• Woodland  
P.O. Post Office - Wallangra

WALLANGRA



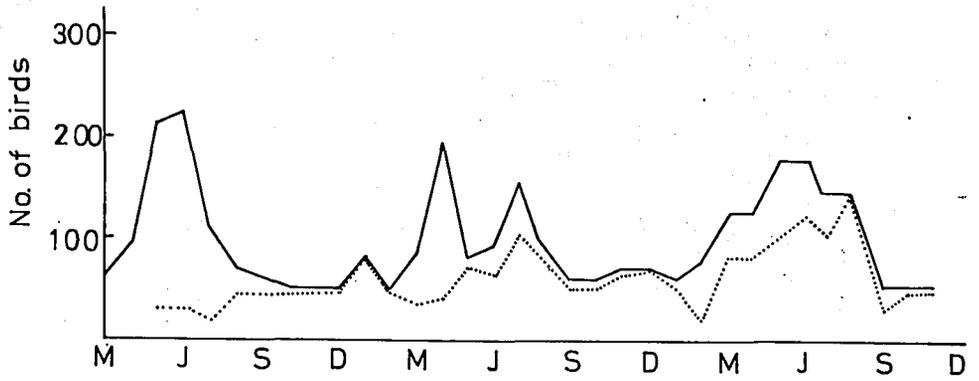
0 1 2 km

FIGURE 12

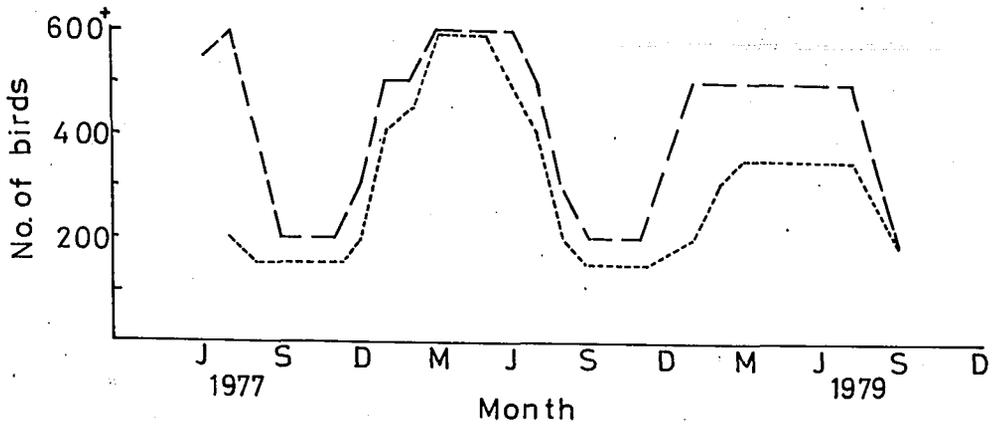
NUMBER OF WHITE COCKATOOS AT  
THE TWO FIELD AREAS EACH MONTH  
(1977 - 1979)

- a) \_\_\_\_\_ Numbers in the Swan Vale home range  
..... Numbers at the Swan Vale permanent roost site
- b) \_\_\_\_\_ Numbers in the Wallangra Site A home range  
----- Numbers in the Wallangra Site B home range

a. SWAN VALE



b. WALLANGRA



allopreen, sit close or attend nest trees. About 50 to 80 birds presumably formed the permanent population, present in every year of the study. Their range centred on a permanent roost site used for at least 10 years prior to 1977 (M.G.M. Woods and J.E. Courtney, pers. comm.). Nest trees were scattered throughout this range.

In 1977 (Fig. 12a) two influxes of Cockatoos increased the population in May and June. The two 'groups' were attracted to separate sunflower crops in both the Swan Brook and Kings Creek valleys within the range. At least four different temporary roost sites were used by these birds. The permanent population fed and some also roosted with the temporary population.

In 1978 two influxes occurred in March and April and a third in late June. The first influx fed with the permanent population in Swan Brook valley and roosted at the permanent roost site, while the second fed and roosted temporarily in Kings Creek valley. These latter birds were evicted by intensive shooting in early May. The third influx fed with the enlarged permanent population in the Swan Brook valley but roosted to the north of the Swan Vale range.

In 1979 the first influx of Cockatoos occurred in March with a further influx from May to July. These birds used both temporary and permanent roost sites, although in August all used the permanent roost. By late August in 1977, 1978 and 1979 the population had returned to late spring breeding levels again.

#### b. WALLANGRA

Both Site A and B at Wallangra supported larger populations than Swan Vale, although their ranges were comparable. The spring-summer populations consisted of at least 150-200 birds at both sites, but these were augmented each year by a further 300-500 birds in autumn.

At Site A (Fig. 12b) an increase in numbers occurred directly after breeding in December in both years. In 1978 an additional increase occurred in March, whereas in 1979 numbers appeared fairly stable from January to July. From July to September the population decreased leaving a permanent population of at least 200 birds. Numerous smaller flocks were dispersed over the home range so that population numbers may be greatly underestimated. However, a decline in numbers present in September to December was apparent at Site A and B.

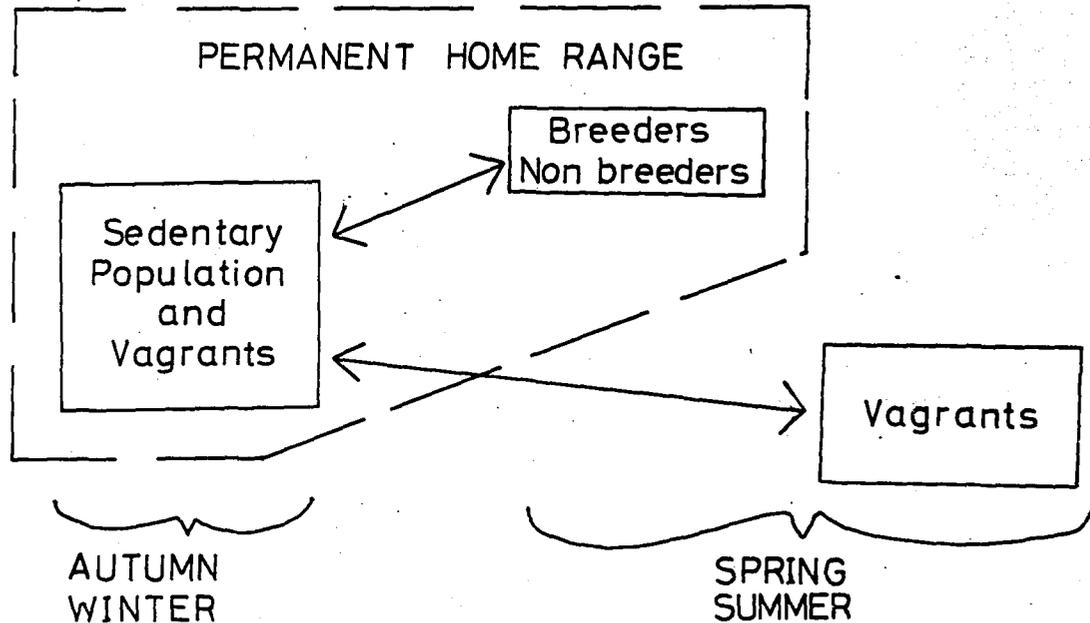
The autumn and winter influxes at Site A did not appear to be caused by the addition of birds from areas directly adjacent. The total population at Site B rose and fell at similar times to the population of Site A ( $r = 0.73$ ,  $df = 25$ ,  $P < 0.01$ ). In 1978 the population at Site B increased to a similar magnitude to that of Site A, possibly due to the presence of a sunflower crop at Site B that year only. In 1979 the total populations at both sites was not as great as in 1978.

The influx and aggregation of Cockatoos during the autumn and winter in certain areas where they are usually uncommon or in smaller numbers, has been noted in other areas of north-east New South Wales from the Plains area west of Moree to the Slopes, Tablelands and the coast (G. Holmes pers. comm, pers. obs.).

The population structure of Cockatoos (Fig. 13) appeared to include a sedentary population of breeding and non-breeding birds living within a home range; and a mobile population presumably of juveniles of the year, immature and adult non-breeding birds, which would join a sedentary population especially in non-breeding months.

FIGURE 13

POPULATION STRUCTURE OF THE  
WHITE COCKATOO



## 5.2 FLOCK SIZES AND ACTIVITIES

### 5.2.1 Seasonal

The population fluctuations were correlated with mean flock size recorded at Swan Vale ( $r = 71$ ,  $df = 22$ ,  $P < 0.01$ ) although this was not significant at Wallangra ( $r = 0.33$ ,  $df = 15$ ,  $P > 0.05$ ) (Figs. 12 and 14). Mean flock size and the range of flock sizes seen was greater in autumn and winter months (Fig. 14), although this trend was less pronounced at Wallangra. There, late summer produced a peak in mean flock size due to the introduction of young and the trend for flocking with the cessation of breeding. However, at both field areas, but especially at Wallangra the mean flock size was greatly underestimated as large flocks (especially feeding flocks) were counted only once, while numerous sub-units and small flocks were all included in the collected data.

The frequencies of each flock size from one to over 100 changed seasonally at both field areas; the patterns were similar each year (Figs. 15a, b). Flocks of 1 to 5 birds predominated each season. At Swan Vale flocks of 50 or more birds occurred only in autumn and winter. Spring and summer showed strong emphasis on small flock sizes owing to breeding activities. However, changes in flock size distribution at Swan Vale appeared to occur in the last month of winter and summer. In August the population dropped to the breeding level retained in spring and early summer; flock sizes were smaller in these months. By February the breeding cycle had finished; flocking increased and remained thus through the autumn and winter.

However, seasonal trends were evident at both field areas, with this greater emphasis on large flock sizes in autumn and winter (Fig. 15a, b). A G-test (Sokal and Rohlf 1973) was used to test the differences between seasons (Table 8). In 1977 at Swan Vale the frequencies of the various flock sizes showed no significant differences

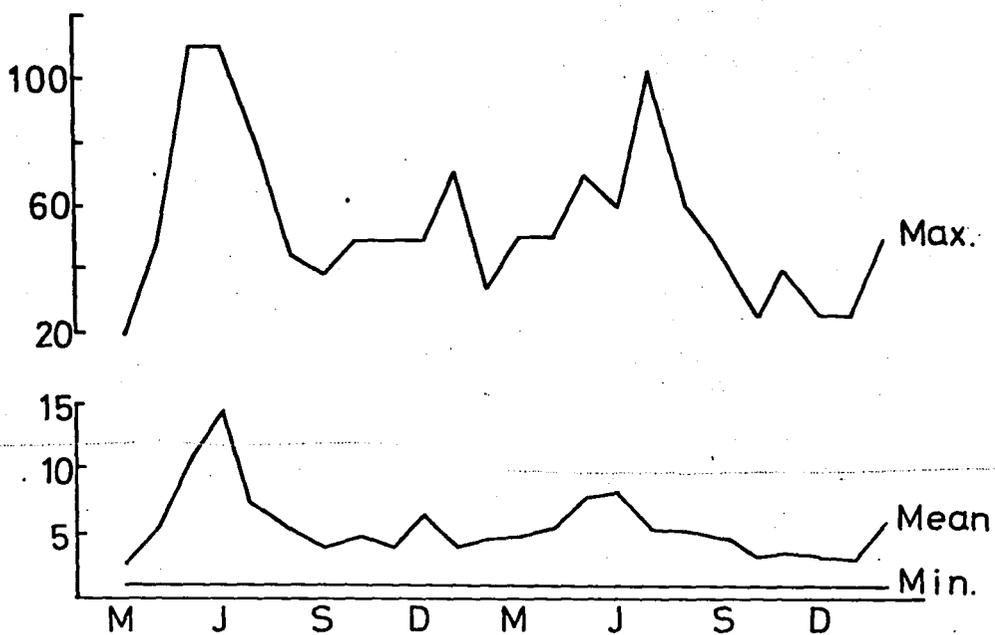
FIGURE 14

MEAN AND RANGE OF FLOCK SIZES

OF WHITE COCKATOOS

THROUGHOUT THE YEAR AT BOTH FIELD AREAS

### SWAN VALE



Flock size

### WALLANGRA

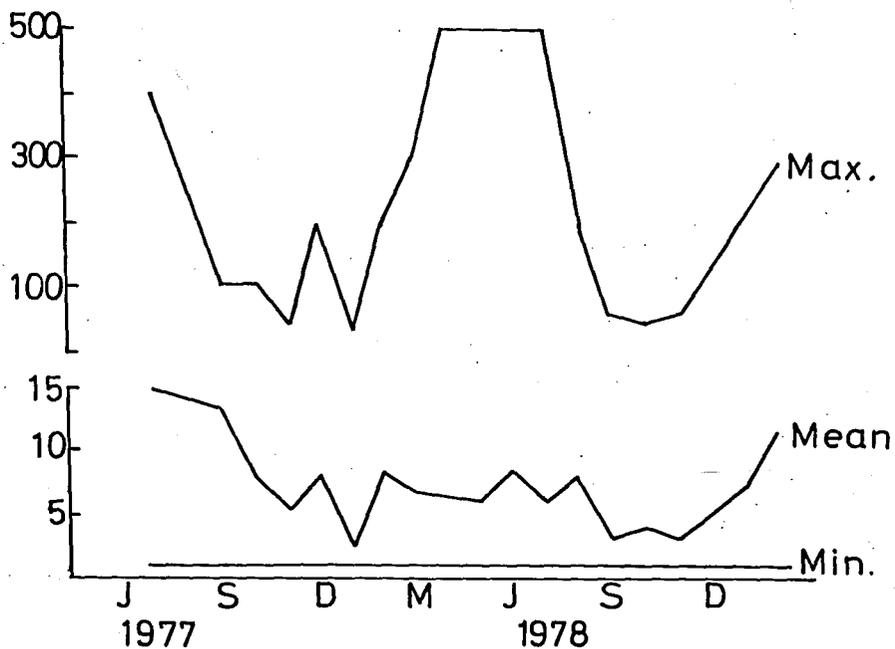


FIGURE 15

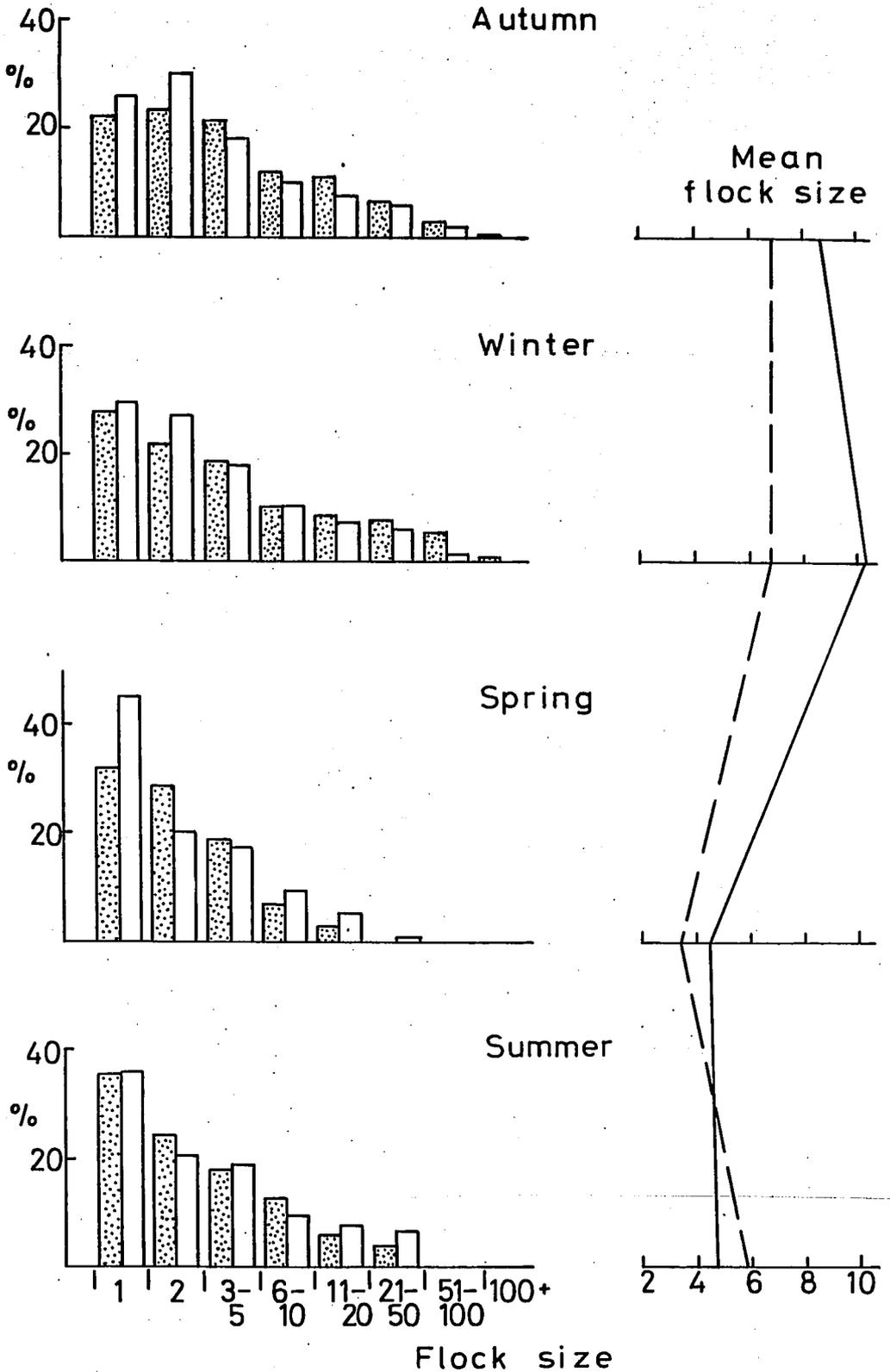
## DISTRIBUTION AND MEAN OF FLOCK SIZES EACH SEASON AT

a. SWAN VALE and b. WALLANGRA


 1977                      ----- 1977  
 1978                      \_\_\_\_\_ 1978

|        | <u>Total number of flocks</u> |      |           |
|--------|-------------------------------|------|-----------|
|        | Swan Vale                     |      | Wallangra |
|        | 1977                          | 1978 | 1978      |
| Autumn | 604                           | 824  | 596       |
| Winter | 514                           | 729  | 885       |
| Spring | 444                           | 865  | 478       |
| Summer | 319                           | 453  | 636       |
|        | 1881                          | 2871 | 2595      |

# a. SWAN VALE



# b. WALLANGRA

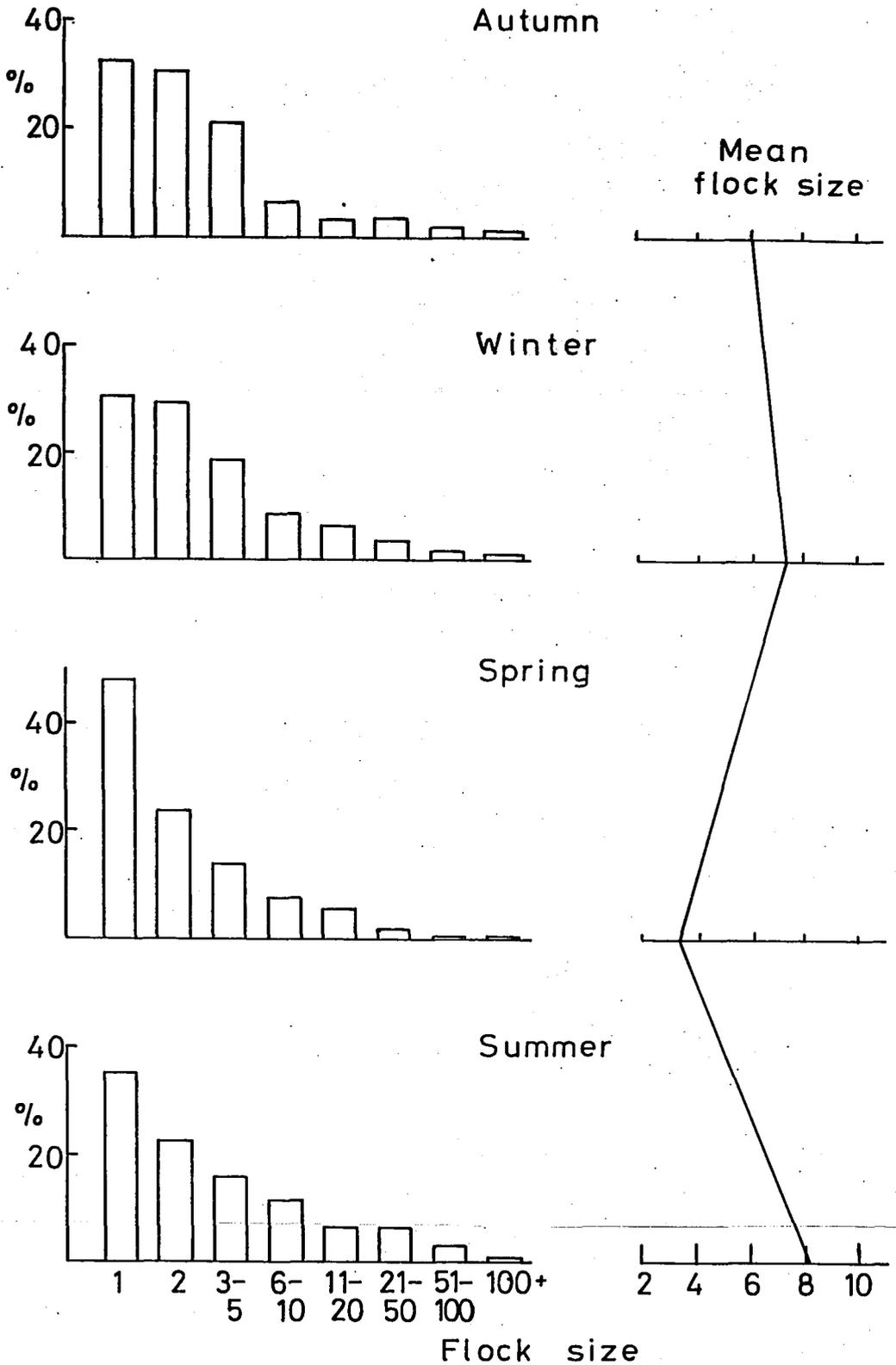


TABLE 8

## SEASONAL DIFFERENCES IN FLOCK SIZES OF WHITE COCKATOOS.

(G test, Sokal &amp; Rohlf 1973, pp. 293-303, on data presented in Fig. 15a,b)

## a. SWAN VALE 1977.

Overall (all four seasons)  $G = 88$ ,  $d.f. = 21$ ,  $P < 0.005$ ;

but which seasons differ from which? :-

|        | Winter           | Spring | Summer          |
|--------|------------------|--------|-----------------|
| Autumn | 14 <sup>NS</sup> | 46*    | 36*             |
| Winter |                  | 46*    | 26*             |
| Spring |                  |        | 0 <sup>NS</sup> |

## b. SWAN VALE 1978.

Overall  $G = 152$ ,  $d.f. = 21$ ,  $P < 0.005$ ;

Which seasons differ? :-

|        | Winter          | Spring | Summer |
|--------|-----------------|--------|--------|
| Autumn | 6 <sup>NS</sup> | 112*   | 34*    |
| Winter |                 | 88*    | 22*    |
| Spring |                 |        | 36*    |

## c. WALLANGRA 1978.

Overall  $G = 122$ ,  $d.f. = 21$ ,  $P < 0.005$ ;

Which seasons differ? :-

|        | Winter           | Spring | Summer |
|--------|------------------|--------|--------|
| Autumn | 14 <sup>NS</sup> | 60*    | 32*    |
| Winter |                  | 66*    | 30*    |
| Spring |                  |        | 62*    |

G values in tables are for seasons compared in pairs.

 $d.f. = 7$  for all cases.Significance: NS  $P > 0.05$ , \* $P < 0.005$ .

between autumn and winter, and between spring and summer. These two periods however were significantly different from each other. In 1978 at Swan Vale autumn and winter again proved to be similar, although all the other seasons were significantly different from one another (Table 8). However, spring differed the most from the other seasons (that is, it had the highest G values), although it differed least with summer.

At Wallangra in 1978 flock sizes were similar in autumn and winter, although the other seasons were all significantly different from one another (Table 8). Spring showed a greater difference from the other seasons (with the highest G values).

Birds were seen in pairs more frequently than as single birds at both field areas (Fig. 16). Single birds were seen more frequently in the breeding season than in the non-breeding season. This is also apparent, but less defined in the case of pairs. Flocks of 3-5 were less common than single birds and pairs, but they occurred throughout the year; not only after the breeding season (December to February) when one might expect juveniles to be travelling with their parents.

Flocking tendencies were evidenced in the dispersion of Cockatoo flocks within their home range (Fig. 17). At both field areas large flocks of more than 61 birds were seen at predictable locations each month. The monthly patterns showed a more restricted range than the consummate maps of all non-breeding months (Fig. 17b). On the other hand the breeding months saw predominantly flocks of less than 30 birds dispersed through the home range, with each monthly pattern being similar to the consummate pattern. (Fig. 17a).

In conclusion, the distribution of flock sizes in each month roughly reflected the total population fluctuations at each field area. The tendency to flock was greater in the non-breeding months.



SWAN VALE

WALLANGRA

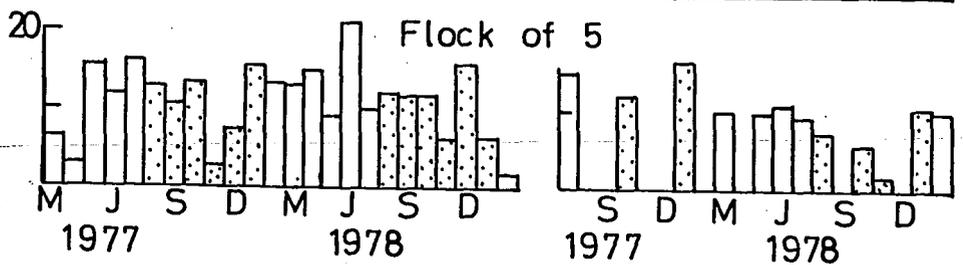
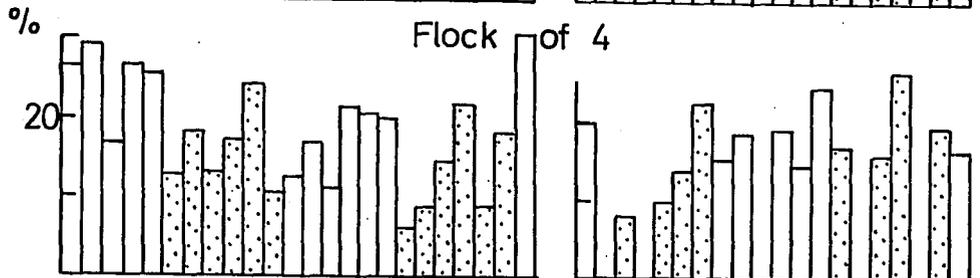
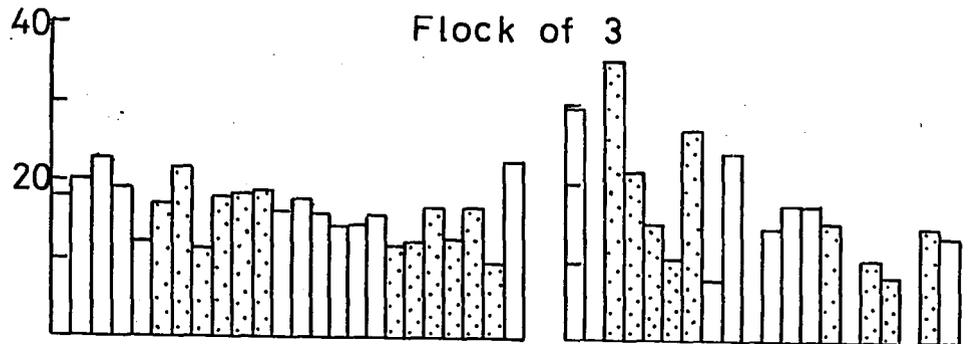
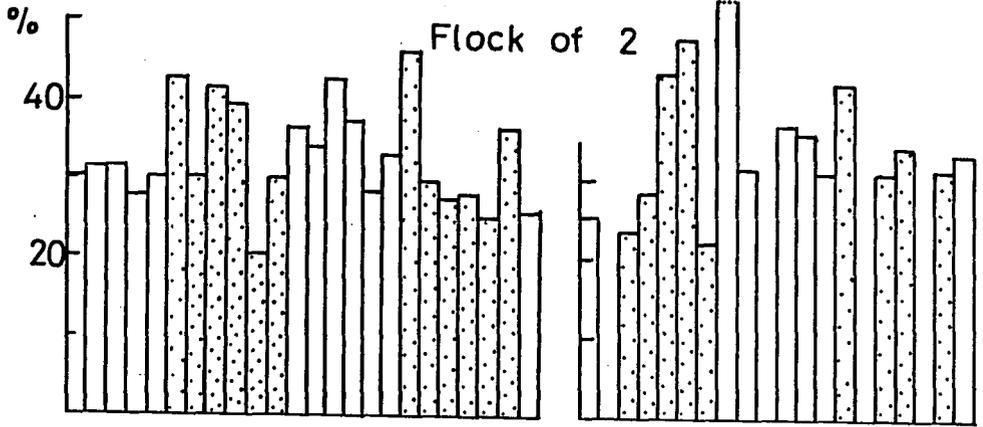
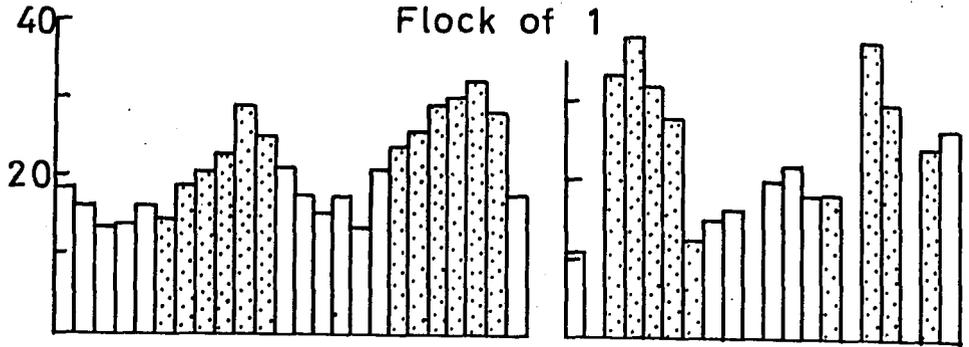


FIGURE 17

DISPERSION OF WHITE COCKATOOS WITHIN THEIR HOME RANGES AT

a. SWAN VALE and b. WALLANGRA

LEGEND

\_\_\_\_\_ Main road

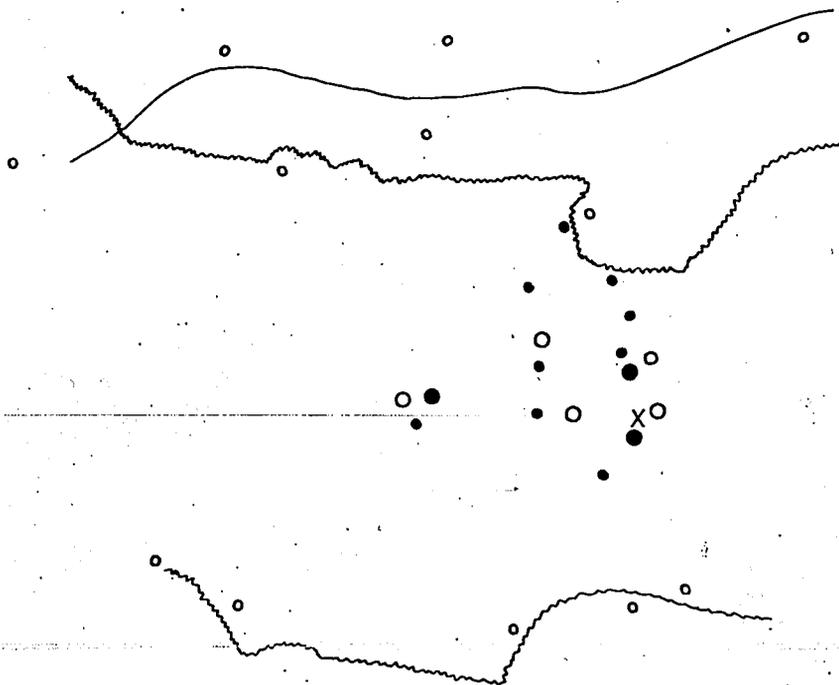
~~~~~ Creek

X Roost

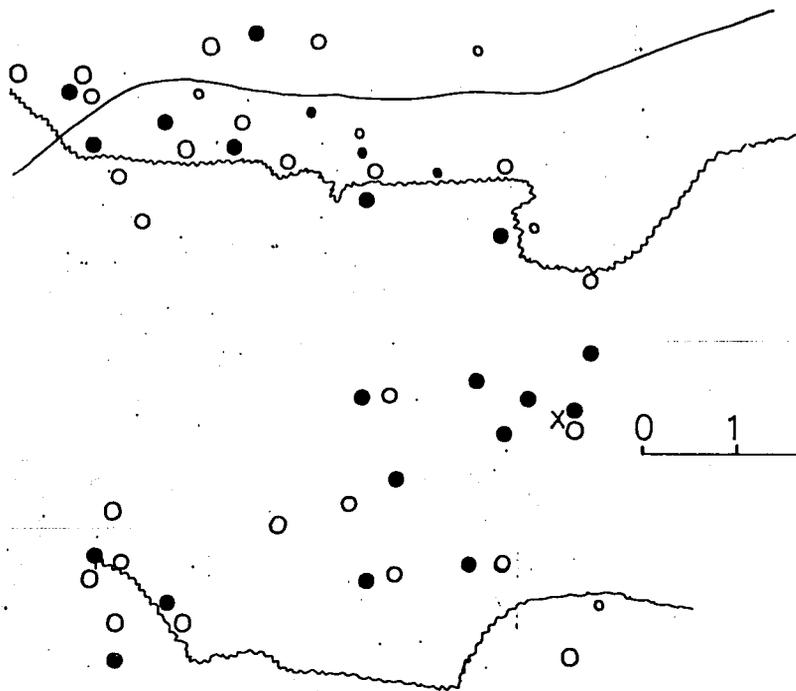
Flock Sizes - present during more than two monthly field trips  
in the general area indicated :-

- o 1 - 10
- 11 - 30
- 31 - 60
- 61 - 100
- 101 - 300
- 301 +

a. SWAN VALE  
Breeding (Aug. - Jan.)

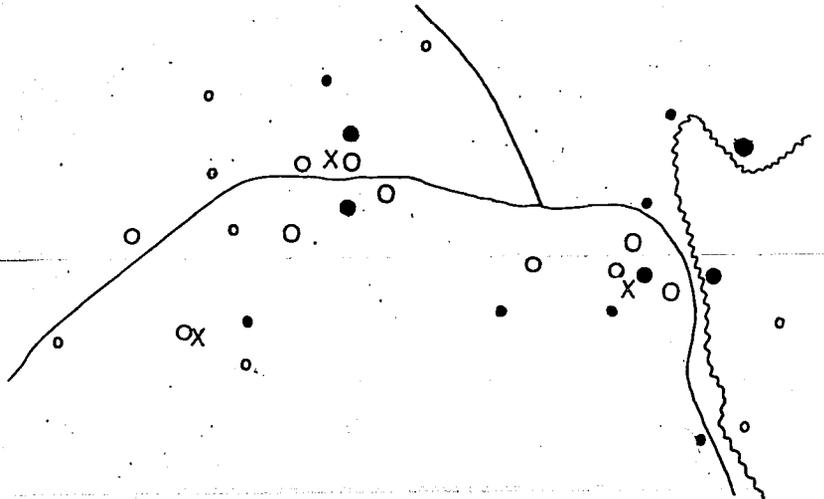


Non-breeding (Feb. - Jul.)

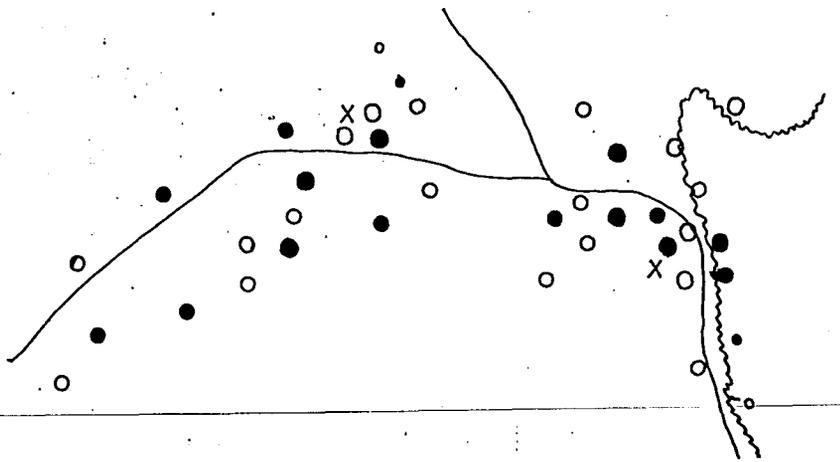


b. WALLANGRA

Breeding (Aug. - Jan.)



Non-breeding (Feb. - Jul.)



0 1 2 km

### 5.2.2 Diurnal flock activity.

A similar daily routine of flock activities and movements was evident (Fig. 18) at both field areas. On awakening Cockatoos perched and called in small to large (1-100) flocks near their roost trees, before flying off in flocks of 1-20 to aggregate at a major feeding area. Sometimes birds "minor fed" before "major feeding". At both field areas there were often a few flocks (of 2-200) major feeding during the morning. After feeding the Cockatoos dispersed and headed for a roost or day rest area. Often "minor feeding" (groups of 1-100) occurred near these areas before the birds settled to rest (usually in groups of 1-30). In the afternoon Cockatoos flew to a major feeding area where aggregations were usually large (10-600). After feeding the birds flew off in flocks of 1-100 to aggregate adjacent to (at both field areas) or within (Wallangra) a roost area. "Minor feeding" occurred occasionally before but frequently after the major afternoon feeding session. Prior to roosting Cockatoos flew and perched in flocks of 1 to 500. Around dusk they dispersed and settled into roost trees in flocks of 1 to 30. Drinking occurred after the "major feeding" periods or during the midday rest.

The general patterns of daily activity did not vary greatly between the seasons (Fig. 19, Table 9). At Swan Vale feeding and resting took place at similar hours in similar proportions each season, although feeding occurred during more hours of the day in spring (Fig. 19). However, the proportion of time spent feeding in this season did not differ markedly from the other seasons (Table 9a). At Wallangra (Table 9b) birds spent slightly less time resting and more time feeding in all seasons. This discrepancy in proportions of feeding time may have resulted from more observations of "minor feeding" owing to the less difficult terrain at Wallangra. As "minor feeding" did not necessarily

FIGURE 18

## DAILY ROUTINE OF THE WHITE COCKATOO

- Some or all birds participated in this activity
- No birds participated in this activity

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I observed a full daily cycle on 62 days at Swan Vale  
and 39 days at Wallangra,  
(i.e. 59% of total field days)

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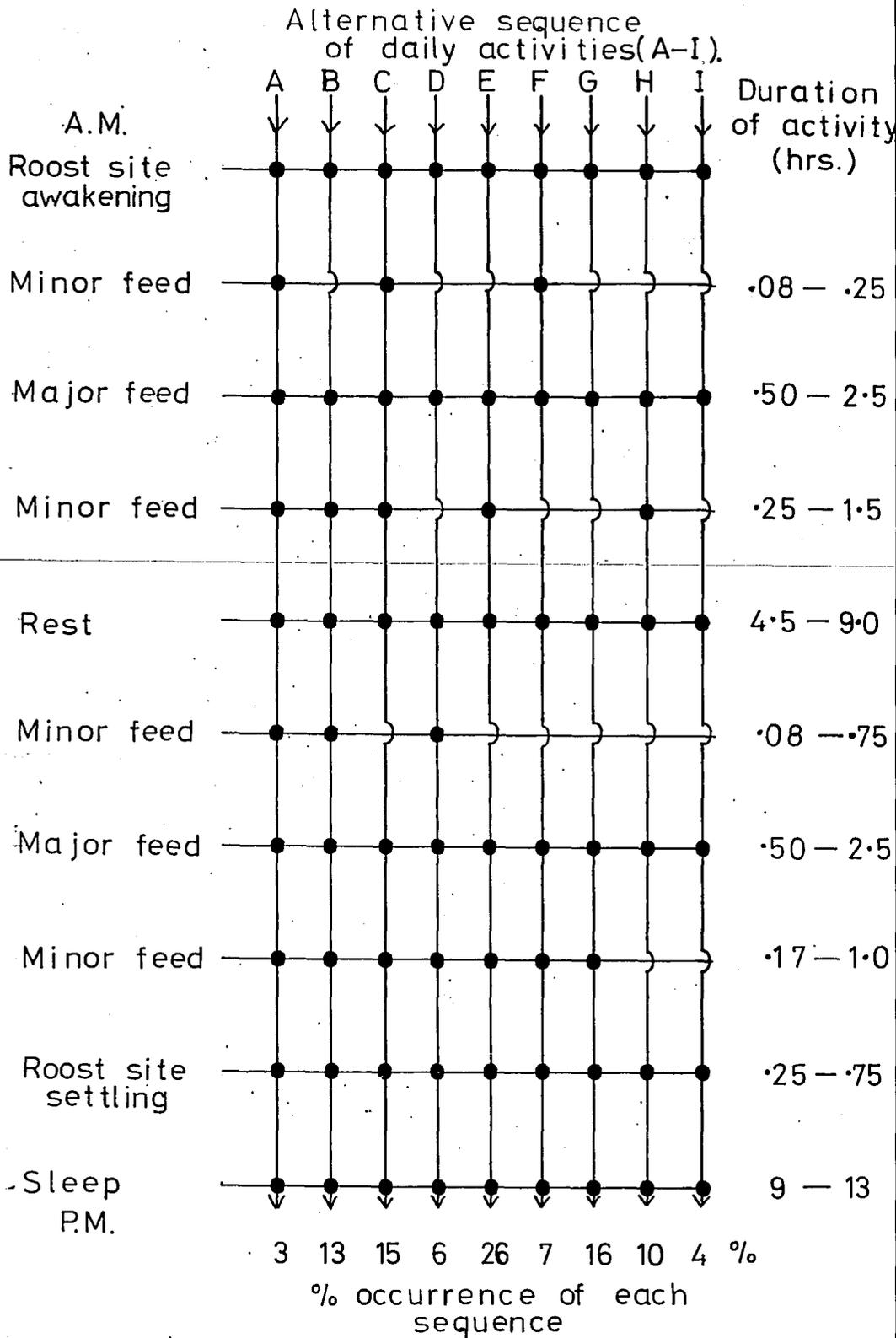
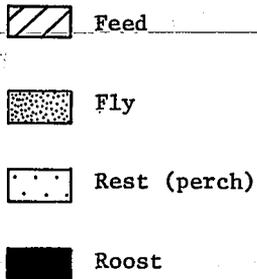


FIGURE 19

## DAILY ACTIVITIES OF WHITE COCKATOOS EACH SEASON

## AT SWAN VALE



No. of 'bird hours' =  $\frac{\text{no. of birds} \times \text{minutes spent in particular activity}}{60}$

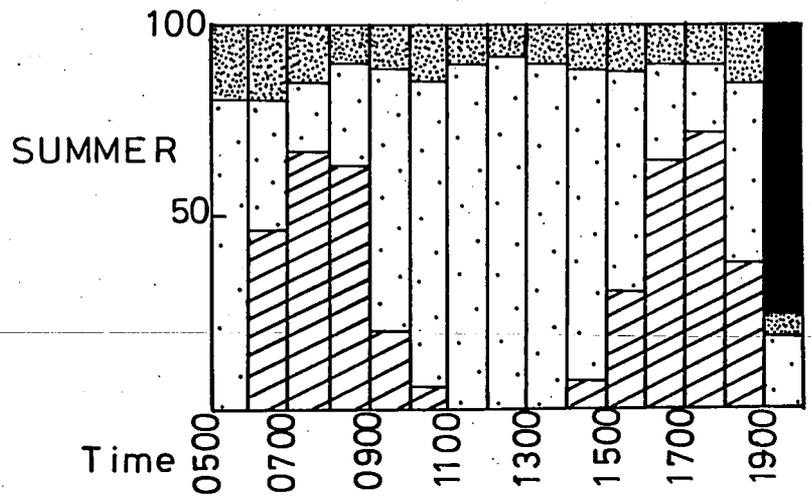
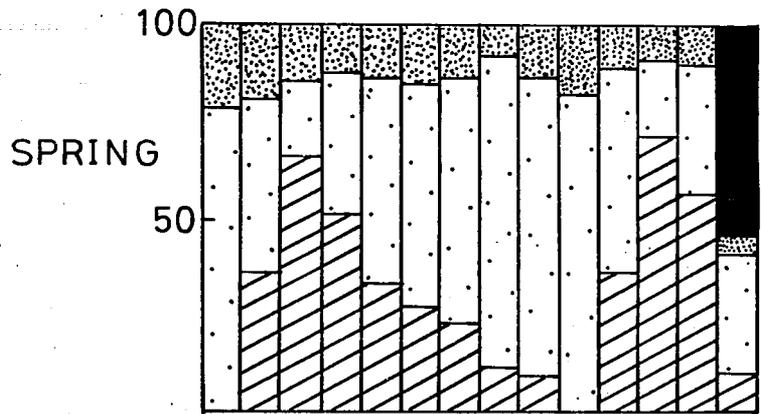
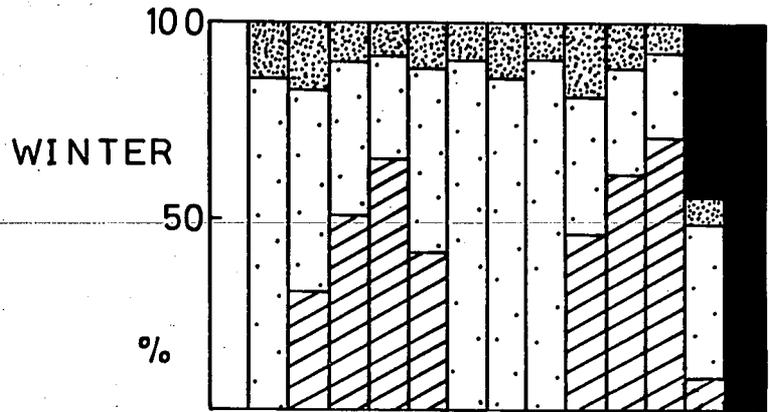
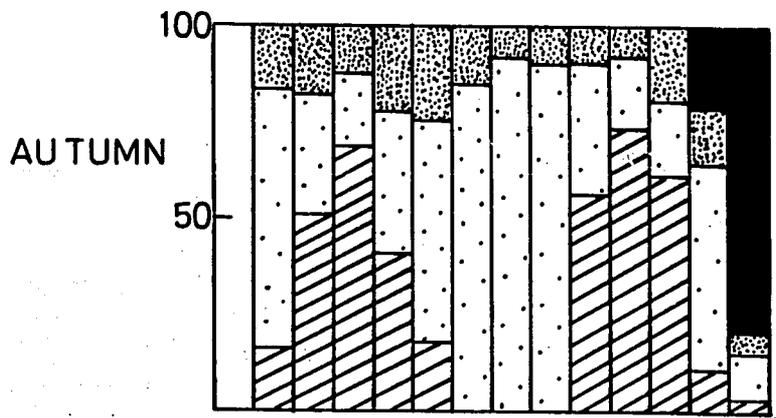
60

Autumn 2855

Winter 3196

Spring 2726

Summer 2548



Time

0500

0700

0900

1100

1300

1500

1700

1900

TABLE 9

## DAILY ACTIVITY OF WHITE COCKATOOS EACH SEASON

a. SWAN VALE

| SEASON | % Day Fly* | % Day Rest/Perch | % Day Feed | Total 'Bird hours' #<br>observed |
|--------|------------|------------------|------------|----------------------------------|
| Autumn | 16         | 51               | 33         | 2855                             |
| Winter | 13         | 55               | 32         | 3169                             |
| Spring | 15         | 54               | 31         | 2726                             |
| Summer | 14         | 57               | 29         | 2548                             |

b. WALLANGRA

|        |    |    |    |      |
|--------|----|----|----|------|
| Autumn | 16 | 48 | 36 | 7142 |
| Winter | 16 | 46 | 38 | 7321 |
| Spring | 13 | 47 | 40 | 5560 |
| Summer | 15 | 51 | 34 | 6591 |

Data for 1977 and 1978 combined.

\*Flying is an exaggeration as it was impossible to time such an activity, and resting birds were difficult to observe without scaring them into flight.

#'Bird hours' = No. of birds x Minutes in each activity

result in food ingestion, this does not represent a lower food availability (requiring more feeding time) at Wallangra.

Activity at the nest increased in spring at all times of the day. This was most marked at Wallangra. The January to late July daily patterns of mass movement of the Cockatoo population from the feeding and roosting areas, to their most common day rest site near the Macintyre River, was less apparent from August to December. During these months the reduced numbers of birds spent much time in the roosting and nesting areas.

The distribution of flock sizes during the day at both field areas (Fig. 20) suggests a bimodal pattern, with peaks during major feeding periods. At Swan Vale (Fig. 20a) the mean flock size during the afternoon aggregating and feeding session was greater than that for the morning. This was evident in all seasons, but less so in summer and spring owing to the reduced numbers of birds, and breeding activities. These trends were not so obvious at Wallangra (Fig. 20b). During spring the pattern is less defined and small flock sizes occurred throughout the day. Flocks were smaller in the morning than in the afternoon in winter and summer, but about the same in autumn.

The occurrence of different flock sizes engaged in the three main daily activities (feeding, perching and flying) varied seasonally (Fig. 21). In feeding and perching larger mean flock sizes occurred in autumn and winter than in spring and summer at both field areas, although flocks were also large in summer at Wallangra (Fig. 21b); maximum flock size was generally far less for the spring and summer months. The pattern for mean flock size engaged in flying was less marked, although maximum flock sizes were greater in the autumn-winter months. Feeding flocks were generally larger than perching flocks, and both were greater than flying flocks.

FIGURE 20DIURNAL FLUCTUATION IN MEAN FLOCK SIZE OF  
WHITE COCKATOOS EACH SEASON AT

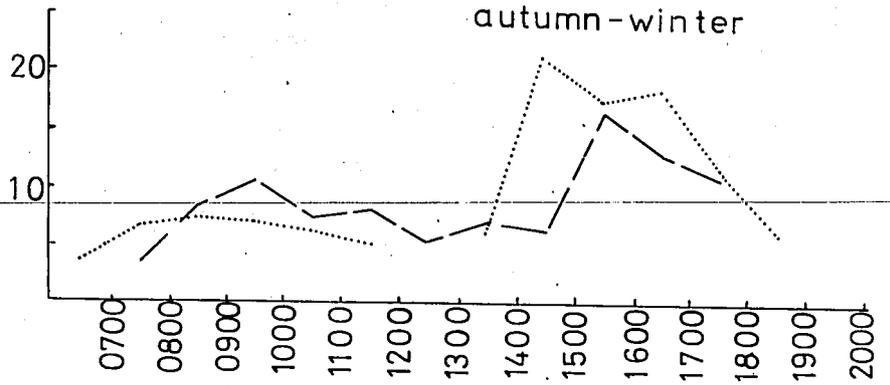
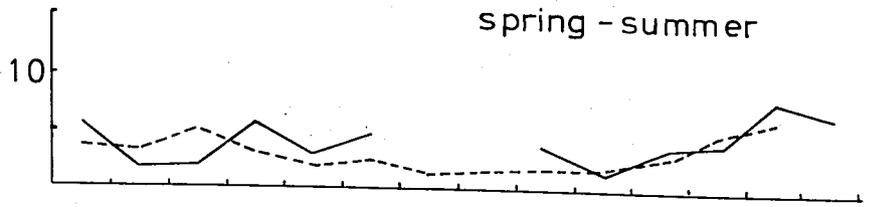
a. SWAN VALE 1977 and b. WALLANGRA 1978

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|             | Number of flocks |           |
|-------------|------------------|-----------|
|             | Swan Vale        | Wallangra |
| ---- Spring | 444              | 478       |
| ____ Summer | 319              | 636       |
| .... Autumn | 604              | 596       |
| ___ Winter  | 514              | 885       |

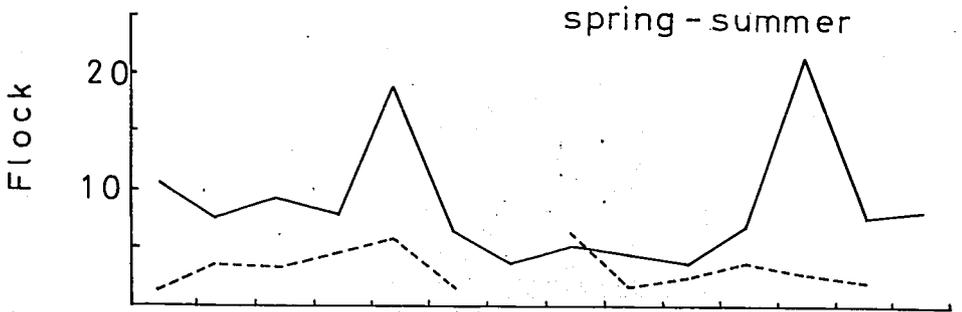
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a. Swan Vale

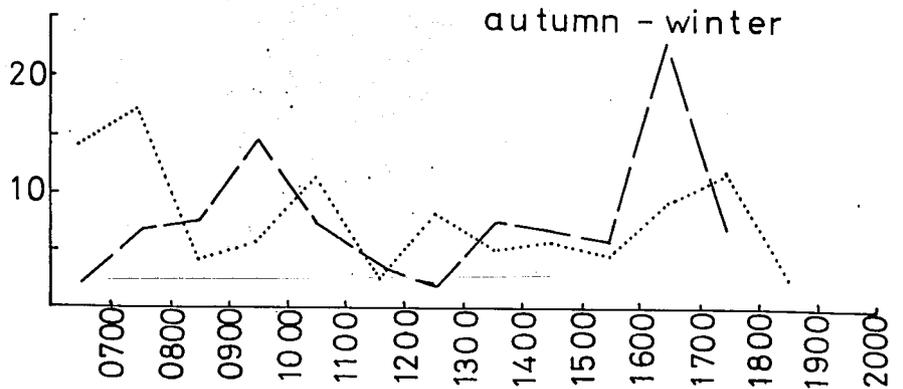


Size

b. Wallangra



Flock



Time

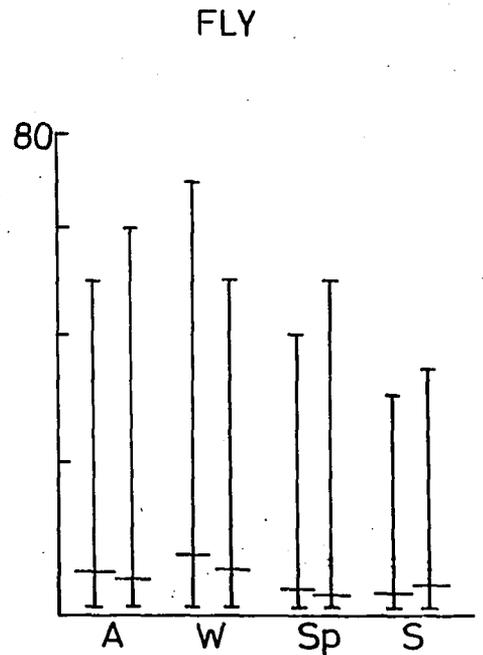
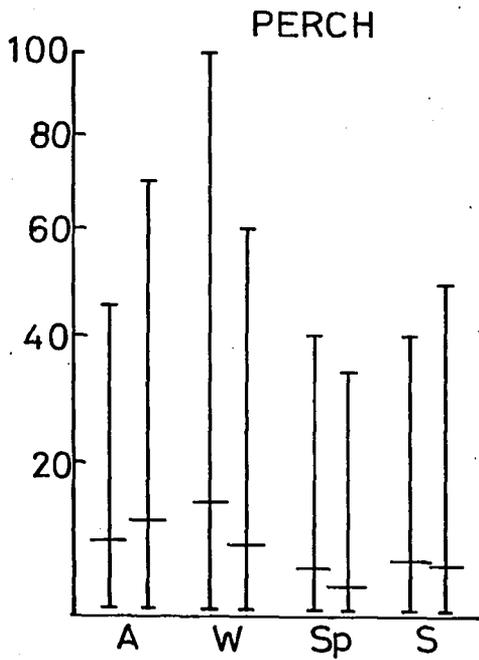
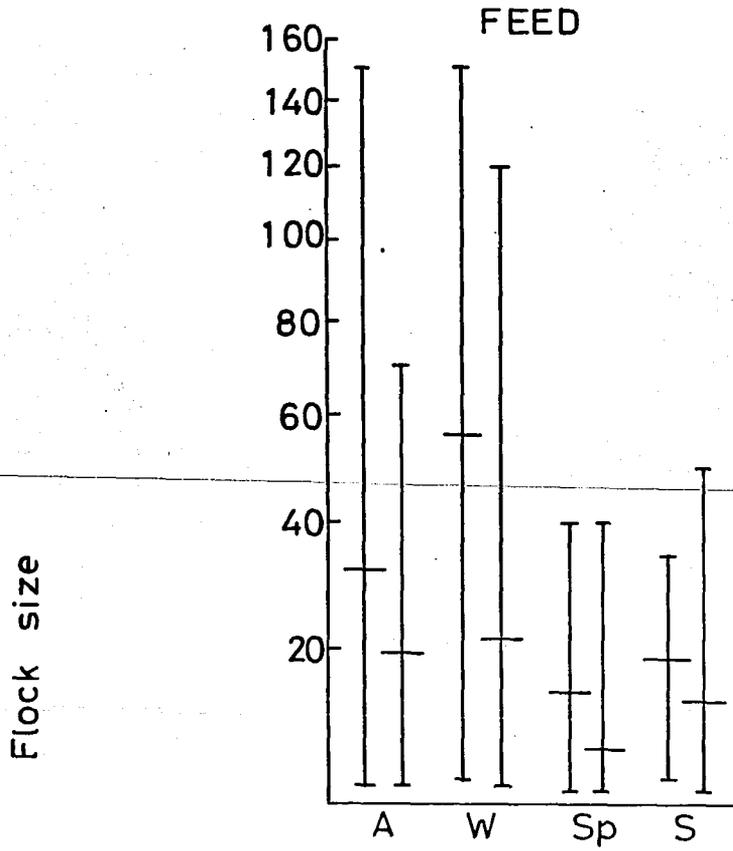
FIGURE 21

MEAN AND RANGE OF FLOCK SIZES OF WHITE COCKATOOS IN THE  
THREE MAIN ACTIVITIES - FEEDING, FLYING AND PERCHING -  
EACH SEASON FOR 1977 AND 1978 AT:

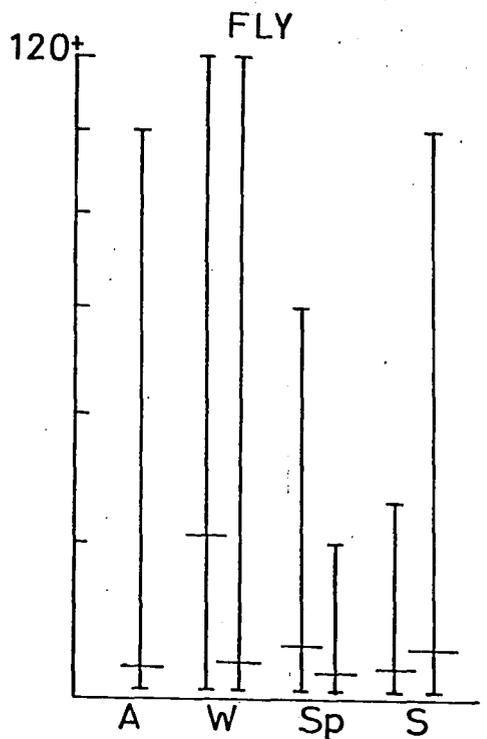
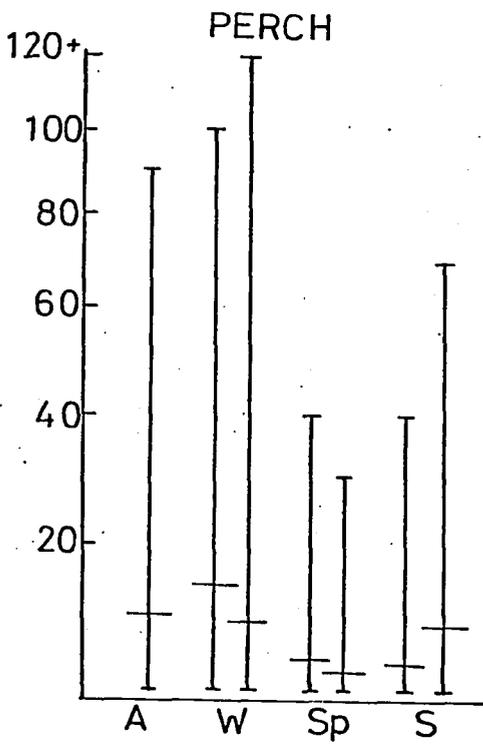
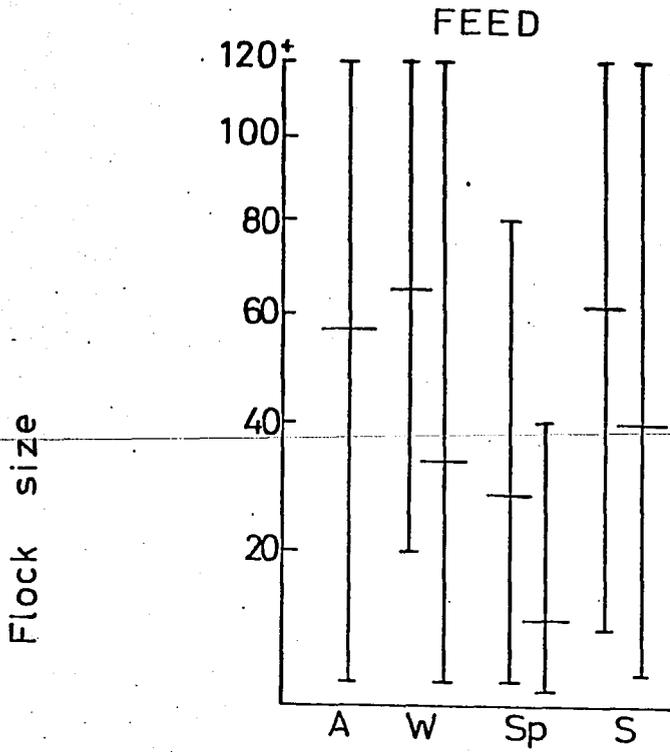
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a. SWAN VALE and b. WALLANGRA

# a. SWAN VALE



b. WALLANGRA



## CHAPTER 6

## FEEDING ECOLOGY

## 6.1 FEEDING PERIODS

I divided foraging behaviour by the White Cockatoo into "major" and "minor feeding". "Major feeding" describes relatively cohesive flocks of 10 to 500 birds which foraged intensively for periods of 15 to 120 minutes. "Major feeding" occurred mainly on standing crops and crop stubble in both field areas. Birds were observed actively ingesting seed during "major feeding". I used the term "minor feeding" to describe incohesive flocks of one to 100 birds which searched for periods of 5 to 45 minutes in native and modified, fallow and ploughed, grasslands. Birds were rarely observed ingesting seed during "minor feeding" but were possibly searching for grit, vegetable matter or insects.

At both field areas throughout the year feeding was mainly restricted to two periods, one in the early morning and one in the late afternoon, of approximately one to two hours duration (Fig. 22). Birds started feeding about an hour after dawn and two to three hours before dusk. Infrequently birds were observed feeding outside these two periods near day rest or nest sites. At Swan Vale "minor feeding" generally occurred after "major feeding" both in the morning and afternoon; but at Wallangra it was less predictable, occurring before, after, and occasionally during "major feeding". "Minor feeding" increased at both field areas in spring during the breeding season (Table 10).

At both field areas there were seasonal differences in the amount of time devoted to "minor" and "major feeding", tested using a G test (Sokal and Rohlf 1973) (Table 10). At Swan Vale spring and summer were not significantly different; neither were autumn and winter. These

FIGURE 22

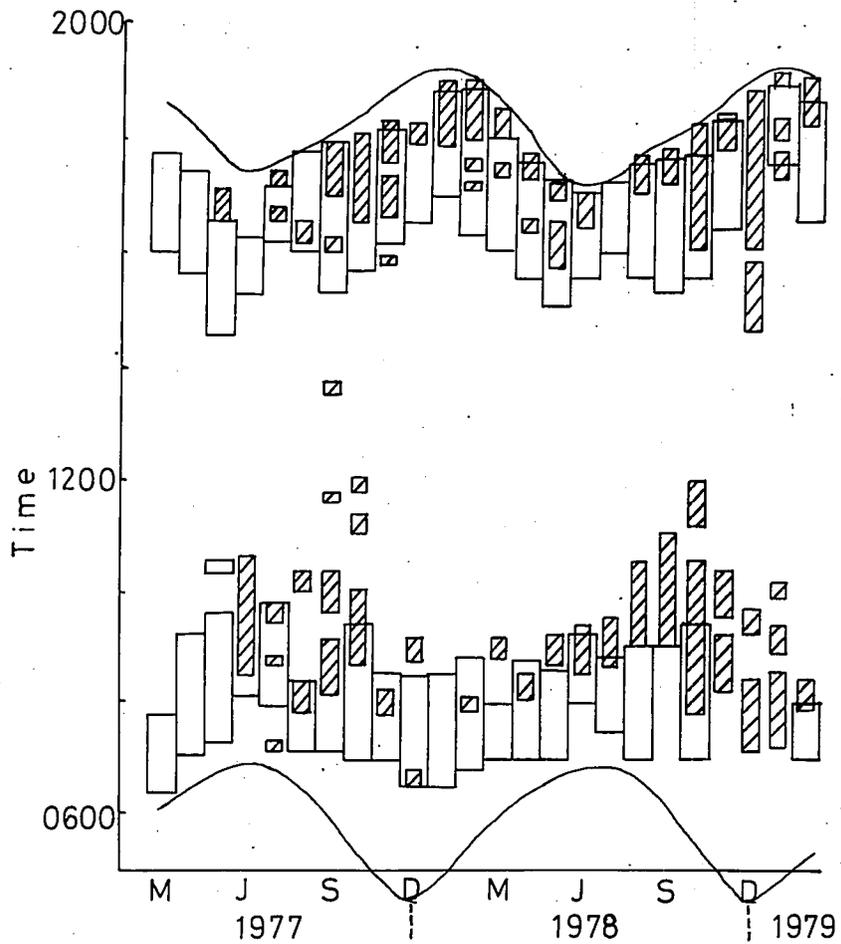
## WHITE COCKATOO FEEDING PERIODS

 "Major feeding" - crop and stubble

 "Minor feeding" - native and modified grassland

 sunrise and sunset

### SWAN VALE



### WALLANGRA

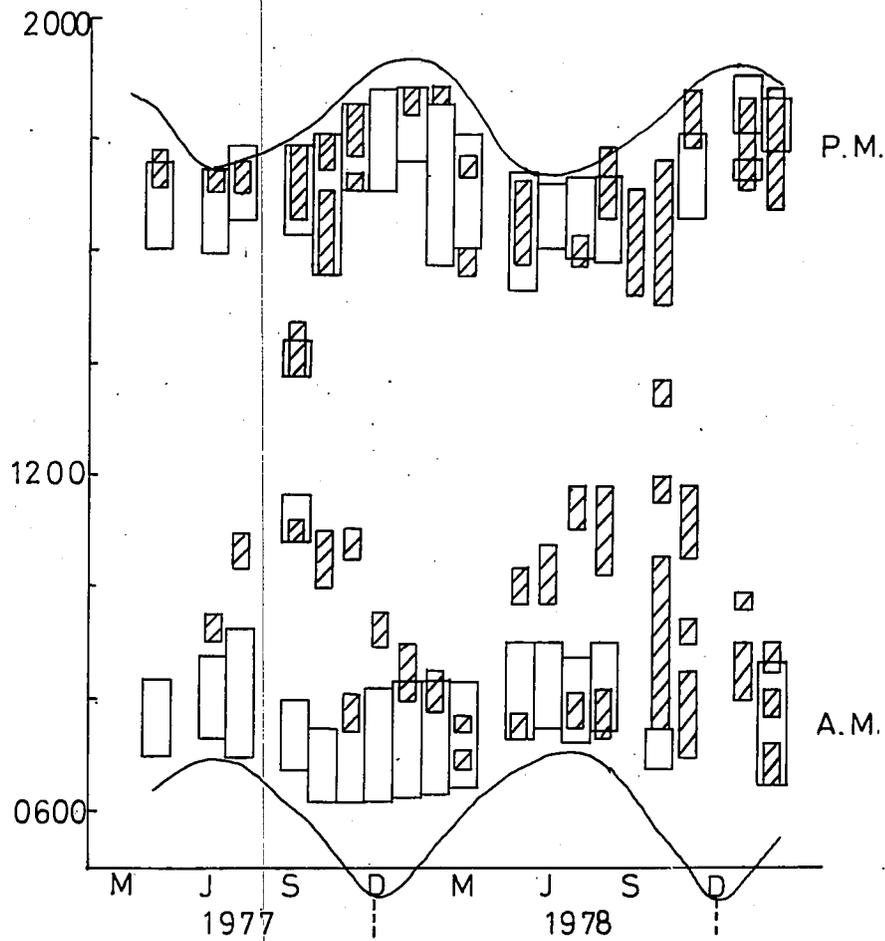


TABLE 10

## "MAJOR" AND "MINOR FEEDING" BY WHITE COCKATOO

a. SWAN VALE

| SEASON | "Minor" hours | "Major" hours | % "Major" | % "Minor" | Total Bird hours |
|--------|---------------|---------------|-----------|-----------|------------------|
| Autumn | 217           | 725           | 77        | 23        | 942              |
| Winter | 291           | 723           | 71        | 29        | 1014             |
| Spring | 353           | 492           | 58        | 42        | 845              |
| Summer | 280           | 459           | 62        | 38        | 739              |

SWAN VALE - Overall between four seasons  $G = 130$ ,  $d.f. = 3$ ,  $P < 0.005$   
 Testing between pairs of seasons - which seasons differ?

|        | Winter          | Spring          | Summer          |
|--------|-----------------|-----------------|-----------------|
| Autumn | 4 <sup>NS</sup> | 98 <sup>x</sup> | 58 <sup>x</sup> |
| Winter |                 | 62 <sup>x</sup> | 32 <sup>x</sup> |
| Spring |                 |                 | 0 <sup>NS</sup> |

b. WALLANGRA

| SEASON | "Minor" hours | "Major" hours | % "Major" | % "Minor" | Total Bird hours |
|--------|---------------|---------------|-----------|-----------|------------------|
| Autumn | 1470          | 1726          | 54        | 46        | 3196             |
| Winter | 1765          | 2245          | 56        | 44        | 4010             |
| Spring | 2293          | 1594          | 41        | 59        | 3887             |
| Summer | 1859          | 2365          | 56        | 44        | 4224             |

WALLANGRA - Overall between four seasons  $G = 322$ ,  $d.f. = 3$ ,  $P < 0.005$ .  
 Testing between pairs of seasons - which seasons differ?

|        | Winter          | Spring           | Summer           |
|--------|-----------------|------------------|------------------|
| Autumn | 40 <sup>x</sup> | 78 <sup>x</sup>  | 36 <sup>x</sup>  |
| Winter |                 | 246 <sup>x</sup> | 0 <sup>NS</sup>  |
| Spring |                 |                  | 240 <sup>x</sup> |

x  $P < 0.005$     NS  $P > 0.05$      $df = 1$  for all cases in tables, where seasons compared in pairs  
 Data combined from Autumn 1977 to end of Summer (February) 1979.

'Bird hours' = No. of birds feeding x hours feeding.

two periods however, differed significantly from each other, although winter and summer proved more similar than any other pair of seasons (having a lower G value), with spring being the most different season (Table 10). At Wallangra however, summer and winter were the only seasons not significantly different in their "minor" and "major feeding" patterns. Of the remaining significantly different pairs of seasons, autumn was most similar to summer and winter (that is, it had the lowest G values); spring showed the greatest difference from the other seasons (with the highest G values) (Table 10).

Throughout the year at both field areas more birds fed in the afternoon period than in the morning (Table 11). Pooling data on 'bird hours' feeding per hour of observation for both field areas, morning feeding was less than afternoon feeding ( $P < 0.005$ ; Wilcoxon's signed-ranks test). The 'crops' collected from Cockatoos were generally fuller in the afternoon ( $X = 11.99$  g dry weight) than in the morning ( $X = 5.38$  g dry weight) ( $t = 2.29$ ,  $df = 39$ ,  $P < 0.05$ ) (Fig. 23). The only empty 'crops' encountered were from Cockatoos shot in the morning or at midday, after the morning feeding period. Feeding flocks were significantly ( $P < 0.05$ ) larger during the afternoon period in all seasons at Swan Vale, and in winter and spring at Wallangra (Fig. 24). Feeding flocks at Wallangra were generally larger than those at Swan Vale.

## 6.2 FOOD AVAILABILITY

Swan Vale and Wallangra fall within the wet southern and eastern Australian bioclimatic zones (Nix 1976) where the native growing season occurs mainly in spring and early summer. Following further (seasonal) rains some growth may occur in late summer and autumn. No growth occurs in winter due to the low temperatures. Seed production in growing pastures is a response to a complex relationship between rainfall, temperature, nutrient balances and perhaps daylength (Beadle 1948).

TABLE 11

## WHITE COCKATOO FEEDING 'BIRD HOURS' IN EACH FEEDING PERIOD AT

SWAN VALE and WALLANGRA

SWAN VALE

| Season | Feeding period | Feeding 'bird hours' | Hours of observations | Feeding 'Bird hours' per hour of observation |
|--------|----------------|----------------------|-----------------------|--|
| Autumn | a.m.           | 433                  | 74                    | 5.85   |
|        | p.m.           | 509                  | 67                    | 7.60   |
| Winter | a.m.           | 406                  | 66                    | 6.15   |
|        | p.m.           | 608                  | 66                    | 9.21   |
| Spring | a.m.           | 254                  | 80                    | 3.18   |
|        | p.m.           | 591                  | 79                    | 7.48   |
| Summer | a.m.           | 259                  | 43                    | 6.02   |
|        | p.m.           | 480                  | 48                    | 10.00  |

WALLANGRA

|        |      |      |    |       |
|--------|------|------|----|-------|
| Autumn | a.m. | 1374 | 29 | 47.38 |
|        | p.m. | 1822 | 28 | 65.07 |
| Winter | a.m. | 1684 | 42 | 40.10 |
|        | p.m. | 2326 | 38 | 61.21 |
| Spring | a.m. | 1750 | 42 | 41.67 |
|        | p.m. | 2137 | 48 | 44.52 |
| Summer | a.m. | 1775 | 32 | 55.47 |
|        | p.m. | 2449 | 34 | 72.03 |

Data from Autumn 1977 to end of Summer 1979 combined.

FIGURE 23

DRY WEIGHTS OF WHITE COCKATOO 'CROP' <sup>CONTENTS</sup> THROUGHOUT THE DAY

(Mean, 2 Standard Errors and Range graphed)

---

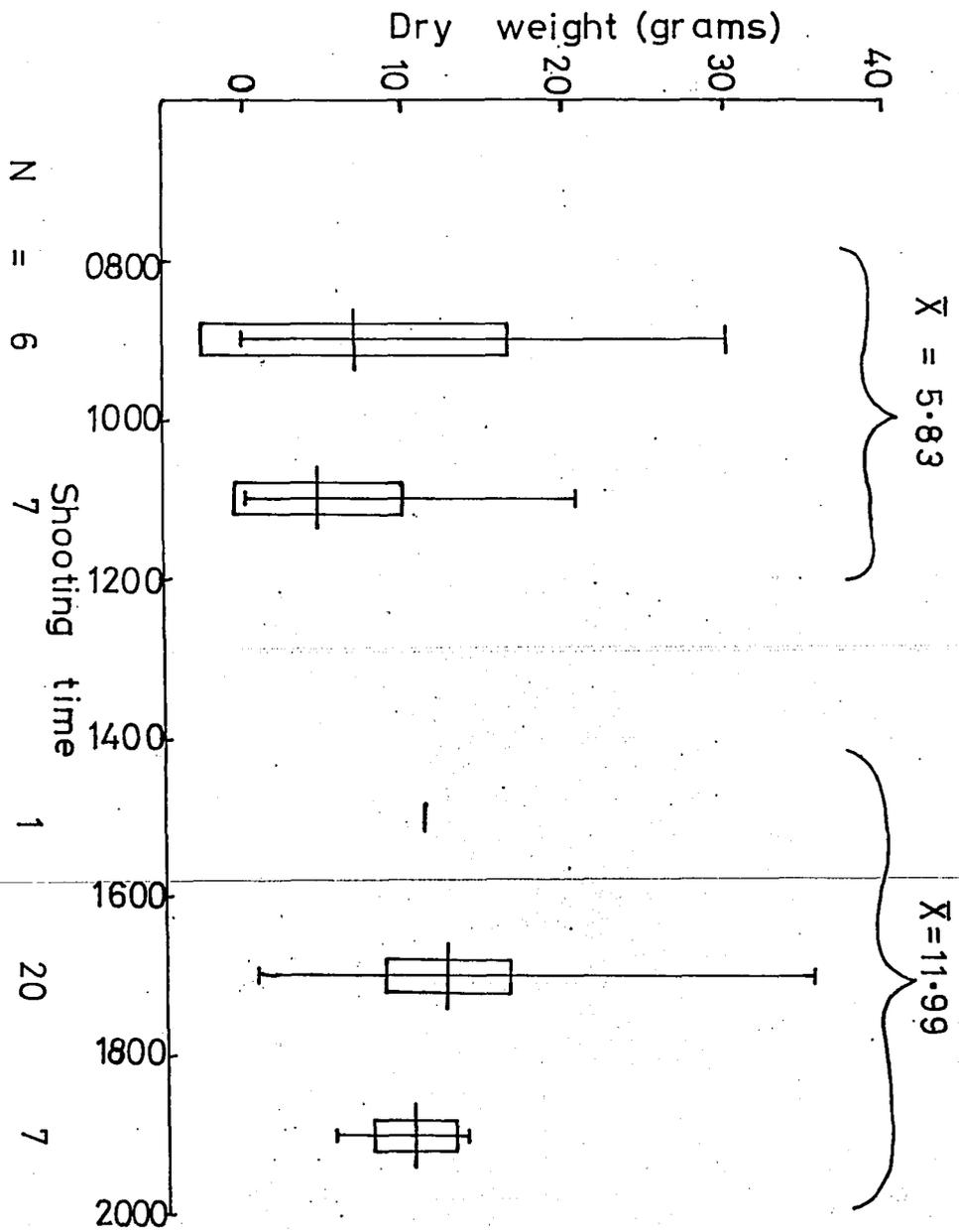


FIGURE 24

SEASONAL FLOCK SIZES OF WHITE COCKATOOS PARTICIPATING  
IN MORNING AND AFTERNOON FEEDING PERIODS AT EACH FIELD AREA

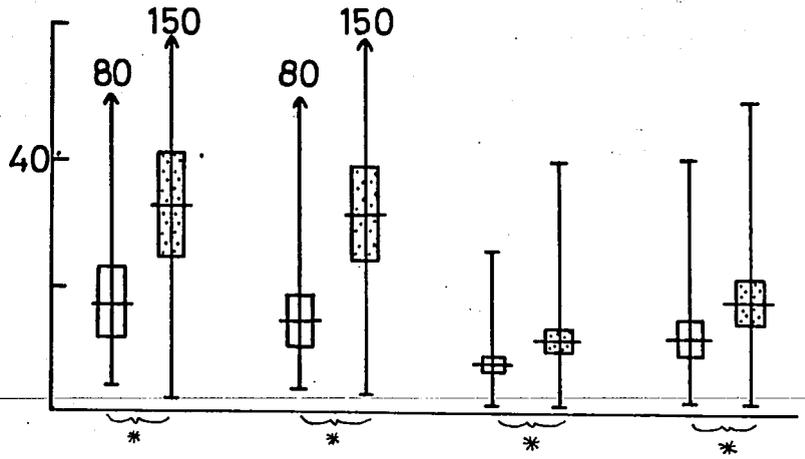
(Mean, 2 Standard Errors and Range of feeding flock sizes graphed for each season of 1977 and 1978, and for each feeding period).

\* indicates afternoon flocks are significantly larger  
in that season (t test,  $P < 0.05$ )  
NS not significant (t test,  $P > 0.05$ )

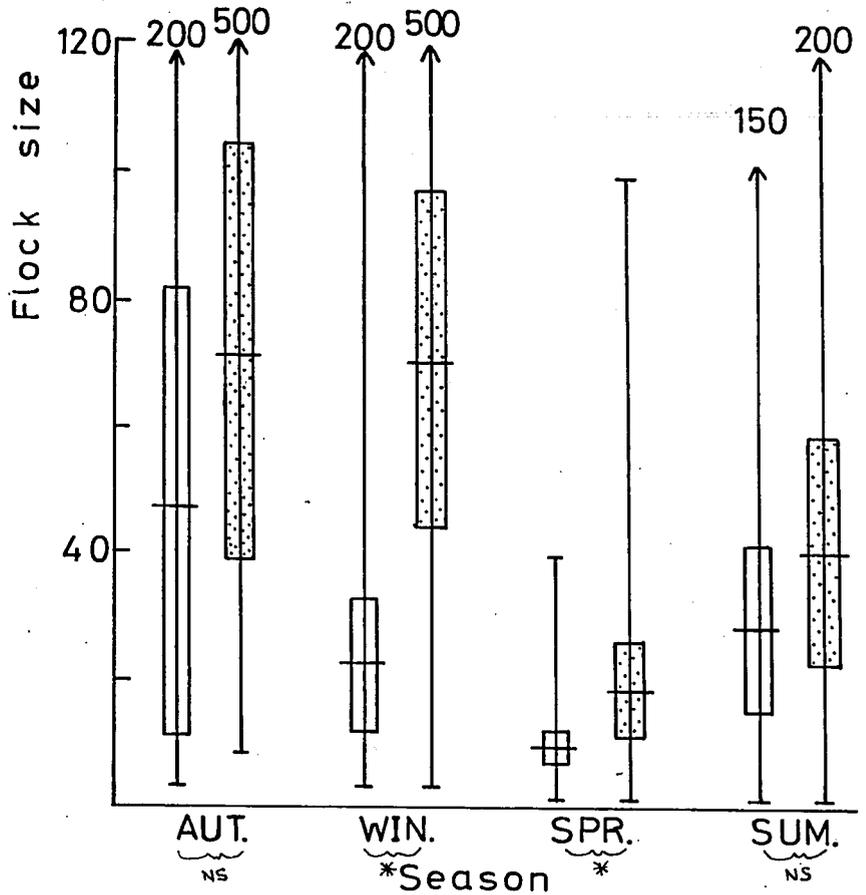
Total Number of Feeding Flocks Included:

|  | Swan Vale | Wallangra |
|--|-----------|-----------|
|  a.m.  | 167       | 127       |
|  p.m. | 201       | 124       |

### SWAN VALE



### WALLANGRA



Throughout the year the area occupied by native grassland remains constant. At Swan Vale it comprises 65% of grassland, native plus modified, and 33% of total grassland at Wallangra. However, the availability of seed in these native grasslands and from exotic grasses and weeds in modified fallow fields and along contour banks, varies throughout the year.

Seeds produced after flowering may be retained on the plant for a long period or fall onto the soil surface and perhaps become buried ("surface" and "buried seed bank" respectively, Sagar and Mortimer 1976). The "buried seed bank" includes seed from previous plant generations. Additions to the "surface seed bank" occur from invading seed and to the "buried seed bank" by sowing seed. Seeds may germinate from either "bank" and grow to established plants, thus continuing the cycle. Annuals and ephemerals usually grow and set seeds quickly. Perennials generally remain vegetative throughout the year, and flower and release seed later than annuals.

At Swan Vale and Wallangra the proportion of grasses and weeds with ripe seed in the head or fallen from the head are shown in Fig.25. The peak in November/December corresponded with the ripening of seeds from annual plants. The peak in March/April/May corresponded with the seed ripening of perennial plants. At both field areas, perennial grasses were dominant; this resulted in a larger perennial seed fall.

Native and exotic seeds may be available to birds throughout the year, though they are less abundant during winter and early spring. At these times the seed may be buried and difficult to find, or may be germinating with seeds not yet formed in the next generation of plants (S. Bowen pers. comm.).

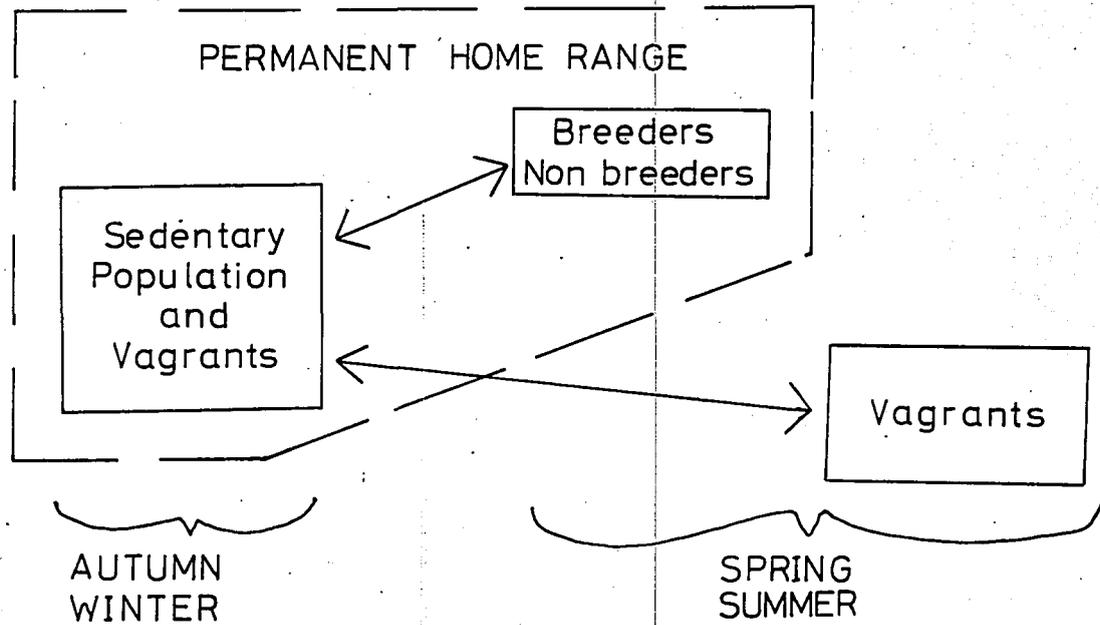
Crop seed is also available throughout the year in standing or

FIGURE 25

## NATIVE AND EXOTIC GRASS SEED CYCLE AT THE FIELD AREAS

- a. Growth cycle of perennials and annuals
- b. % of plants with ripe seeds in the heads  
or newly fallen/falling from the heads.

Estimates from personal observation which accord with unpublished observations by S. Bowen pers. comm..



stubble form. Crops comprise 20-45% of the total modified land at Swan Vale and 32-50% at Wallangra.

The relative areas of standing crops and stubble, and other modified, both fallow and ploughed land at each field area is presented in Fig. 26a and b . Crop seed is available to Cockatoos for 5 to 12 days after sowing, depending on seed germination rates. The birds sometimes dig up freshly sown or shooting seed, or feed on spilt and stored grain during sowing and harvest. Crop seed is not available during the growth of seedlings until the heads of the plants set seed. Cockatoos ate seed from standing crops from the soft 'milk' dough stage until harvest, a period of two to three months. After harvest, crop seed was available for the birds in stubble fields until eaten out by birds and livestock or dissipated by rain spoilage, burial, germination or by ploughing. I checked the ground regularly for the presence or absence of seed.

### 6.3 FOOD EATEN

Table 12 lists published records and personal observations of foods eaten by White Cockatoos in various parts of Australia. These include a wide variety of native, exotic and crop seeds, fruits and berries, as well as bulbous roots and insects.

At Swan Vale and Wallangra I observed Cockatoos feeding on crops of sunflower, sorghum, wheat, barley and oats; such crops constituted the major food source during "major feeding". "Minor feeding" was observed mainly on the ground during normal feeding hours and in trees during day rest periods. At both Swan Vale and Wallangra Cockatoos were observed feeding on exotic seeds of burr medic (*Medicago polymorpha*), clover (*Trifolium* sp.) and catsear (*Hypochoeris* sp.), dandelion (*Taraxacum officinale*), plantain (*Plantago* sp.) and the seeds and roots

FIGURE 26

## FOOD AVAILABILITY

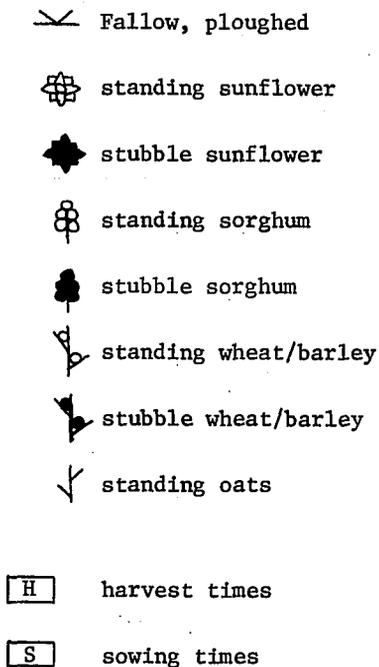
MONTHLY CHANGES IN THE COMPOSITION\* OF CULTIVATED LAND AT

a. SWAN VALE and b. WALLANGRA

Modified land is 35% of total grassland at Swan Vale.

Modified land is 67% of total grassland at Wallangra.

The remaining grassland is native grassland.



Crop seed availability commences with seed formation in this Figure.

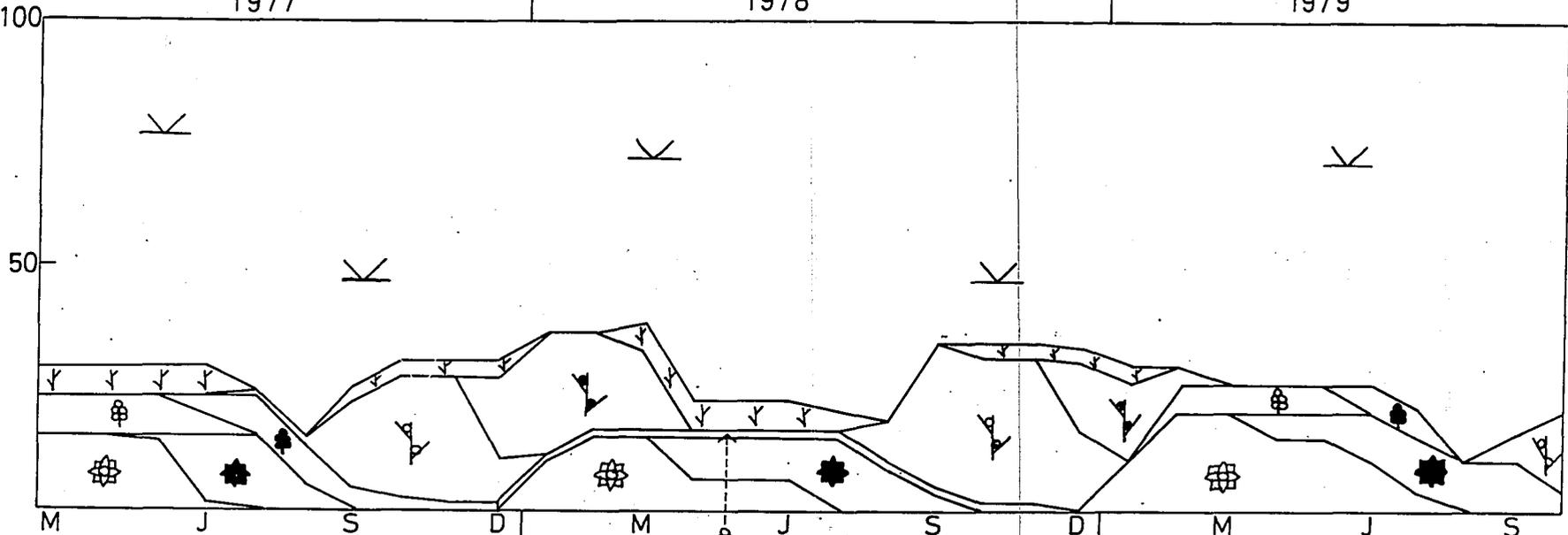
\* Area of each crop presented as a percentage of total area of modified land. Areas of crop and stubble fields calculated from aerial (1975) photographs using a planimeter.

a. SWAN VALE

1977

1978

1979



M J S D M J S D M J S

[H] [H]

[S] [H] [H]

[S] [H] [H] [H]

[H]

[S]

[S]

[H]

[S]

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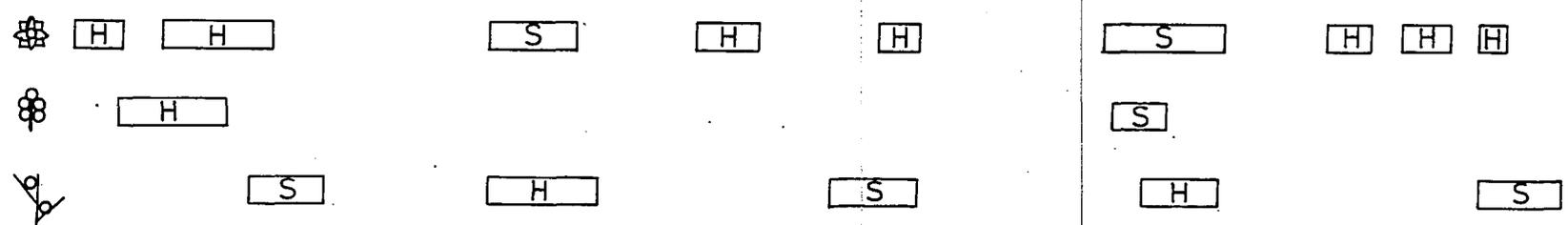
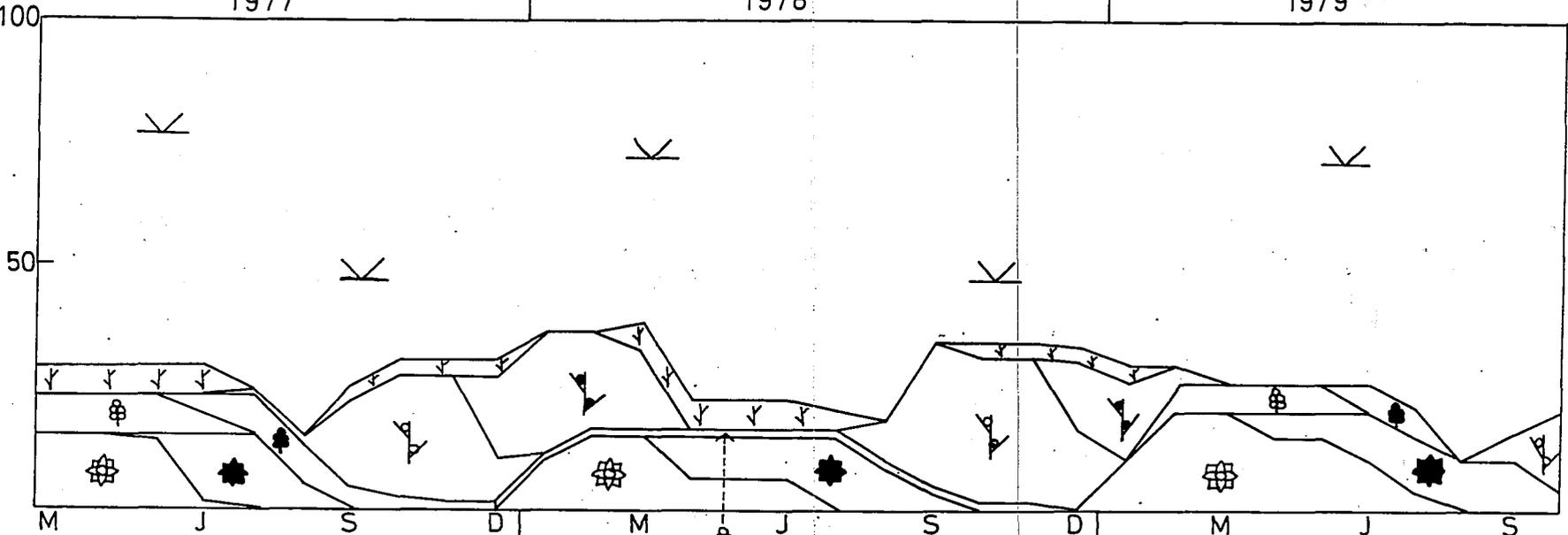
[S]

a. SWAN VALE

1977

1978

1979



b. WALLANGRA

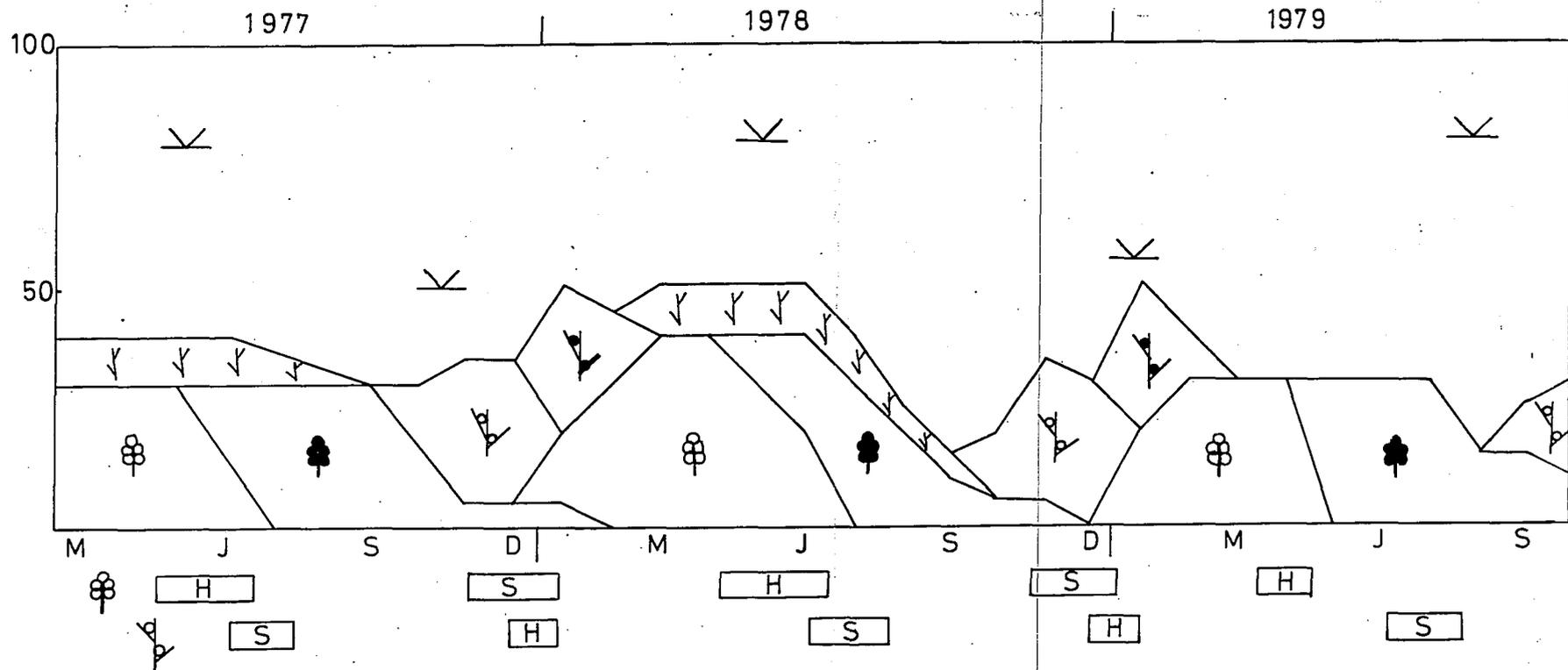


TABLE 12

## FOODS EATEN BY WHITE COCKATOOS IN VARIOUS PARTS OF AUSTRALIA

## 1. SEEDS OF:

A. GRAIN CROPS

|           |                          |  |
|-----------|--------------------------|--|
| Sunflower | <i>Helianthus annuus</i> | pers.obs.  |
| Sorghum   | <i>Sorghum</i> sp.       | "  |
| Wheat     | <i>Triticum aestivum</i> | "  |
| Barley    | <i>Hordeum vulgare</i>   | "  |
| Oats      | <i>Avena sativa</i>      | "  |
| Maize     | <i>Zea mays</i>          | North 1912; Forshaw 1978;<br>Kinghorn-1924; Hyem 1936;<br>Chisholm 1944. |

B. NATIVE SHRUBS/TREES

|                     |                                 |                      |
|---------------------|---------------------------------|----------------------|
| Black boy           | <i>Xanthorrhoea semiplana</i>   | Forshaw 1969         |
| Pandanus            | <i>Pandanus</i> sp.             | Parker 1971          |
| Black bean          | <i>Castano-spermum australe</i> | Bourke & Austin 1947 |
| She-oak             | <i>Casuarina</i> sp.            | Forshaw 1969         |
| Wattle              | <i>Acacia</i> sp.               | pers.obs.            |
| River oak           | <i>Casuarina cunninghami</i>    | "                    |
| Yellow Box          | <i>Eucalyptus melliodora</i>    | "                    |
| White Box           | <i>E. albens</i>                | "                    |
| Rough-barked Apple  | <i>Angophora floribunda</i>     | "                    |
| Smooth-barked Apple | <i>A. costata</i>               | "                    |
| Black Cypress Pine  | <i>Callitris endlicheri</i>     | "                    |
| Kurrajong           | <i>Brachychiton populneum</i>   | "                    |
| Dogwood             | <i>Jacksonia scoparia</i>       | "                    |

C. EXOTIC/GRASS/HERB/TREE/VEGETABLE

|                    |                             |                              |
|--------------------|-----------------------------|------------------------------|
| Bathurst burr      | <i>Xanthium spinosum</i>    | Campbell Ford 1903           |
| Noogoora burr      | <i>Xanthium chinense</i>    | Forshaw 1969; De Warren 1928 |
| Scotch thistle     | <i>Onopordon acanthium</i>  | Forshaw 1969                 |
| Variegated thistle | <i>Silybum marianum</i>     | Batey 1907; pers.obs.        |
| Spear thistle      | <i>Cirsium vulgare</i>      | pers.obs.                    |
| Catsear            | <i>Hypochoeris</i> sp.      | "                            |
| Dandelion          | <i>Taraxacum officinale</i> | "                            |
| Burr medic         | <i>Medicago polymorpha</i>  | "                            |
| Clover             | <i>Trifolium</i> sp.        | "                            |
| Plantain           | <i>Plantago</i> sp.         | "                            |

TABLE 12 (Cont'd)

## C. (Cont'd)

|                                    |                                |  |
|------------------------------------|--------------------------------|--|
| Pecan nuts                         | <i>Carya pecan</i>             | pers.obs.                                |
| Almond nuts                        | <i>Prunus</i> sp.              | "  |
| Fig                                | <i>Ficus</i> sp.               | "  |
| Paddymelon                         | ?                              | "  |
| Pumpkin                            | <i>Cucurbita</i> sp.           | "  |
| Ossage orange                      | <i>Maclura pomifera</i>        | B. Johnson pers.comm.                    |
| Orange                             | <i>Citrus</i> sp.              | Hobbs & Kaveney 1962                     |
| <br>                               |                                |  |
| 2. <u>BULBOUS ROOTS/CORMS</u>      |                                | North 1912; Batey 1907;<br>Chisholm 1944 |
| Onion grass                        | <i>Romulea rosea</i>           | Leach 1928; Bridgewater<br>1932          |
| Spike rush                         | <i>Heleocharis sphacelata</i>  | Forshaw 1969                             |
| Christmas bell                     | <i>Blandfordia</i> sp.         | Green 1961                               |
| Flag lily                          | ?                              | Green 1961                               |
| Pineapple plant                    | ?                              | Green 1961                               |
| Potato                             | <i>Solanum tuberosum</i>       | Green 1961                               |
| Bear's ear                         | <i>Cymbonotus</i> sp.          | pers.obs.                                |
| <br>                               |                                |  |
| 3. <u>BERRIES/FRUITS</u>           |                                |  |
| Palm                               | <i>Ptychosperma alexandre</i>  | North 1912                               |
| Hawthorn                           | <i>Crategus monogyma</i>       | Forshaw 1969                             |
| Red Ash                            | <i>Alphitona excelsa</i>       | pers.obs.                                |
| Mango                              | <i>Mangifera indica</i>        | Officer 1967                             |
| <br>                               |                                |  |
| 4. <u>FLOWERING HEADS</u>          |                                |  |
| Milk thistle                       | <i>Silybum marianum</i>        | Forshaw 1969                             |
| Red Gum                            | <i>Eucalyptus tereticornis</i> | Bravery 1970                             |
| <br>                               |                                |  |
| 5. <u>PLANT MATTER</u>             |                                |  |
| Decomposing bull kelp              | F. Phaeophyceae                | Hinsby 1947                              |
| Young shoots of crops              |                                | pers.obs.                                |
| <br>                               |                                |  |
| 6. <u>INSECTS AND THEIR LARVAE</u> |                                |  |
| Eggs of swarm grasshopper          | <i>Chortoictes terminifera</i> | Forshaw 1969                             |
| Ants eggs                          | F. Formicidae                  | Forshaw 1969                             |
| Wood-boring larvae                 | F. Cerambycidae                | Hill 1907                                |
| Fly larvae in Pandanus syncarps    | O. Diptera                     | Parker 1971                              |

of thistles (*Cirsium vulgare* and *Silybum marianum*) (Plate 3); at Wallangra Cockatoos dug up the bulbous root of bear's ear (*Cymbonotus* sp.). The young shoots of lucerne (*Medicago* sp.), wheat, barley and oats were sometimes eaten.

At both field areas Cockatoos were observed eating the seeds and fruits of Rough-barked Apple (*Angophora floribunda*), Yellow Box (*Eucalyptus melliodora*), White Box (*E. albens*) and River Oak (*Casuarina cunninghamii*). At Swan Vale Cockatoos ate the seeds of cultivated Almond (*Prunus* sp.), Fig (*Ficus* sp.) and Osage Orange (*Maclura pomifera*) trees. At Wallangra Cockatoos chewed the fruits of Smooth-barked Apple (*Angophora costata*) and ate the seeds from Cypress Pine (*Callitris endlicheri*) cones, and from Kurrajong (*Brachychiton populneum*) and Dogwood (*Jacksonia scoparia*) seed pods. Dead branches of eucalypts, apples (*Angophora* spp.) and River Oaks were chewed, possibly to extract wood-boring larvae.

These "minor feeding" activities occurred throughout the year whenever the seeds, fruits and roots were available. However, such foods did not appear to constitute a major part of the Cockatoo diet. Following "major feeding", Cockatoos appeared to ingest little or no food during their "minor feeding" on the ground. In many instances there was no evidence of seeds on searching an area where Cockatoo had "minor" fed. On two occasions such areas contained "mown" grass that had been cut off and chewed into balls by the Cockatoos.

Cockatoos spent time on the ground both "major" and "minor feeding" each month. Fig. 27a and b show the proportions of time spent each month in different feeding areas at Swan Vale and Wallangra. The time spent in native and modified grasslands is an exaggeration of true "feeding time" as much of this time was not spent actively feeding, especially when "major feeding" on crop or stubble had occurred.

## PLATE 3

NON-CROP FEEDING AREAS USED  
BY COCKATOOS

- 
- a. Modified grassland at Swan Vale;  
thistle bush in centre fed upon by  
White Cockatoos.
  
  - b. Native grassland at Wallangra;  
remains of catsear *Hypochoeris* sp. after being  
fed upon by White Cockatoos and Galahs.
-

a



b



FIGURE 27

## USE OF FEEDING AREAS BY WHITE COCKATOOS AT

a. SWAN VALE and b. WALLANGRA

LEGEND

|   |                       |
|---|-----------------------|
|  | standing sunflower    |
|  | stubble sunflower     |
|  | standing sorghum      |
|  | stubble sorghum       |
|  | standing wheat/barley |
|  | stubble wheat/barley  |
|  | standing oats         |
|  | native grassland      |
|  | modified grassland    |

Proportions of feeding 'bird hours' in certain feeding areas are depicted for each month.

$$\text{Feeding 'bird hours'} = \frac{\text{No. of birds} \times \text{No. of minutes on ground}}{60}$$

Proportions were calculated from March 1977 to March 1979, and estimated for April to September 1979.

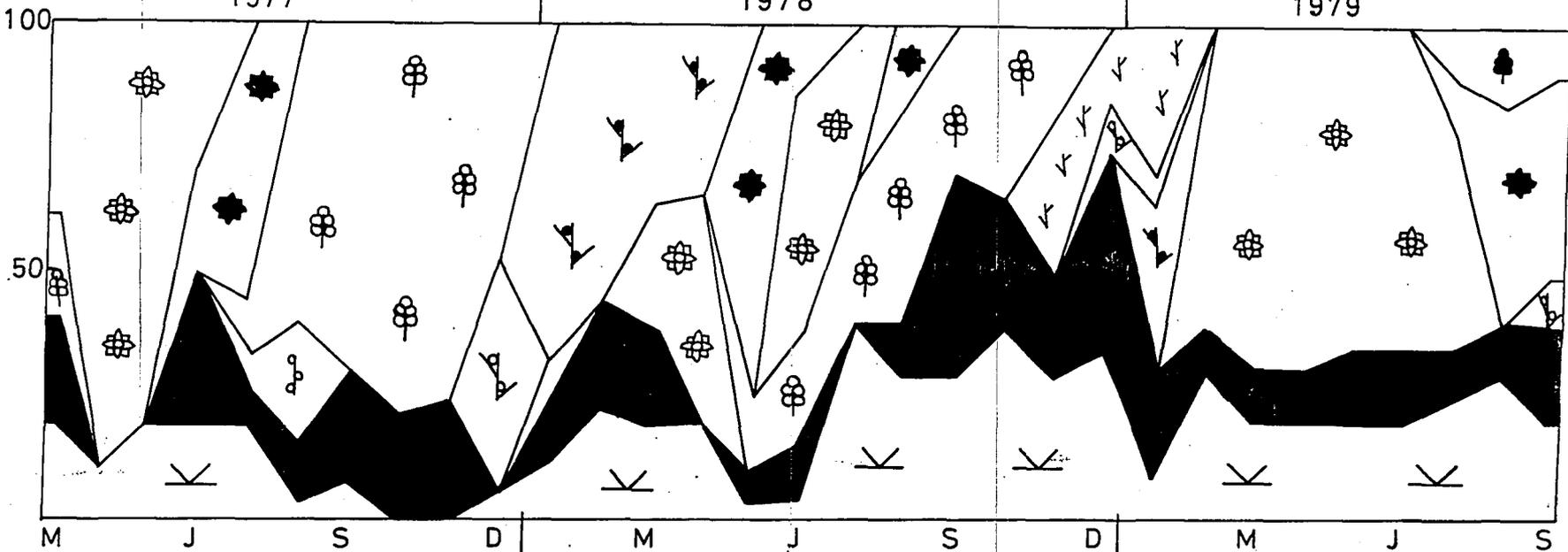
|                  | <u>Number of Feeding 'Bird hours'</u> |     |      |     |           |      |      |     |     |     |     |     |
|------------------|---------------------------------------|-----|------|-----|-----------|------|------|-----|-----|-----|-----|-----|
|                  | J                                     | F   | M    | A   | M         | J    | J    | A   | S   | O   | N   | D   |
| <b>SWAN VALE</b> |                                       |     |      |     |           |      |      |     |     |     |     |     |
| 1977             | -                                     | -   | 36   | 122 | 214       | 181  | 185  | 96  | 154 | 158 | 132 | 64  |
| 178              | 96                                    | 160 | 162  | 205 | 203       | 187  | 165  | 200 | 124 | 142 | 135 | 89  |
| 1979             | 182                                   | 148 |      |     | estimates |      |      |     |     |     |     |     |
| <b>WALLANGRA</b> |                                       |     |      |     |           |      |      |     |     |     |     |     |
| 1977             | -                                     | -   | -    | 625 | -         | 531  | 698  | -   | 553 | 512 | 599 | 353 |
| 1978             | 750                                   | 880 | 1336 | -   | 1235      | 1104 | 1003 | 674 | 346 | 941 | 938 | 345 |
| 1979             | 945                                   | 951 |      |     | estimates |      |      |     |     |     |     |     |

a. SWAN VALE

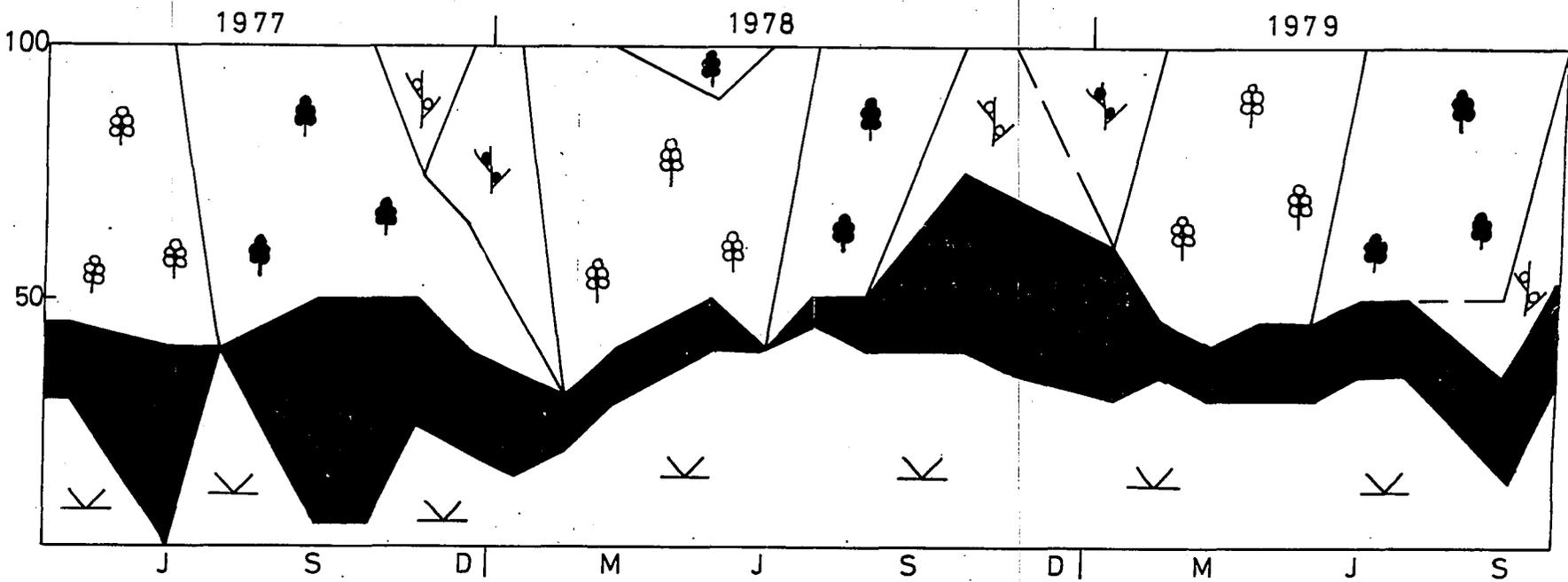
1977

1978

1979



b. WALLANGRA



Throughout the year the birds fed on whatever crop or stubble was available, choosing crop seed despite the relatively small acreages of crop available in the total grassland area (Fig. 26a, b).

At Swan Vale (Fig. 27a) crop seed was eaten throughout the year. Sunflower seed from crop and stubble was eaten from February and March until August and September, throughout its period of availability. Standing sorghum was available in 1977 and 1978. However, in 1977 sunflower was preferred and the sorghum was eaten at a stubble area near the permanent roost only when there was no more sunflower. The sorghum stubble area became a self-sown crop with seed available to and eaten by Cockatoos from May to December 1978. In 1979 sorghum was planted only in the far south-west part of the field area. However, up to 12 Cockatoos ate sorghum from this farmer's storage bin from July to September 1979. The Cockatoos at Swan Vale (Fig. 27a) ate wheat and barley from standing and stubble areas each year from December to February or April. In 1979 the stubble was ploughed in December/January, earlier than in previous years, and Cockatoos transferred to the early sunflower crops in February.

Each year at Swan Vale the native and modified grasslands were the chief sites for feeding in spring, especially in 1978 when the sorghum near the roost area was depleted and before wheat was available. Spring, summer and early autumn were the seasons when seed was probably most available in native and modified grasslands. However, seed from standing and stubble crops was also available at these times.

At Wallangra (Fig. 27b) sorghum areas were used for major feeding. These areas were available to and preferred by the birds from February to October in 1978 and 1979, and throughout the year in 1977 when some sorghum areas remained fallow. Barley and wheat were eaten in late spring and summer. Seeds from native and modified grasslands were

also eaten in these seasons. At Wallangra many Cockatoos participated in "minor feeding" activity in native and modified grasslands throughout the year although "major feeding" had also occurred. Birds did not appear to feed intensively during these "minor feeding" periods.

The 'crop' contents of Cockatoos shot each month during 1979 within the Swan Vale and Wallangra Site A home ranges, confirmed the pattern of feeding favouring consumption of crop seed during "major feeding" periods. Ninety-three % of 46 Cockatoos shot contained some crop seed. Sixty-six % of birds shot after "major" and "minor feeding" had taken place, contained only crop seeds consumed during the "major feeding" period. In 34% of birds some native and modified seeds were represented, comprising from 0.2 to 100% of individual 'crop' seed numbers. In 12% of birds bark, green leaves and stems, presumably taken during "minor feeding", were present amongst crop seed.

At Swan Vale (Fig. 28a) sunflower seed dominated 'crop' composition in number and dry weight from March to August, being 95% of diet by weight. Sorghum, wheat and oats were present in small proportions in three months. No birds were collected between September and February. Non-crop seeds were present in only two 'crops' in March and August. One 'crop' contained a thistle (*Cirsium vulgare*) seed and the other two unidentified seeds (Plate 4).

At Wallangra Site A (Fig. 28b) sorghum seed was eaten in greatest quantities from March to September, comprising 94% of diet by weight. Wheat, barley and oats were eaten from October to March, and in June, comprising 39% of diet by weight in those months. Native and modified (exotic) seeds were present in 48% of 'crops', being eaten in March, May, June and from October to January, and comprised 21% of diet by weight in those months. The most common of these were seeds of the variegated thistle (*Silybum marianum*) and spear thistle (*Cirsium vulgare*), with catsear

FIGURE 28

## MONTHLY SEED COMPOSITION OF WHITE COCKATOO 'CROPS' AT

a. SWAN VALE and b. WALLANGRA.

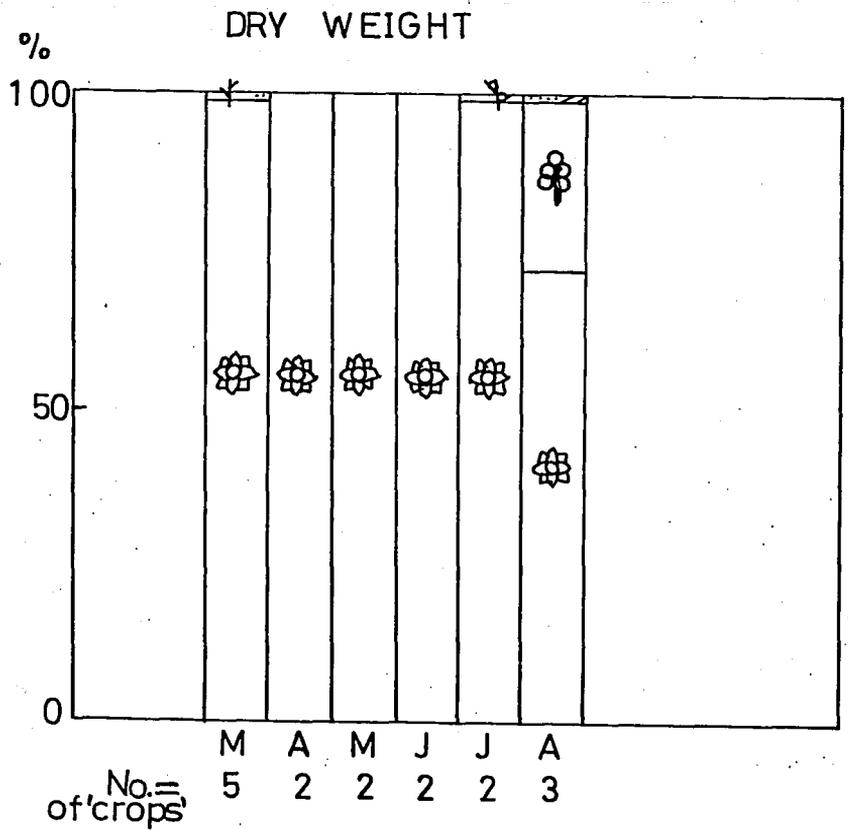
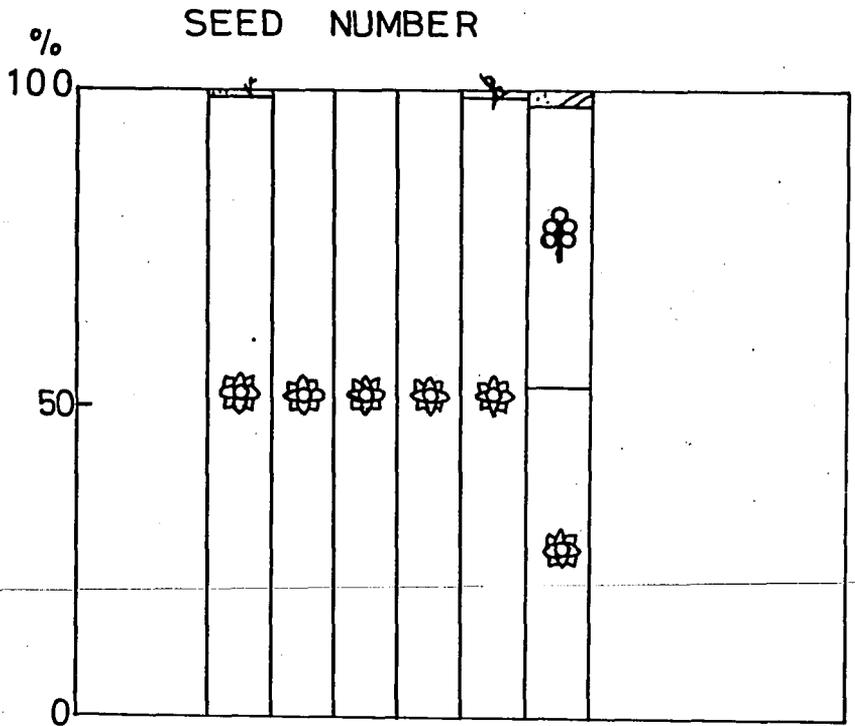
Proportions of:-

1. number of seeds
2. dry weights of seeds

LEGEND

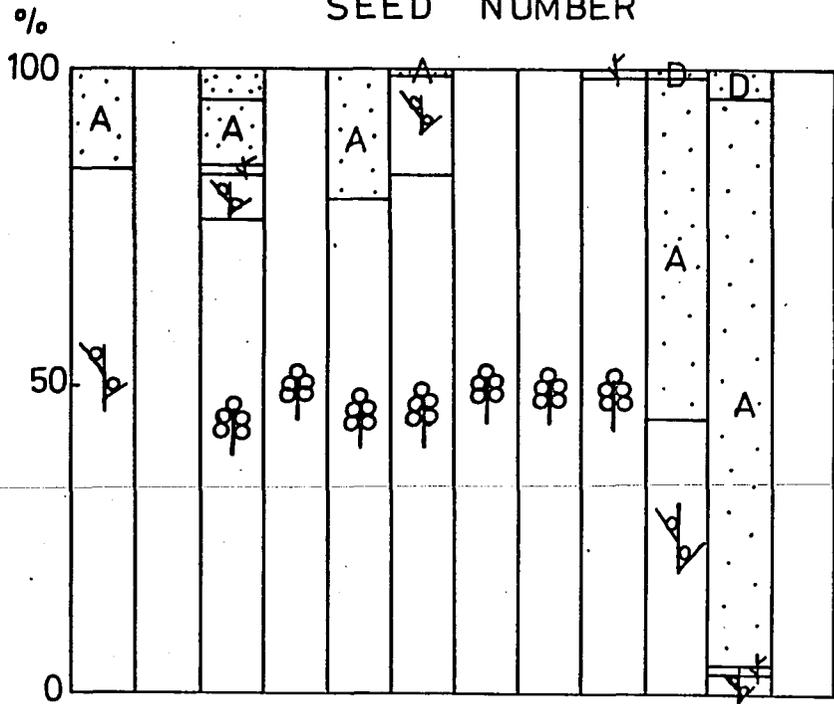
-  sunflower  
 sorghum  
 wheat/barley  
 oats  
 A thistle *Silybum marianum*  
 D catsear/dandelion *Hypochoeris / Taraxacum* spp.  
     (exotic)  
 modified seed  
 native seed

# a. SWAN VALE

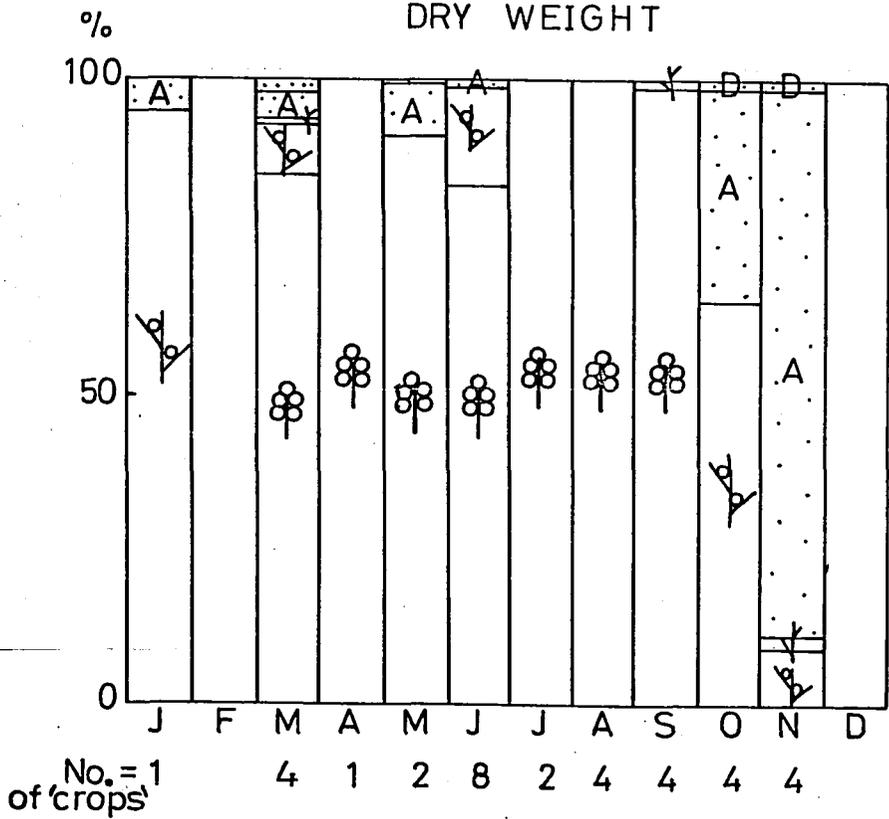


b. WALLANGRA

SEED NUMBER



DRY WEIGHT

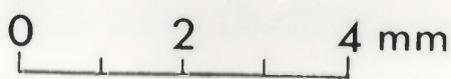
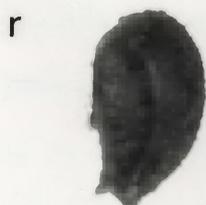
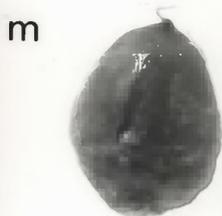
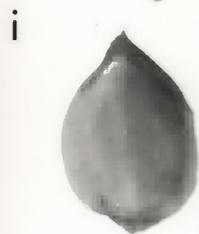
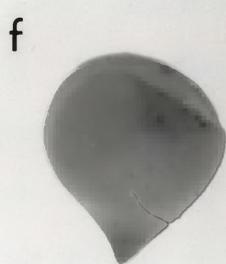


## PLATE 4

SEEDS FOUND IN THE 'CROPS' OF  
WHITE COCKATOOS AND GALAHS

|    |  |  |
|----|--|--|
| a. | <i>Helianthus annuus</i>                             | sunflower  |
| b. | <i>Sorghum</i> sp.                                   | sorghum  |
| c. | <i>Triticum aestivum</i> /<br><i>Hordeum vulgare</i> | wheat (barley)                                     |
| d. | <i>Avena sativa</i>                                  | oats   |
| e. | <i>Silybum marianum</i>                              | variegated thistle                                 |
| f. | <i>Cirsium vulgare</i>                               | spear thistle                                      |
| g. | <i>Cirsium vulgare</i> ?                             | spear thistle                                      |
| h. | <i>Medicago</i> sp.                                  | medic burr   |
| i. | <i>Rumex</i> sp.                                     | dock   |
| j. | <i>Setaria</i> sp.                                   | pigeon grass                                       |
| k. | <i>Echinochloa</i> sp.                               | barnyard grass                                     |
| l. | <i>Bothriochloa macra</i> *                          | wallaby grass                                      |
| m. | <i>Alternanthera nana</i> *                          |  |
| n. | <i>Polygonum</i> sp.                                 | ?  |
| o. | <i>Hypochoeris</i> sp./<br><i>Taraxacum</i> sp.      | catsear/dandelion<br>(unhusked seeds very similar) |
| p. | <i>Amaranthus retroflexus</i>                        | weed   |
| q. | unidentified grass                                   |  |
| r. | unidentified seed                                    |  |
| s. | unidentified ? <i>Phalaris</i> sp.                   | canary grass                                       |
| t. | unidentified ? <i>Trifolium</i> sp.                  | clover   |

\* Native seeds



(*Hypochoeris* sp.) or dandelion (*Taraxacum* sp.) also consumed in spring (Plate 4).

At both field areas in October to January seeds of sorghum, thistle and dandelion or catsear were seen in the bills and felt in the 'crops' of nestling Cockatoos.

Cockatoos collected from the two field areas also ingested seed husk, bark, leaf, stem and insect larvae. Seed husks and bark were ingested by 85% of Cockatoos, and comprised from 0.07 to 12% of the dry weight of individual 'crops'. Green material ingested included shoots of wheat and oats, leaves of dandelion or catsear, and stems of a pea (*Swainsona* sp.). Two Cockatoos had ingested insect larvae in August: one Lepidopteran larva (2.5 cm long) in one crop and 25 Hymenopteran larvae (< 1 cm long) in the other. Although the sample sizes were small, there were no differences between males and females in seed diet throughout the year. Both sexes had husk and bark in their crops, but during the breeding season (August - November) only females had green leaves and stems in their crops.

Generally at both field areas birds consumed whichever crop seed was available at the time. During autumn and winter seed from summer crops of sunflower or sorghum dominated Cockatoo diets. In spring and summer wheat and barley seed were eaten, although seeds from modified areas reached their peak level of consumption by the birds at this time.

It is feasible that less energy is expended in searching for and extracting seed from crops where seed is abundant in a localized area, than from areas of native and modified grassland where seed is more dispersed and at times far less abundant. A significant variation occurs in calorific content of seeds between species, and within and between plant families (Kendleigh and West 1965). The seeds of Gramineae are consistently low in energy value, Leguminosae are higher, while Plantaginaceae and Compositae rate the highest values (Table 13). Of

TABLE 13

## GROSS ENERGY VALUES OF SOME SEEDS PRESENT AT SWAN VALE AND WALLANGRA

(from Kendeigh and West 1965)

| CLASSIFICATION              | COMMON NAME    | SEED CONDITION | AVERAGE KCAL/GRAM<br>OF SEED |
|-----------------------------|----------------|----------------|------------------------------|
| GRAMINEAE                   |                |                |                              |
| <i>Bromus</i> sp.           | Brome          | Hulled         | 4.491                        |
| <i>Digitaria</i> sp.        | Cotton grass   | Hulled         | 4.380 & 4.616                |
| <i>Echinochloa</i> spp.     | Barnyard grass | Hulled         | 4.819                        |
| <i>Echinochloa</i> spp.     | Barnyard grass | Whole          | 4.422                        |
| <i>Panicum</i> spp.         | Panic          | Hulled         | 4.647 & 4.700                |
| <i>Setaria</i> spp.         | Pigeon grass   | Hulled         | 4.585, 4.494 & 4.534         |
| <i>Setaria</i> spp.         | Pigeon grass   | Whole          | 4.468                        |
| <i>Zea mays</i>             | Corn           | Hulled         | 4.317                        |
| CYPERACEAE                  |                |                |                              |
| <i>Carex</i> sp.            | ?              | Hulled         | 4.788                        |
| POLYGONACEAE                |                |                |                              |
| <i>Rumex</i> sp.            | Dock           | Hulled         | 4.786                        |
| FABACEAE                    |                |                |                              |
| <i>Trifolium pratense</i>   | Clover         | Hulled         | 4.980                        |
| PLANTAGINACEAE              |                |                |                              |
| <i>Plantago</i> sp.         | Plantain       | Hulled         | 5.204                        |
| COMPOSITAE                  |                |                |                              |
| <i>Taraxacum officinale</i> | Dandelion      | Hulled         | 5.105                        |

the crop seeds, White Cockatoos prefer sunflower, a Composite, although sorghum, wheat, barley and oats, all Gramineae are also eaten.

Modified<sup>(exotic)</sup> non-crop seeds consumed by Cockatoos included the Compositae thistle, dandelion or catsear seeds.

Collections of 7 adult Cockatoos from the Moree area made in March and August 1977 also exhibited the birds' preferences for crop seed. Sunflower, sorghum and pecan nuts were identified in these 'crops'.

#### 6.4 SELECTION OF FEEDING SITES

At both field areas the majority of White Cockatoos followed main flight paths between roosts and feeding sites, and day rest and feeding sites. These movements were predictable once a feeding site was 'established', being used each day. The flight paths used and distances flown mirrored the birds' preferences for certain feeding sites. At Swan Vale Cockatoos flew long distances of 300 metres to six kilometres to feed on sunflower crops (Fig. 29a). Crops of sorghum, wheat, oats and barley within two and a half kilometres of the roost were selected for feeding; mostly native and modified areas close to the roost were used for "minor feeding". Similarly, at Wallangra Cockatoos fed on crops and "minor feeding" areas within three and a half kilometres of roost and day rest areas. The longest distances flown were those to sorghum crops (Fig. 29b).

At both field areas during the non-breeding late summer, autumn and winter months Cockatoos travelled more widely to feed (Figs 30 and 31). At these times the summer crops of sunflower and sorghum were available and used at Swan Vale and Wallangra, respectively, by the majority of birds for "major feeding". During the breeding season the patterns of movement to and from feeding sites was restricted at Swan Vale (Fig. 30b, c). The majority of birds fed close to their

FIGURE 29

DISTANCES FLOWN BY WHITE COCKATOOS  
FROM ROOSTS TO FEEDING AREAS AT  
a. SWAN VALE and b. WALLANGRA

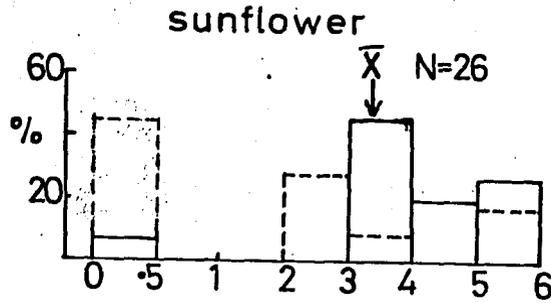
N = number of direct distances from roost to particular  
crop or pasture (scored once only for each roost to  
feeding area)

 - temporary roosts to sunflower crops

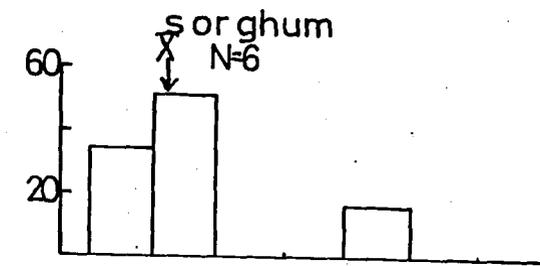
 - permanent roosts to feeding areas

a. SWAN VALE

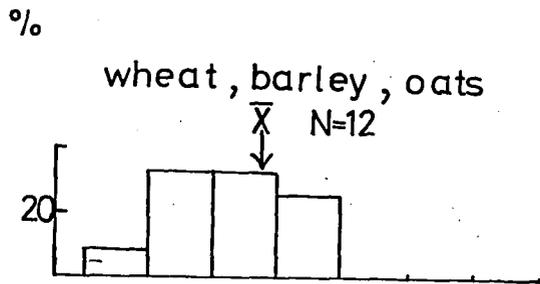
$\bar{X}$  distance (km):  
roost to  
all crops of



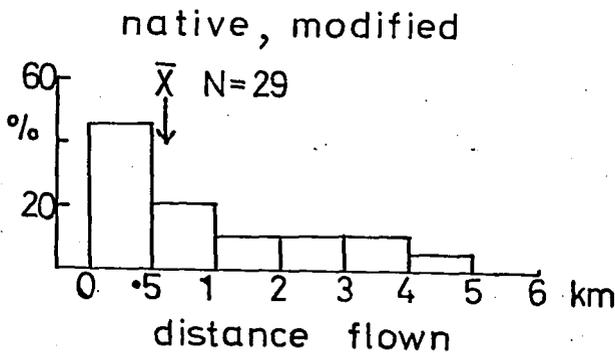
sunflower - 3.91 N=34



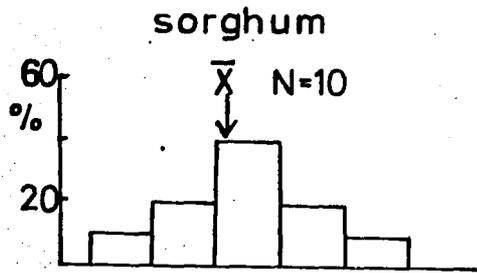
sorghum - 3.55 N=8



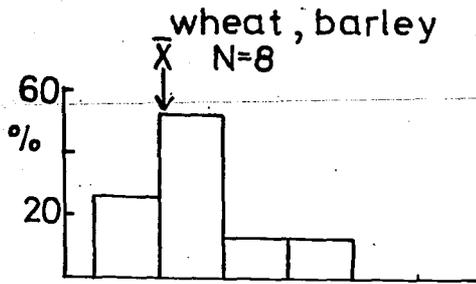
wheat  
barley, oats - 2.77 N=15



b. WALLANGRA



$\bar{X}$  distance (km)  
roast to  
all crops of  
sorghum - 1.70 N=12



wheat,  
barley - 1.05 N=12

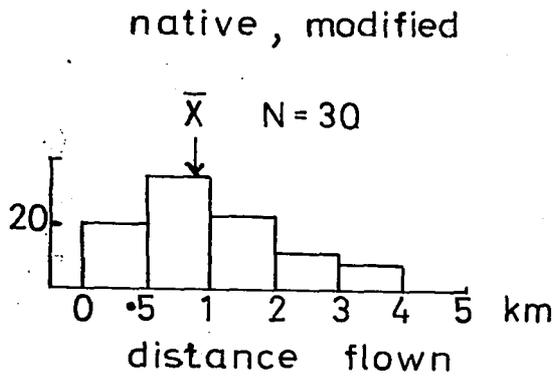
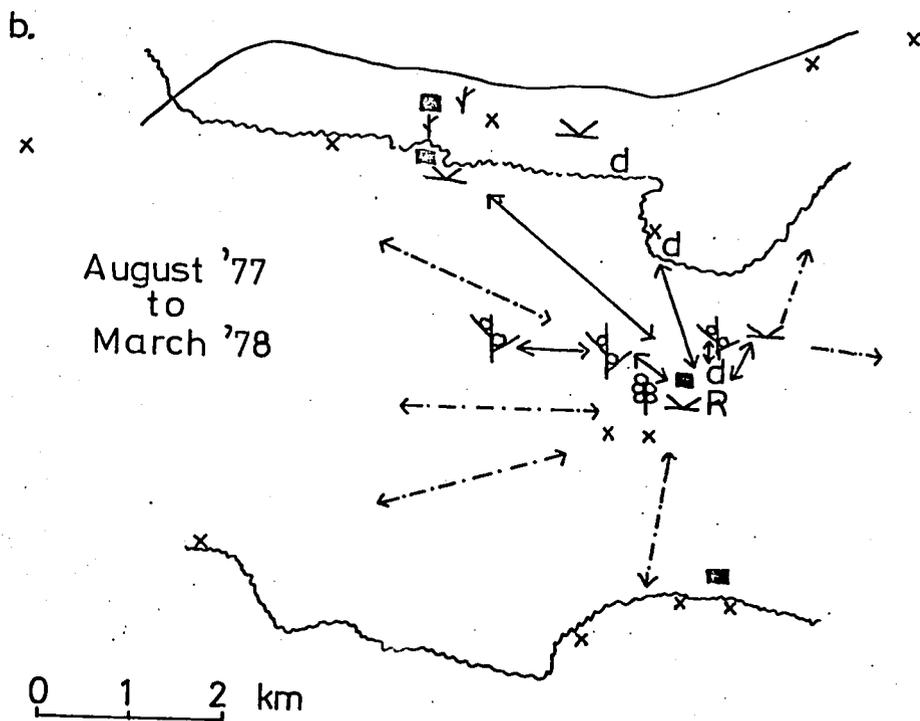
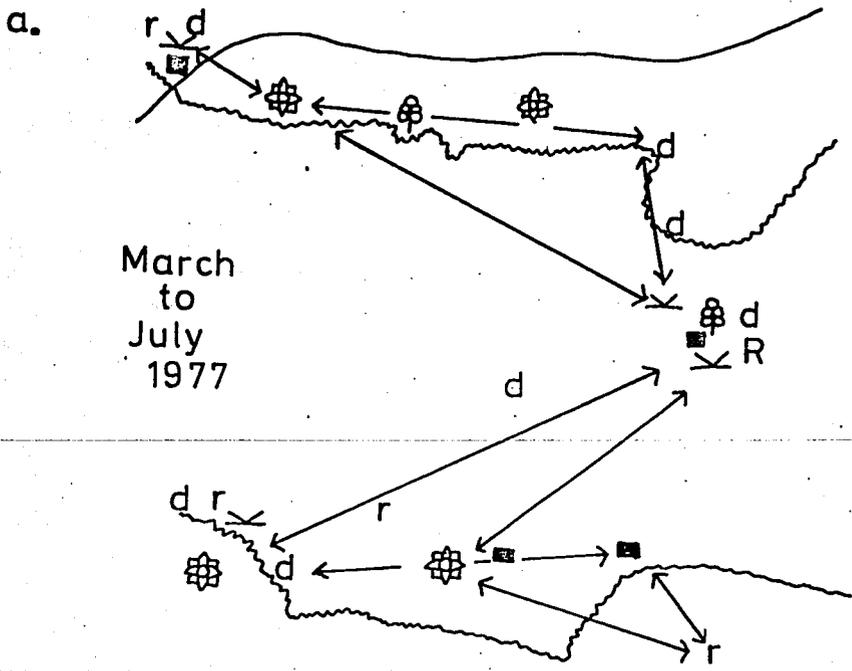


FIGURE 30

FEEDING AREAS USED BY WHITE COCKATOOS  
AT SWAN VALE EACH YEAR

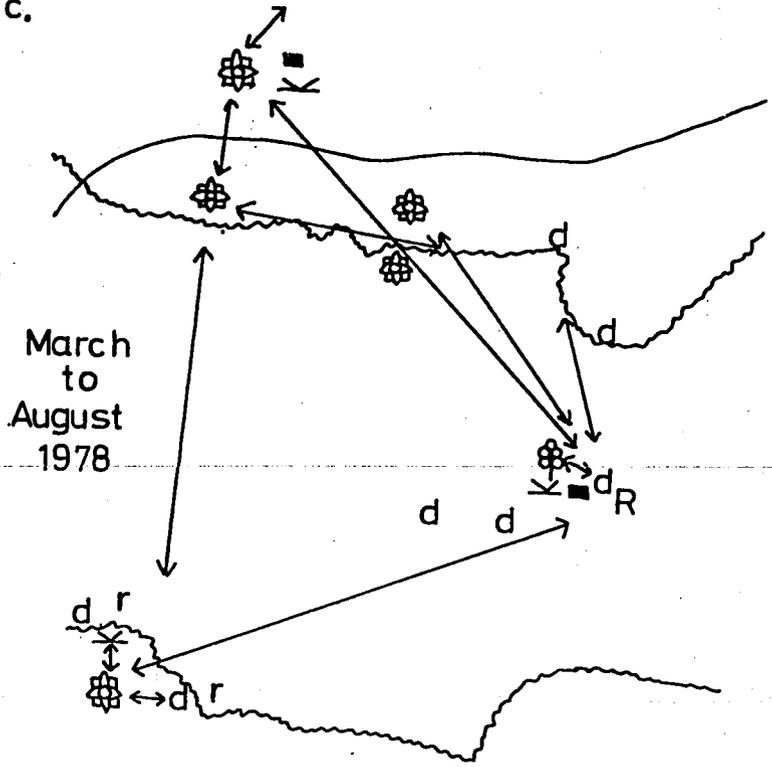
- R - permanent roost  
 r - temporary roost  
 d - day rest  
 x - nest trees  
 ☼ - sunflower crop  
 ⦿ - sorghum crop  
 ⋈ - wheat/barley crop  
 ↓ - oats crop  
 ∨ - modified grassland  
 ■ - native grassland
- ←→ - flight paths by majority of birds  
 ←·→ - flight paths of pairs and small groups in  
breeding season
- ~~~~~ - creek  
 ——— - main road

# SWAN VALE

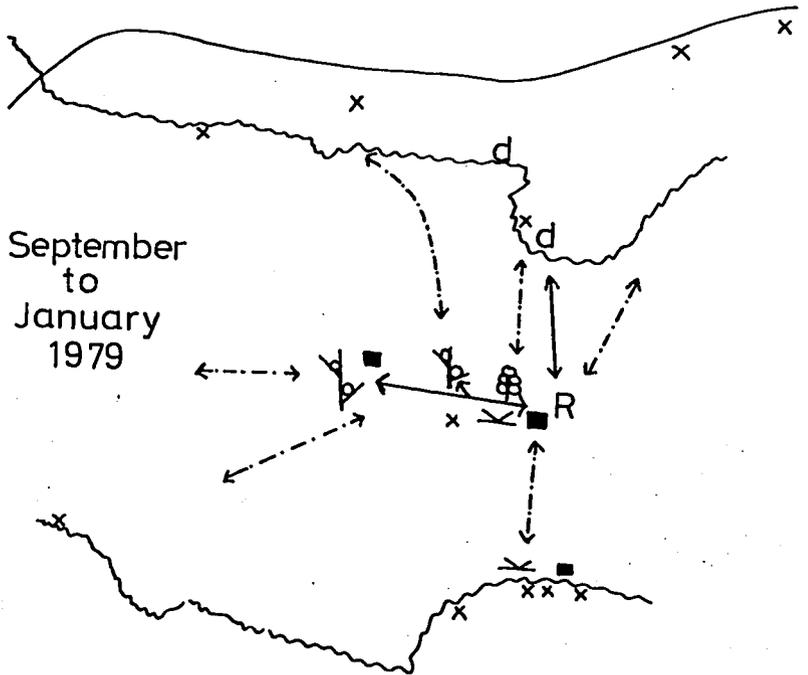


# SWAN VALE

c.



d.



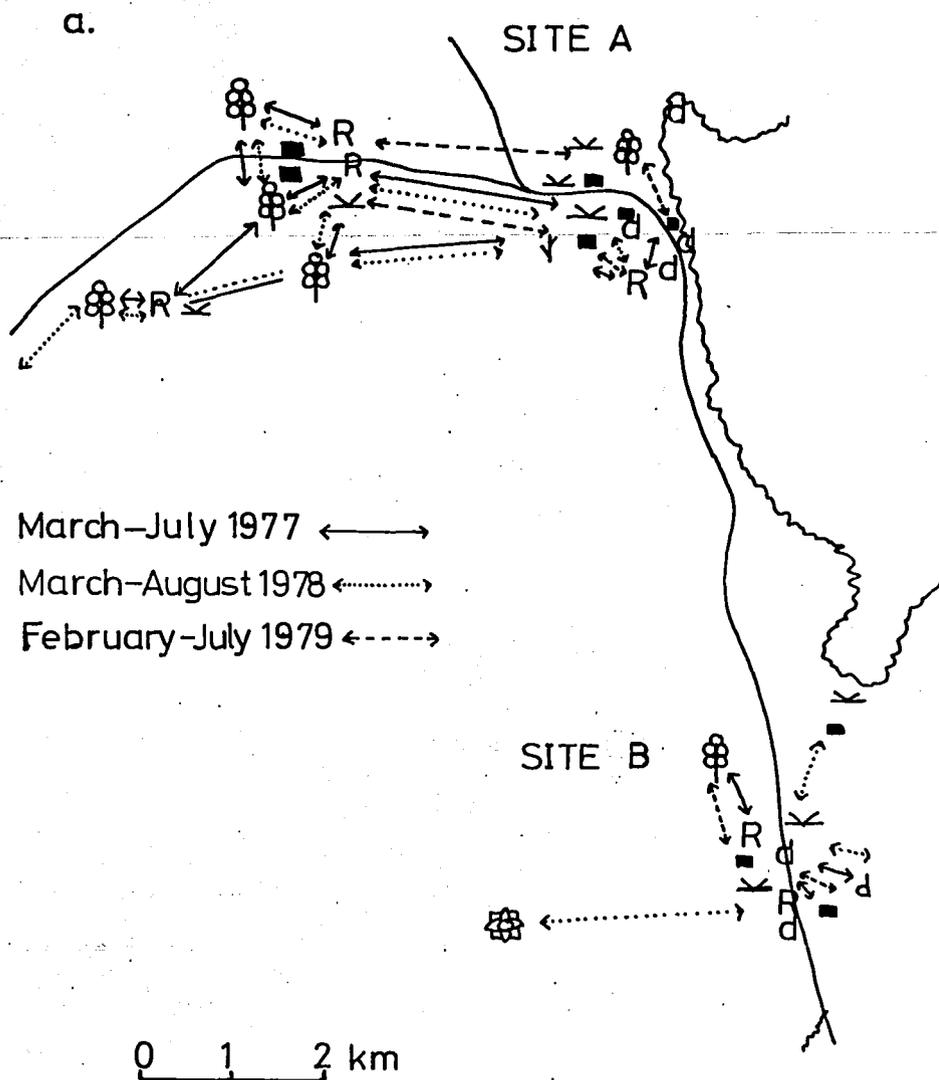
0 1 2 km

FIGURE 31

FEEDING AREAS USED BY WHITE COCKATOOS  
AT WALLANGRA EACH YEAR

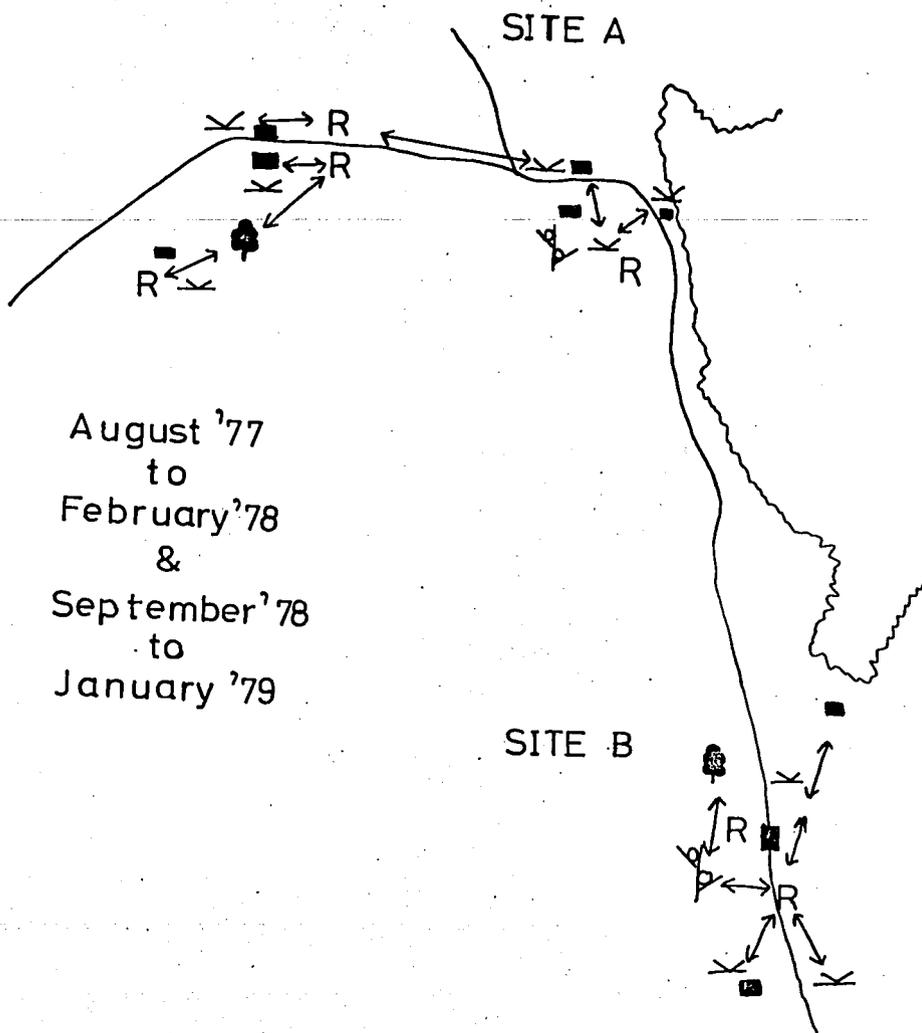
- R - permanent roost
- d - day rest
-  - sunflower crop
-  - sorghum crop
-  - wheat/barley crop
-  - modified grassland
-  - native grassland
-  - flight paths by majority breeding season
-  - flight paths by majority non-breeding season 1977
-  - flight paths by majority non-breeding season 1978
-  - flight paths by majority non-breeding season 1979
-  - Macintyre River
-  - main road

# WALLANGRA



# WALLANGRA

b.



permanent roost site, with pairs dispersing and often feeding near their nests. Similarly, during the breeding season at Wallangra (Fig. 31b), the feeding movements were restricted, with the majority of birds, both non-breeding and breeding, feeding near roost and nest areas which occurred in at least three separate forest patches in the home range.

## CHAPTER 7

## BREEDING BEHAVIOUR

## 7.1 PAIR BEHAVIOUR

I did not observe courtship feeding or any elaborate courtship display in the White Cockatoo. One bird simply approached another, sometimes bobbing its head and swinging its body from one side of the perch to the other with each step (Forshaw 1969, pers. obs.). The approached bird, presumably a female, either gaped its bill aggressively, flew off, or remained still, accepting the approach submissively, often lowering its stance. A mated or courting pair perched side by side sometimes touching and often allopreened. The pair bond may be permanent as some nests are attended throughout the year by a single pair (J.E. Courtney pers. comm., pers. obs.); initial pair formation may therefore be quite a rare event.

At Swan Vale I saw one copulation attempt on 7th October 1977. The female was crouched low on a branch with her head raised, while the male attempted several times to stand across her back in a perpendicular stance. Eventually he mounted and turned parallel to her body lowering his head over her neck. Both birds had their wings slightly raised and the male's tail was fanned and moved beside and beneath her tail. This position was held for only 5 seconds before the male dismounted and supplanted a third bird which had approached the female from the other side.

Copulation was observed on two occasions at Wallangra in August 1978. Prior to one observation, the male preened the female about the head. The two pairs held the copulation position for about 1 and 2 minutes respectively. In the first the male dismounted and flew off, while the female remained perched. In the second case the male

bobbed his head with crest raised, prior to dismounting and approaching a spectator Cockatoo perched close by. Immediately after the intruder had disappeared, the male preened the female.

Forshaw (1969) states that this species is very wary near the nest. At the approach of an intruder the sitting bird slips away silently and calls only when well clear of the nest. My observations support this, but occasionally when unaware of human intruders Cockatoos called loudly from their nest trees. However, they did not visit their nests if aware of human presence.

Established nest sites appear may well be used over many years. J.E. Courtney (pers. comm.) reports that at least three nests at Swan Vale have been used every year for 25 to 30 years. As pairs visit their nest holes throughout the year (see 'The Nest' next Section), it seems likely that re-use of nests involves the same birds (or at least one member of the pair). I never observed any conflict over nest holes.

## 7.2 THE NEST

Like most parrots White Cockatoos nest in tree-holes. Throughout the year nests were located by flushing birds from holes. Fresh chewing and claw marks around a hollow, or distinctive wood-chips lying at the base of tree-trunks were good indicators of active nest sites.

At Swan Vale all but two pairs nested in living and dead Manna Gum (*Eucalyptus viminalis*), (Table 14) (Plate 5d). The odd pairs nested in a White Box (*E. albens*) and a Rough-barked Apple (*Angophora floribunda*). Nest holes ranged from 7 to 16.5 metres <sup>above the ground</sup> ( $\bar{X} = 10.2$ ) (Table 14). The trees were 11 to 23.5 metres high ( $\bar{X} = 16.9$ ).

At Wallangra nests were examined in two forest stands in the ranges of the populations at both Site A and Site B, 8 km apart. Two

TABLE 14

## NEST TREES USED BY WHITE COCKATOOS AT SWAN VALE AND WALLANGRA

| FIELD AREA          | NEST NO. | TREE SPECIES                                    | TREE                 | NEST HOLE                                       |     | NEST HEIGHT (m) | TREE HEIGHT (m) | IN USE  |
|---------------------|----------|---|----------------------|---|-----|-----------------|-----------------|---------|
|                     |          | E. - <i>Eucalyptus</i><br>A. - <i>Angophora</i> | L - live<br>D - dead | T - trunk<br>L - live<br>B - branch<br>D - dead |     |                 |                 |         |
| Swan Vale           | +1a      | <i>E. viminalis</i>                             | L                    | T   | D   | 10.4            | 22.6            | 1       |
| "                   | 1b*      | "   | L                    | B   | L/D | 8.5             | 22.6            | 2       |
| "                   | 2        | "   | L                    | B   | D   | 16.5            | 22.6            | 1, 2    |
| "                   | 3*       | " ?   | D                    | T   | D   | 7.0             | 11.0            | 1, 2    |
| "                   | 4        | " ?   | D                    | B   | D   | 11.0            | 16.0            | 1, 2, 3 |
| "                   | 5        | "   | L                    | T   | L   | 11.0            |                 | 1, 2    |
| "                   | 6        | "   | L                    | T   | L   | 9.0             | 15.0            | 1       |
| "                   | 7*       | " ?   | D                    | T   | D   | 7.7             | 12.0            | 1, 2    |
| "                   | 8        | " ?   | D                    | T   | D   | 9.8             | 15.5            | 1, 2    |
| "                   | 9        | "   | L                    | T   | D   | 11.0            | 23.5            | 1, 2, 3 |
| "                   | 10       | "   | L                    | T   | D   | 11.0            |                 | 1       |
| "                   | 11       | "   | L                    | T   | L   | 12.0            | 20.0            | 2, 3    |
| "                   | 12       | <i>E. viminalis</i>                             | L                    | T   | L   |                 |                 | 3       |
| "                   | 13*      | <i>E. albens</i>                                | L                    | B   | L   | 9.0             | 11.0            | 1       |
| "                   | 14       | <i>A. floribunda</i>                            | L                    | B   | D   |                 |                 | 3       |
| Wallangra<br>Site A | 1*       | <i>A. costata</i>                               | L                    | B   | L   | 10.2            | 15.0            | 1, 2    |
| "                   | 2        | "   | L                    | B   | L   | 11.6            | 24.4            | 1, 2    |
| "                   | 3        | "   | L                    | T   | L   | 11.6            | 25.6            | 1       |

TABLE 14 (Cont'd)

| FIELD AREA          | NEST NO. | TREE SPECIES                                    | TREE                 | NEST HOLE                                       |   | NEST HEIGHT (m) | TREE HEIGHT (m) | IN USE  |
|---------------------|----------|---|----------------------|---|---|-----------------|-----------------|---------|
|                     |          | E. - <i>Eucalyptus</i><br>A. - <i>Angophora</i> | L - live<br>D - dead | T - trunk<br>L - live<br>B - branch<br>D - dead |   |                 |                 |         |
| Wallangra<br>Site A | 4*       | <i>A. costata</i>                               | L                    | T   | L | 8.5             | 21.3            | 1, 2    |
| "                   | 5        | " ?   | D                    | T   | D | 11.9            | 15.5            | 1, 2    |
| "                   | 6        | "   | L                    | T   | D | 13.4            | 14.6            | 1       |
| "                   | 7*       | "   | L                    | B   | L | 8.0             | 18.0            | 2       |
| "                   | 8*       | "   | L                    | B   | D | 7.6             | 20.4            | 2       |
| "                   | 9        | "   | L                    | B   | D | 10.0            |                 | 2, 3    |
| "                   | 10       | "   | L                    | T   | D | 11.6            | 22.6            | 1, 2, 3 |
| "                   | 11       | "   | L                    | B   | L |                 |                 | 2       |
| "                   | 12       | "   | L                    | T   | D |                 |                 | 2       |
| "                   | 13       | "   | L                    | B   | L |                 |                 | 1       |
| "                   | 14*      | "   | L                    | T   | L | 5.5             | 15.5            | 3       |
| "                   | 15       | <i>E. blakelyi</i>                              | L                    | T   | L | 10.2            | 27.1            | 1, 2    |
| Wallangra<br>Site B | 1*       | <i>E. albens</i>                                | L                    | T   | L | 7.5             | 13.0            | 1, 2, 3 |
| "                   | 2*       | "   | L                    | T   | L | 8.7             | 17.0            | 1, 2    |
| "                   | 3*       | <i>E. blakelyi</i>                              | L                    | B   | L | 8.6             | 15.5            | 2, 3    |
| "                   | 4*       | "   | L                    | T   | L | 4.5             | 13.0            | 2       |
| "                   | 5*       | "   | L/D                  | B   | D | 7.5             | 12.0            | 2       |
| "                   | 6*       | <i>A. costata</i>                               | L                    | T   | L | 4.5             | 16.0            | 1       |

TABLE 14 (Cont'd)

| FIELD AREA            | NEST NO. | TREE SPECIES<br>E. - <i>Eucalyptus</i><br>A. - <i>Angophora</i> | TREE                 |  | NEST HOLE                                       |   | NEST HEIGHT<br>(m) | TREE HEIGHT<br>(m) | IN USE<br>1 - 1977<br>2 - 1978<br>3 - 1979 |
|-----------------------|----------|---|----------------------|--|---|---|--------------------|--------------------|--|
|                       |          |   | L - live<br>D - dead |  | T - trunk<br>L - live<br>B - branch<br>D - dead |   |                    |                    |  |
| Wallangra<br>(Site B) | 7        | <i>A. costata</i>   | L                    |  | T   | L | 10.0               | 18.0               | 1, 2                                       |
| "                     | 8        | "   | L                    |  | B   | L |                    |                    | 1, 2                                       |
| "                     | 9        | "   | L                    |  | B   | L | 11.9               | 22.9               | 1  |
| "                     | +10a     | "   | L                    |  | B   | L | 12.8               | 27.5               | 1  |
| "                     | 10b      | "   | L                    |  | T   | L | 15.9               | 27.5               | 2, 3                                       |
| "                     | 11       | "   | L                    |  | B   | L | 13.1               | 19.2               | 1, 2, 3                                    |
| "                     | 12       | "   | L                    |  | B   | L |                    |                    | 1, 2                                       |

\* Nest trees climbed

Not all nests have been measured and included in this table.

+ a and b - two nests in the one tree used by presumably the same pair.

## PLATE 5

## WHITE COCKATOO NEST TREES

- a. Nest hole at 10.2 m in Smooth-barked Apple  
*Angophora costata* at Wallangra Site A
- b. Nest hole at 11.6 m in Smooth-barked Apple  
*Angophora costata* at Wallangra Site A
- c. Nest hole at 7.5 m in White Box  
*Eucalyptus albens* at Wallangra Site B
- d. Nest hole at 7.7 m in dead Manna Gum  
*Eucalyptus viminalis* at Swan Vale



(Plate 5c)

pairs nested in White Box (*E. albens*)<sub>A</sub> and four in Blakely's Red Gum (*E. blakelyi*) (Table 14), but the majority of pairs nested in Smooth-barked Apples (*Angophora costata*) (Plate 5a, b). Nests were located above the ground between 4.5 and 15.9 metres ( $\bar{X} = 10.0$ ). Total height of the nest trees varied from 12 to 27.5 metres ( $\bar{X} = 20.0$ ). The mean height of nest holes at both sites was approximately 10 metres. There was no correlation between nest heights and tree heights at the field areas ( $r = 0.51$ ,  $df = 25$ ,  $P > 0.05$ ).

Nest trees were often clumped in distribution. At Swan Vale on Kings Creek three nest trees were 30, 90 and 120 metres apart, although others were scattered over the home range. At Wallangra most nest trees were clustered in the two forest areas examined at Site A and Site B. Within each of these two 'colonies' there were several nest tree clusters, each separated by a distance greater than that between nest trees within each cluster. Mean distance between nest trees in a cluster was 30 metres. Each cluster of nest trees was separated by a distance of 100 to 400 metres from its nearest cluster; other individual nest trees were further apart (200 to 500 metres) from the nearest nest tree or cluster.

Some trees contained two or more suitable nesting holes but observations proved that several were abandoned sites. I did not observe any nest tree occupied by more than one pair at any one time. However it was not uncommon to see up to 10 birds perched in nest trees during the breeding season.

The mean entrance of nest holes was 17 x 27 centimetres ( $N = 12$ ), but the mean internal diameter of the nest holes was 32 x 40 cm ( $N = 6$ ). Nest hole depth varied from 20 to 100 cm ( $\bar{X} = 60$  cm,  $N = 9$ ).

<sup>white</sup><sub>A</sub> Cockatoos maintain their nest by chewing the inner walls of the hollow, producing a "honeycomb" appearance. The resulting wood-chips, ranging from 4 to 40 mm in length, are then added to the floor lining, or discarded forming a pile at the base of the nest tree. The 2-10 cm deep lining of wood-chips inside a nest hole is turned by the birds prior to laying. On examining a nest immediately after flushing out an adult, the floor would

sometimes be uneven, with wood-chips piled up to one side.

At Swan Vale at least 8 nests were used in two consecutive breeding seasons (from 1977 to 1979) (Table 14). Two were used all three years. A nest that had been used each year for about 30 years (J.E. Courtney pers. comm.) including the 1977 season, was abandoned for another nest hole in the same tree in 1978. The young of this nest were dyed, and fledged successfully. However, the nest tree was abandoned in 1979 and a pair nested in a new hole in an Apple tree (*Angophora floribunda*) 50 metres away. Three other nests at Swan Vale were used for only one season; another four were used for at least one season.

At the two Wallangra sites at least twelve nests were used in both 1977 and 1978 breeding seasons (Table 14). At least three nests were used for all three years. Three nests were abandoned after one season. Two definitely new nests were found during the second season. The remaining eight nests were used for at least one season. Three holes were excavated by birds during 1978 but were not used that season. It appears that holes must be of suitable depth and width before Cockatoos utilise them as nests. In 1978 birds began to excavate a cone-shaped hole which was no more than 15 cm deep at its lowest point before the tree was felled by roadworkers.

Birds continued to inspect and clean nests almost throughout the year (Fig. 32). More frequent visits by birds to their nests occurred immediately prior to, and during laying at both field areas in August and September. This was followed by a gradual decline in nest visits as nestlings developed. After the young fledged in December/January, adults apparently spent time attending them and few if any nest visits were recorded during this period.

The breeding season extended from August to January at both field areas, but nests were at varying stages at any one time. The "breeding

FIGURE 32

## NEST ATTENDANCE BY WHITE COCKATOOS THROUGHOUT THE YEAR

Values graphed = proportions of times nests were checked  
that birds were present.

**L** = laying period

**H** = hatching period

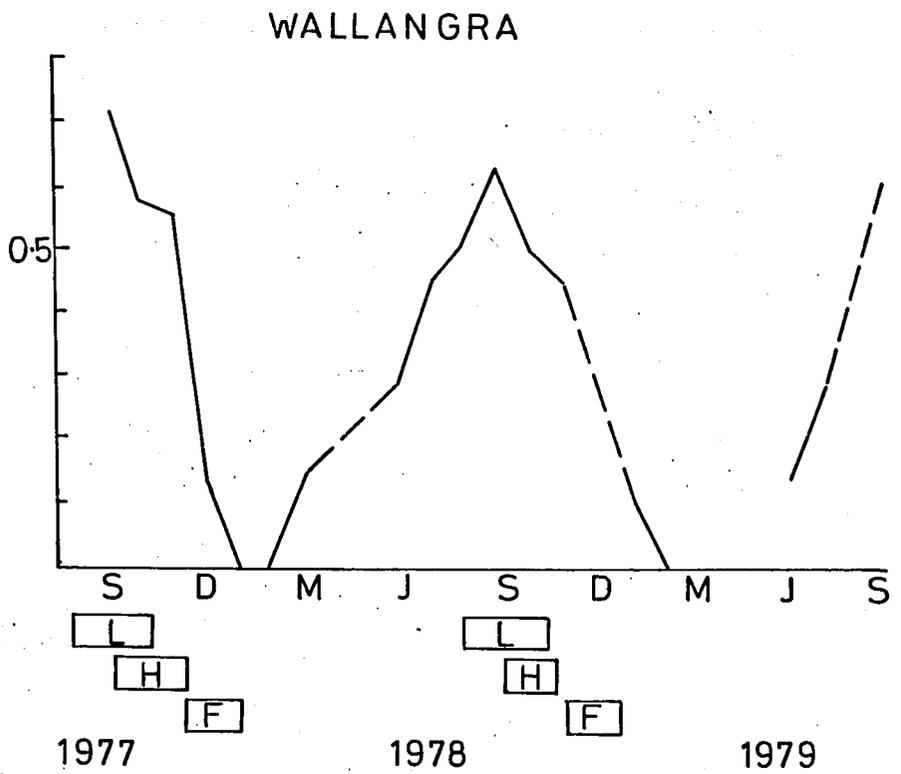
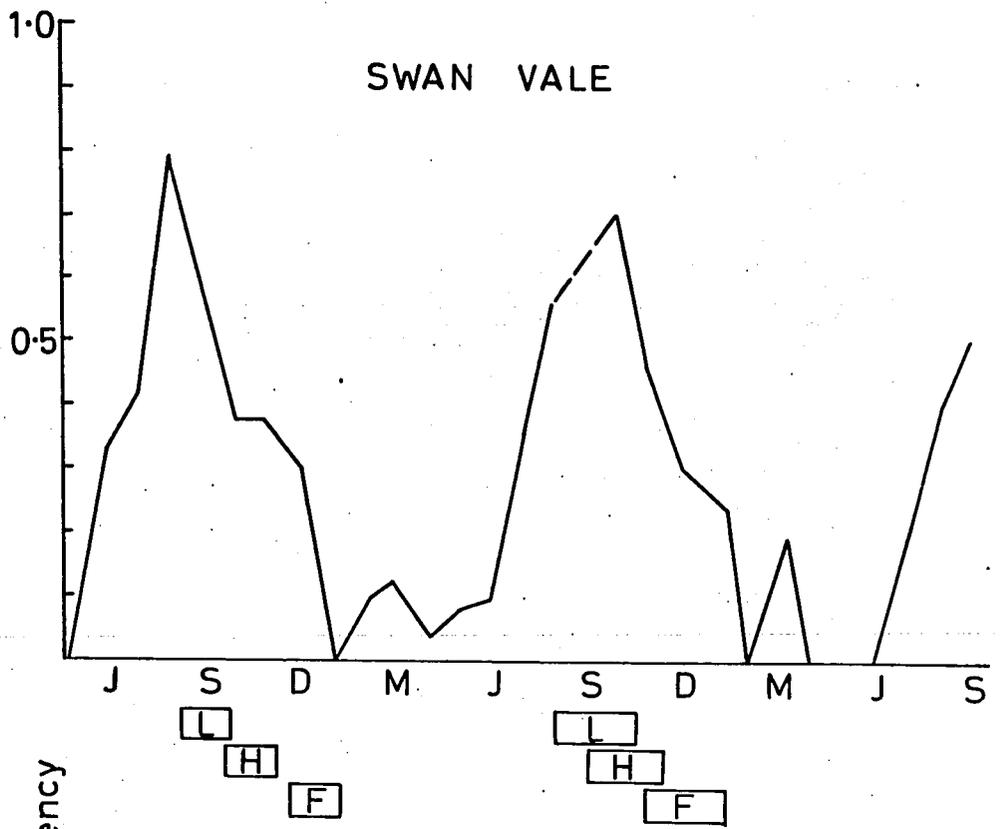
**F** = fledging period

Number of Nest Observations


---

|                 | J  | F  | M  | A  | M  | J  | J  | A  | S  | O  | N  | D  |   |
|-----------------|----|----|----|----|----|----|----|----|----|----|----|----|---|
| SWAN VALE 1977  |    |    | -  | 2  | 2  | 6  | 12 | 5  | 12 | 21 | 13 | 10 |   |
| 1978            | 4  | 4  | 17 | 22 | 23 | 10 | 11 | 7  | 11 | 35 | 26 | 10 |   |
| 1979            | 20 | 6  | 10 | 3  | 3  | 5  | 5  | 5  | 6  |    |    |    |   |
| WALLANGRA       |    |    |    |    |    |    |    |    |    |    |    |    |   |
| Site A + B 1977 |    |    |    |    |    |    |    |    |    | 14 | 14 | 11 | 7 |
| 1978            | 8  | 7  | 7  | -  | -  | 7  | 9  | 14 | 13 | 45 | 27 | -  |   |
| 1979            | 20 | 10 | -  | -  | -  | 7  | 7  | -  | 10 |    |    |    |   |

---



season" here is defined as the period from the beginning of laying to the fledging of the last young. Egg laying was recorded from early August to late October, at both Swan Vale and Wallangra. Young fledged from late November to mid January.

### 7.3 LAYING AND INCUBATION

Prior to laying Cockatoo pairs spent more time at their nests. Although it was impossible to sex these birds in the field, both members of a pair entered the nest, sometimes remaining inside together prior to laying. Adults remained inside the nest for periods of one to four hours during laying and incubation. More frequently one bird incubated while its mate perched outside the nest in the same or a nearby tree. According to Lendon (1973) and Forshaw (1978), 2 or rarely 3 white elliptical eggs are laid. At Swan Vale I observed 5 clutches of three eggs and 1 of two (Table 15), but at Wallangra there were only 3 clutches of three and 7 of two eggs. On the basis of these 16 clutches, sizes of 2 and 3 were equally frequent. The sample size is small owing to the inaccessibility of most nests. Nests examined were generally less than 10 metres from the ground.

The incubation period is reputedly 30 days (Forshaw 1978). I did not observe laying, but noted two incubation periods of at least 20 and 22 days, and another of less than 38 days. As members of a pair were frequently seen exchanging positions at the nest, it is likely that both sexes incubate.

### 7.4 THE NESTLING

The number of eggs that hatched are shown in Table 15. At both field areas only 24 (60%) of a total of 40 eggs hatched.

The development of nestlings was monitored at three nests at

TABLE 15  
BREEDING SUCCESS OF THE WHITE COCKATOO

| Field area<br>Year  | Nest# | Clutch<br>size | No. of eggs<br>hatched | No. of young<br>fledged |
|---------------------|-------|----------------|------------------------|-------------------------|
| SWAN VALE           |       |                |                        |                         |
| 1977                | 1a    | 3              | 3                      | [ 3]*                   |
| 1977                | 3     | 3              | 1                      | 1                       |
| 1977                | 13    | 3              | 0                      | 0                       |
| 1977                | 6     | ?              | ?                      | 1                       |
| 1978                | 1b    | 3              | 3                      | 3                       |
| 1978                | 3     | 3              | 2                      | [ 2]*                   |
| 1978                | 7     | 2              | 1                      | 1                       |
| 1978                | 4     | ?              | ?                      | 2                       |
| TOTAL               |       | 17             | 10                     | 5 (+3) <sup>‡</sup> [5] |
| Wallangra<br>Site A |       |                |                        |                         |
| 1977                | 4     | ?              | 2                      | 1                       |
| 1977                | 1     | 3              | 2                      | 2                       |
| 1978                | 1     | 2              | 2                      | [ 2]*                   |
| 1978                | 4     | 2              | 2                      | 2                       |
| 1978                | 7     | 2              | 1                      | 0                       |
| 1978                | 11    | ?              | 1                      | 1                       |
| 1978                | 8     | 1+?            | ?                      | 0                       |
| TOTAL               |       | 9              | 7(+3) <sup>‡</sup>     | 4 (+2) [+2]             |
| Wallangra<br>Site B |       |                |                        |                         |
| 1977                | 1     | 3              | 2                      | 2                       |
| 1977                | 6     | ?              | 0                      | 0                       |
| 1977                | 7     | ?              | 2                      | 2                       |
| 1978                | 1     | 2              | 1                      | 1                       |
| 1978                | 2     | 3              | 0                      | 0                       |
| 1978                | 4     | 2              | 2                      | 0                       |
| 1978                | 3     | 2              | 2                      | 2                       |
| 1978                | 5     | 2              | 0                      | 0                       |
| TOTAL               |       | 14             | 7(+2)                  | 5 (+2)                  |
| OVERALL TOTAL       |       | 40             | 24(+5)                 | 14(+7) [+7]             |

\* Human predation of chicks before fledging - square brackets

‡ Brackets when clutch size unknown

# Nest No. correspond to those in Table 14

Swan Vale and five at Wallangra. The chicks hatched one to two days apart and emerged with pale yellow down on the head, neck and back (Plate 6a). They remained blind for 7-9 days. "Pins" (pinfeathers) appeared from about 7 to 17 days of age (Plate 6b,c). At 10 to 15 days of age, 11 to 14 yellow crest "pins" appeared on the fore crown, and back and scapular "pins" began sprouting at about 17-23 days (Plate 7a,b). The crest "pins" sprouted at about 20-27 days (Plate 8a).

The yellow down was lost gradually as the "pins" sprouted. Secondary white down feathers developed on the back and rump and were still present on the young prior to fledging. One to six grey feathers were observed on the forehead and/or in the crest in 10% of nestlings. On two juveniles collected in March there was a grey wash on the wing feathers which varied from one primary and secondary to the full complement. Some wing coverts were partially grey.

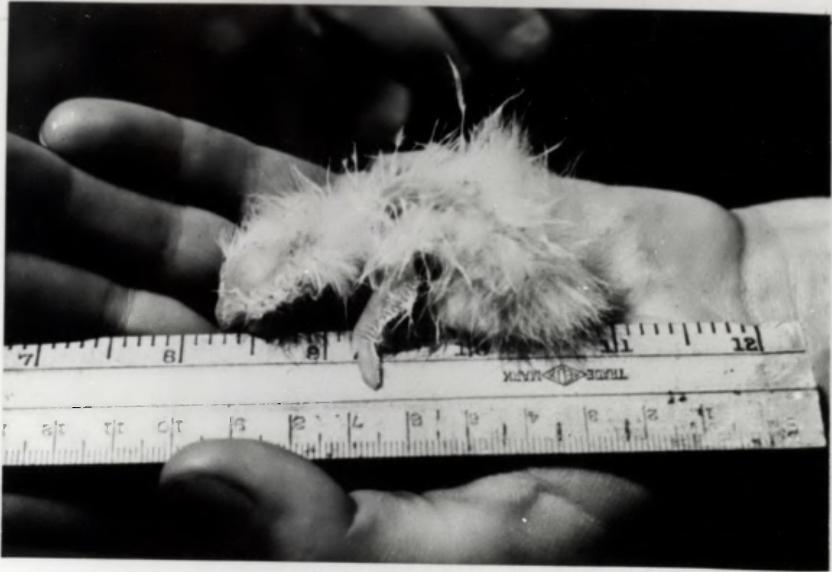
The rate of weight increase in the nestling was high during the first 30-40 days but declined before fledging occurred (Fig. 33). A linear regression of the log of nestling age against body weight was highly significant ( $r = 0.94$ ,  $df = 21$ ,  $P < 0.001$ ). In two nests examined prior to fledging the oldest nestling weighed less than its younger nest-mates. Individual nestlings were distinguished by size and individual characteristics such as grey feathers and bill colour patterns. Measurements of culmen length showed a similar growth trend to bill width (Fig. 33). There were significant regressions of untransformed nestling age against both culmen length ( $r = 0.98$ ,  $df = 22$ ,  $P < 0.001$ ) and culmen width ( $r = 0.93$ ,  $df = 23$ ,  $P < 0.001$ ); there were also significant regressions of log transformed nestling age against both culmen length ( $r = 0.91$ ,  $df = 22$ ,  $P < 0.001$ ) and culmen width ( $r = 0.95$ ,  $df = 23$ ,  $P < 0.001$ ) (Fig. 33). In all aspects the first born nestling increased in growth faster than the younger nestling(s).

## PLATE 6

## NESTLING WHITE COCKATOOS

- a. Newly hatched (< 1 day old) -  
yellow down still damp in places
  
- b. 7 - 12 days old -  
showing distended 'crop' full of seed;  
eyes more or less still closed
  
- c. 7 - 14 days old -  
two nest-mates of different ages;  
eyes partially open

a



b



c



PLATE 7

NESTLING WHITE COCKATOOS

a. 16 - 21 days old -

body pins not quite sprouting.

Note wood-chips on which nestling is standing  
at base of nest tree

b. 20 - 26 days old -

body pins sprouting, crest pins not  
yet sprouting

a



b



PLATE 8

NESTLING WHITE COCKATOOS

- a. 33 - 36 days old -  
body and crest well feathered
  
- b. 66 - 70 days old (9½-10 weeks) -  
adult-like bird prior to fledging,  
hand-held during dyeing of wing and tail

a



b



FIGURE 33

## GROWTH OF WHITE COCKATOO NESTLINGS

## a. Length of culmen

\*Linear regression of nestling age against culmen length -

$$y = 0.45x + 10.21 \quad (r = 0.98, df = 22, P < 0.001).$$

Linear regression of the log of nestling age against

$$\text{culmen length} - y = 16.59 \log x + 2.48 \quad (r = 0.91, df = 22,$$

$$P < 0.001).$$

## b. Width of culmen

Linear regression of nestling age against culmen width -

$$y = 0.23x + 9.21 \quad (r = 0.93, df = 23, P < 0.001).$$

\*Linear regression of the log of nestling age against

$$\text{culmen width} - y = 9.14 \log x + 4.33 \quad (r = 0.95, df = 23,$$

$$P < 0.001).$$

## c. Body weight

Linear regression of nestling age against body weight -

$$y = 13.54x + 90.89 \quad (r = 0.92, df = 21, P < 0.001).$$

\*Linear regression of the log of nestling age against body

$$\text{weight} - y = 588.09 \log x - 261.12 \quad (r = 0.94, df = 21,$$

$$P < 0.001).$$

\* most significant regression graphed

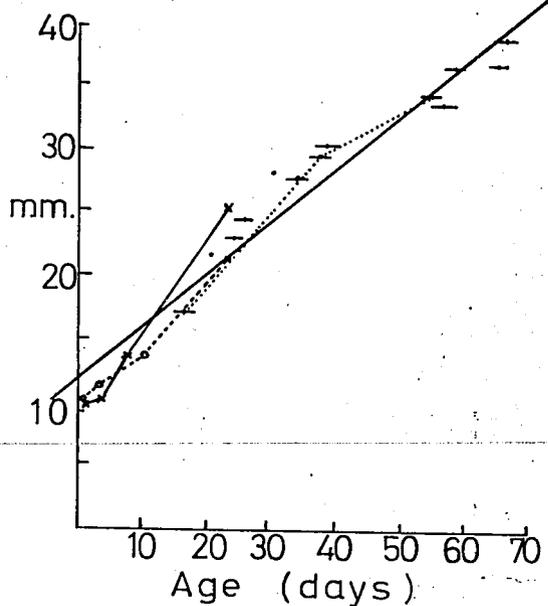
x o . exact age of nestling known

—•— mean and range of nestling age

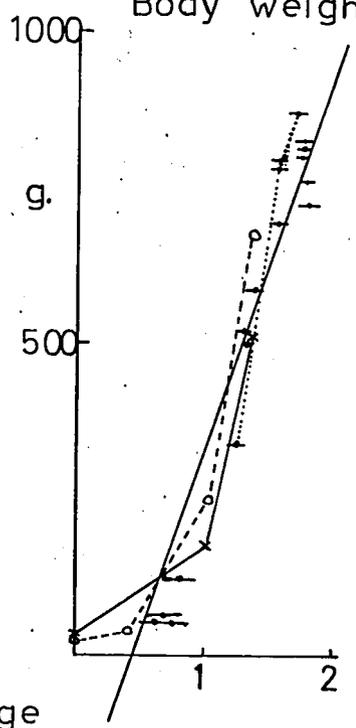
\*—x  
o---o 2 nest-mates

..... lone nestling

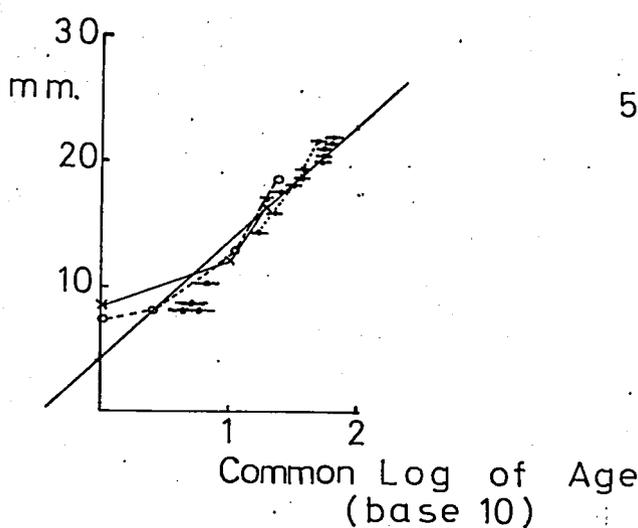
Culmen length



Body weight



Culmen width



Nestlings gave a "food-begging" call as well as a "food swallowing" noise. On inspection young nestlings usually swayed their bodies slowly from side to side, often with the back hunched and body huddled against their nest mate(s); older feathered nestlings however, moved to the edge of the nest floor and held their body and head erect against the nest wall. Nestlings up to about 14 days old gave "food-begging" calls on hearing a noise at the nest entrance. On inspection and handling older nestlings with fully opened eyes gave a threatening "hiss", similar to that given by adults in threat whilst bill-gaping. When over 35 days of age they gave a loud alarm distress "screech", similar to that produced by the adult. This call always attracted adults in proximity which circled above the nest calling loudly. This behaviour was similar to that occurring when a wounded adult gave distress "screech" calls.

Nestlings defaecated inside the nest. Defaecation was effected by a vigorous lateral shaking of the rear half of the body while standing upright with the cloacal area rubbing on the nest lining. Deep un-aerated nests developed a distinctive smell. However, as most nests were clean, the parents probably bury the faeces in the wood-chips, or discard wood-chips with faecal material on them. Some faecal smeared chips were observed beneath a few nest trees. In only 25% of cases infertile eggs and broken egg shells were left in the nest throughout the development of nestling(s).

The parents brooded the nestlings at night until they were about six weeks old; only one adult appears to brood at a time. During the day both parents attended the nest at varying intervals, and presumably both brooded and fed the young. During morning and late afternoon feeding periods, both adults often left the nest area especially when the nestlings were older. Both adults frequently perched together near the nest during the midday rest period. This was also evidenced

by the decrease in numbers of birds at "normal" day rest areas. Less time was spent at the nest as the nestlings grew older. About one to two weeks prior to fledging (J.E. Courtney pers. comm.), parents fed nestlings at the nest entrance, without entering. I examined nestling 'crops' and made 4-6 hour observations of five nests. Nestlings from 1 day to about 5 weeks old were apparently fed twice a day; once each in the morning and late afternoon. Over 5 weeks of age they appeared to be fed in the late afternoon only.

#### 7.5 THE FLEDGLING

Forshaw (1969) claimed that the young Cockatoo fledged after 6 to 9 weeks in the nest. Later (Forshaw 1978) the nestling period is given as about 10 weeks. I examined 3 nests from at or near the time of hatching; this revealed that young fledged at 9½ to 10½ weeks of age. Young fledglings have a bare cere and loreal region and a paler grey bill (Plate 8b), but are difficult to distinguish in the field. The tail and wing feathers are shorter at this stage. Some fledglings and juveniles possessed grey or partly grey feathers in the crest, forehead or wings. These are generally lost after the first moult although year old birds may retain an occasional grey feather. Adults older than 2 years show no traces of grey (J.E. Courtney pers. comm.). Juveniles had pale blue smooth eye skin, but in one to two year old birds this eye skin becomes white and increasingly wrinkled with age (J.E. Courtney pers. comm.). These differences between adults and juveniles are very slight and indistinguishable in the field.

Examination of one nest resulted in the oldest bird leaving the nest prematurely although its nest mate fledged the following day. Recently fledged birds remained close to the nest tree, perching quietly until the parents arrived to feed them. These fledglings still gave "food-begging" and "food swallowing" calls, as well as adult-like

flight and alarm calls. After about one week the young joined the adults away from the nest area. I saw young being fed by adults until late March.

Three nestlings were colour-marked at each field area, but only one was seen again two days post-fledging. Young Cockatoos are inexperienced and less wary than their parents, and consequently many are shot by farmers in the first few months of their lives.

#### 7.6 PROPORTION OF ADULTS BREEDING

In the breeding season from August to early January, three (2♂, 1♀) Cockatoos shot at Swan Vale and 17 (5♂, 12♀) shot at Wallangra Site A were adults. Of these 67% at Swan Vale and 82% at Wallangra were in breeding condition; males having testes > 4 mm long, and females having some oocytes > 4 mm in diameter and convoluted oviducts.

At Swan Vale at least 10-12 pairs had nests in 1977, 12-14 in 1978 and at least 8 in 1979. The total population was estimated at 50-60 birds. Thus, at least 33-56% of the Swan Vale population present during the breeding season attended nests each year. In January 1978 an additional 20 birds were present, leaving by early February. Assuming that these were juveniles fledged locally and that the <sup>mean</sup> fledging rate was 1 young/nest, 20 nests would have been active in the 1977 season. Thus 67% of the population could have nested. This indicates that not all birds breed.

At Wallangra Site A there were at least 10 nests in 1977, 15 in 1978 and 14 in 1979; Site B had at least 8 nests in 1977, 11 in 1978 and 10 in 1979. These two nesting colonies covered an area of less than 5% that occupied by the <sup>populations</sup>  $\wedge$  More nests were present in other forest stands, woodland and savannah areas nearby.

During the breeding months some Cockatoos were observed day resting away from nesting areas and presumably not attending nests. An estimated 50-70% of the population breed at each Wallangra site.

At both field areas there were more nest holes available than were used each breeding season. At Swan Vale three old nests were unused and at least 12 were not used at the Wallangra Sites. Apart from these many other apparently suitable hollows too high to examine, were available but unoccupied at both field areas.

#### 7.7. BREEDING SUCCESS

At Wallangra Site A one clutch of eggs and one <sup>brood</sup> of nestlings were destroyed, and at Site B three clutches of eggs were destroyed and one case of abandonment of 2 three week old nestlings recorded (Table 15). At Wallangra fresh Lace Monitor (*Varanus varius*) clawmarks were seen on the trunks and hollows of all five nest trees where four clutches of eggs and the pair of nestlings had disappeared. A Lace Monitor was disturbed climbing towards a Galah nest at Site A (Plate 9a). At Site A a Brush-tailed Possum (*Trichosurus vulpecula*) took up residence in one nest hole in October 1978, smashing the Cockatoo eggs. On its departure the Cockatoo pair returned to clean the nest in late November, but did not lay again that season. At Site B a colony of bees took over one nest.

At Swan Vale one clutch of three eggs was abandoned but no cases of predation of eggs or young by natural causes was noted (Table 15). Goannas are now extinct at Swan Vale (J.E. Courtney and M.G.M. Woods pers. comm.). A Barn Owl (*Tyto alba*) nested during the 1978 winter in one Cockatoo nest which was active in 1977; a Kookaburra (*Dacelo gigas*) used the nest in the following 1978 breeding season.

Human predation at Cockatoo (and Galah) nests however, was rife

## PLATE 9

NATURAL AND HUMAN INTERFERENCES  
WITH BREEDING OF COCKATOOS

- a. Lace monitor (*Varamus varius*) climbing to  
a Galah nest in an *Angophora costata* at  
Wallangra
  
- b. Destruction of tall trees (*Angophora costata*)  
by roadworkers at Wallangra

a



b



at the two field areas and indeed in many areas throughout the State (J.E. Courtney pers. comm.; pers. obs.). At Swan Vale humans took the nestlings from two nests and in one case destroyed the nest (Table 15). At Wallangra at least three nests were robbed, including one containing two nestlings I had dyed. White Cockatoos are very rarely (if ever) bred in captivity (Lendon 1973). The only case of aviary breeding recorded was that of a hybrid between a White Cockatoo and Galah (Cosgrave 1912). Thus many wild nestlings are stolen each year and sold or kept as pets (Frauca 1970, pers. obs.). The Cockatoo and Galah are unprotected in New South Wales. It is legal to shoot these birds if they are a "nuisance", and legal to take nestlings and raise them yourself. However, it is illegal to sell nestlings or adult birds without a National Parks and Wildlife Service trappers license.

It is possible that natural and human predation of Cockatoo nests was high in nests I examined, as they were below 10.3 metres above the ground and more accessible than average. There were many Cockatoo nests above this height. However, goanna claw marks were also seen on tall nest trees at Wallangra, and old spikes used by humans were present in two very high nests at Swan Vale and one at Wallangra.

Clearing of the much reduced Smooth-barked Apple (*Angophora costata*) forests also results in the disturbance and destruction of Cockatoo nests. During 1979 Ashford Shire Council workers felled many trees on the road side and within the forest for road improvement and soil removal. At least one active Cockatoo nest tree, one nest under excavation and at least two old or possibly active nests were destroyed in the process (Plate 9b).

At Swan Vale 62.5% of nests examined (or 87.5% excluding human predation) fledged juveniles over the two breeding seasons 1977 and 1978 (Table 15). At Wallangra Site A 57.1% of nests (or 71.4%

excluding human predation) successfully fledged young, and at Site B 50% of nests examined fledged young. At Swan Vale 1.0 young fledged per nest (1.63 young/nest excluding human predation). At Site A 0.86 young fledged per nest (or 1.14 young/nest ignoring human predation) and at Site B 0.88 young fledged per nest. Overall on combining field areas the fledging rate for Cockatoos was 0.91 young /nest (or 1.22 /nest ignoring human predation).