# CHAPTER 1

# INTRODUCTION

## 1.1 BIRDS AS PESTS TO AGRICULTURE

Man developed agriculture to produce a highly concentrated source of food from a small area of land. This meant altering the natural ecosystem and replacing it with a more simple though less stable one (Odum 1971). Most species of animals, including birds, suffered as a result of these drastic ecological changes. However, some species, especially those which eat seeds, experienced a local abundance of food and apparently increased in abundance and distribution. Many species of birds have responded in this way and become agricultural pests. They include sparrows and weavers (Ploceidae), finches (Fringillidae), pigeons (Columbidae), grackles (Icteridae), crows (Corvidae), parrots (Psittacidae) and waterfowl (Anatidae) (Murton and Wright 1968). Only bird pests to annual seed, grain and fodder crops are included in this thesis.

Beeton (1977a) and Easdown (1978a) reviewed the literature on agricultural bird pests throughout the world. Most published studies have been primarily concerned with assessing the damage and devising methods to control it (Table 1). Few control methods are based on detailed studies of the behaviour and ecology of the bird species involved. Notable exceptions include studies of Quelea (*Quelea quelea*) (Crook and Ward 1968; Ward 1964, 1965, 1972), Wood Pigeon (*Columba palumbus*) (Murton *et al.* 1963, 1966, 1974), Rook (*Corvus frugilegus*)(Feare 1974; Feare *et al.* 1974), Magpie Goose (*Anseranas semipalmata*)(Frith and Davies 1961), Tasmanian Native Hen (*Tribonyx mortierii*)(Ridpath and Meldrum 1968a,b) and Little Corella (*Cacatua sanguinea*) (Beeton 1977a).

TABLE 1

MAJOR REFERENCES ON BIRD THAT ARE PESTS OF CROPS

| CROP | COUNTRY | SPECIFIC PEST | DAMAGE | CONTROL | ECOLOGY | GENERAL | REFERENCE |
|---|---|---|---|---|---|---|---|
| Sorghum | Africa | Quelea | * | | | | Adesiyun 1973 |
| Sorghum | Africa | Quelea | * | * | | | Crook & Ward 1968 |
| Sorghum | Africa | Quelea | * | * | | * | Curtis 1965, Dogget 1957 |
| Sorghum | Africa | Quelea | * | * | * | | Ward 1964,1965,1972 |
| Sorghum | Australia | Little Corella | * | * | * | | Beeton 1977a |
| Sorghum | Australia | Magpie Goose | * | * | * | | Beeton 1977a |
| Sorghum | Australia | Cockatiel | * | * | | | Lavery 1965 |
| Sorghum | Australia | Lorikeets | * | * | | | Lavery 1965 |
| Sorghum | Australia | Lorikeets | * | | | | Lavery & Blackman 1970 |
| Sorghum | U.S.A. | House sparrow | * | * | | | Tipton *et al.* 1970 |
| Sorghum | U.S.A. | - | * | * | | | McMillian *et al.* 1972 |
| Sorghum | U.S.A. | - | * | * | | | Voigt 1966 |
| Maize/ corn | Africa | Quelea | * | * | | | Funmilayo 1976 |

TABLE 1 (Cont'd)

| CROP | COUNTRY | SPECIFIC PEST | DAMAGE | CONTROL | ECOLOGY | GENERAL | REFERENCE |
|---|---|---|---|---|---|---|---|
| Maize/corn | India | Parrots | * | | | | Ramzan & Toor 1973 |
| Maize/corn | Canada | Blackbird | * | * | | | Dolbeer *et al.* 1976 |
| Maize/corn | Canada/USA | Blackbird | * | * | | | De Grazio *et al.* 1969 |
| Maize/corn | Canada/USA | Blackbird | * | | * | | Dyer 1967, 1975 |
| Maize/corn | U.S.A. | - | * | | | | Granett *et al.* 1975 |
| Maize/corn | U.S.A. | - | * | | | | Stone *et al.* 1972 |
| Maize/corn | U.S.A. | Blackbird | * | | | * | Weins & Dyer 1975 |
| Rice | Africa | Quelea | * | | * | | Crook & Ward 1968 |
| Rice | Australia | Waterfowl | * | * | | | Briggs 1977 |
| Rice | Australia | Waterfowl | * | * | * | | Frith 1957 |
| Rice | Australia | Waterfowl | * | * | * | | Frith & Davies 1961 |
| Rice | U.S.A. | - | * | | | * | Green 1971 |
| Rice | U.S.A. | Blackbird | * | * | | | Neff & Meanley 1957 |
| Rice | U.S.A. | - | * | * | | | Sugden 1975 |
| Wheat/barley/oats | Africa | Quelea | * | | * | | Crook & Ward 1968 |
| Wheat/barley/oats | Africa | Quelea | * | * | * | | Ward 1964,1965,1972 |
| Wheat/barley/oats | Australia | Tasmanian Native hen | * | * | * | | Ridpath & Meldrum 1968a,b |

TABLE 1 (Cont'd)

| CROP | COUNTRY | SPECIFIC PEST | DAMAGE | CONTROL | ECOLOGY | GENERAL | REFERENCES |
|---|---|---|---|---|---|---|---|
| Wheat/barley/ oats | Australia | Tasmanian Native hen | | * | | | Graham 1954 |
| Wheat/barley/ oats | New Zealand | House sparrow | * | | | | Dawson 1970 |
| Wheat/barley/ oats | U.K. | Wildfowl | * | | | | Kear 1965 |
| Wheat/barley/ oats | U.K. | Wood-pigeon | * | * | | | Jones 1974 |
| Wheat/barley/ oats | U.K. | - | * | * | | * | Murton 1968,1974 |
| Wheat/barley/ oats | U.K. | Wood-pigeon | * | * | * | | Murton *et al.* 1963,1968,1974 |
| Wheat/barley/ oats | Scotland | - | * | | | * | Dunnet & Patterson 1968 |
| Wheat/barley/ oats | Scotland | Rook,Starling | * | * | | | Feare 1974 |
| Wheat/barley/ oats | Scotland | Rook | * | | * | | Feare *et al.* 1974 |
| Wheat/barley oats | USA/Canada | Sparrow | * | | | | Camprag *et al.* 1974 |
| Wheat/barley/ oats | USA/Canada | Sparrow | * | * | | | Gilot 1975 |
| Wheat/barley/ oats | USA/Canada | - | * | * | | | Sugden 1975 |

TABLE 1 (Cont'd)

| CROP | COUNTRY | SPECIFIC PEST | DAMAGE | CONTROL | ECOLOGY | GENERAL | REFERENCES |
|---|---|---|---|---|---|---|---|
| Wheat/barley/ oats | USA/Canada | Blackbird | * | | | * | Robertson *et al.*1968 Weins & Dyer, 1975 |
| Sunflower | Australia | Parrots | * | * | | | Beeton, 1977b |
| Sunflower | Australia | Parrots | * | | | | Kochman, 1977 |
| Sunflower | Switzerland | - | * | | | | Vogel 1967 |
| Sunflower | U.S.A. | - | * | | | | Dolbeer, 1975 |
| Sunflower | Yugoslavia | - | * | * | | | Camprag *et al.* 1974 |

Asterisks indicate aspects studied.

Such behavioural and ecological knowledge, particularly of factors relevant to the pest status of a species, may eventually enable the implementation of effective and cheap controls to reduce damage without adversely affecting the species concerned or any other wildlife.

## 1.2 AUSTRALIAN RESEARCH

Many species of parrots, waterfowl, finches and pigeons feed on grain crops in Australia, but only recently has the need for detailed studies of those birds been realized. Frith and Davies (1961) examined the behaviour and ecology of the Magpie Goose in relation to the developing rice industry in the Northern Territory. Geese numbers and movements were found to be limited by the availability of food, water and breeding habitat. They concluded that habitat manipulation through the alteration of water levels could eradicate the species from the area.

Ridpath and Meldrum (1968a, b) investigated the behaviour and ecology of the Tasmanian Native Hen which was causing damage to fodder oat crops. They suggested that Native Hens could be controlled by manipulating or destroying local breeding and shelter sites. This was so successful that State Government intervention was necessary to ensure the survival of the species (Anon 1976). In the Ord River development area of Western Australia, the Little Corella caused severe damage to sorghum crops. Beeton's (1977a) study of this species proved that damage was most severe when there was a shortage of natural food. He suggested that growing crops at specific times of the year and encouraging birds to feed on stubble grain were the most effective ways of reducing damage.

On farms in north-east New South Wales crops of sunflower, sorghum, maize, wheat, barley, oats and to a lesser extent millet, safflower, linseed, tobacco and panicum are all damaged by birds (Bennett 1978). Cockatoos and parrots are the main pests. For many decades winter crops such as wheat, barley and oats have suffered damage by parrots. Over the

last decade summer crops, chiefly sorghum and sunflower, have been grown on increasing acreages. These crops receive the most extensive damage in economic terms, from birds.

The economic impact of parrots is greatest on sunflower crops in north-east New South Wales. Losses to individual farmers are frequently severe and many have ceased growing this crop (de la Motte 1977). Sunflower is a valuable oilseed and is increasing in demand. The sunflower industry in Australia is a recent phenomenon and is still developing. Returns to the primary producer in 1978 for sunflower were $210 per tonne ($210/ha) as compared with sorghum and wheat at $75 per tonne ($187.50/ha and $183/ha respectively) (Frame 1978a, b).

Several aspects of this problem of parrot pests have already been studied in the area by students at the University of New England. De la Motte (1977) investigated means of assessing and mitigating damage by parrots to sunflower crops. He concluded that the plotless sampling method was better than quadrat sampling for measuring damage in sunflower crops. Both the percent area of a crop that was damaged and the monetary losses caused by bird damage could be calculated with "reasonable accuracy". De la Motte (1977) suggested poisoning and especially decoy cropping as means of controlling bird damage to sunflower crops.

Easdown (1978b) studied the agronomics of sunflower growing on the North-west Slopes and Plains of New South Wales. He discussed changing the time of planting and reducing the period of crop susceptibility to bird damage as two means of reducing damage to sunflower crops. Both suggestions are feasible, but technologies and management skills to implement them are poor in some areas. The Australian sunflower industry faces many agronomic and technological problems (Easdown 1978b).

The overall distribution, abundance and pest status of the three major pest species, the White Cockatoo (*Cacatua galerita*), Galah (*Cacatua roseicapilla*) and Cockatiel (*Nymphicus hollandicus*), in north-east

New South Wales was studied by Bennett (1978). The Galah was the most common pest, occurring along with the Cockatiel over a wide area in many habitats. The White Cockatoo was the most destructive pest. Being localized in distribution it was most in danger if methods were taken to eliminate birds from areas where they were pests, especially on sunflower crops. Aerial surveys indicated that numbers of the three pest species were fewer than expected (Bennett 1978). Birds probably congregated on crops in local areas and thus impressed farmers with their numbers and potential for damage.

Broome (1979) planted decoy sunflower crops as a means of curbing damage to main sunflower crops in three areas of north-east New South Wales. Some decoys were successful, attracting birds away from the main crops, whilst others were unsuccessful. However, the planned use of decoy crops is discussed by Broome (1979), and considered a feasible means of controlling bird damage to sunflower crops.

The collective aim of the ongoing University of New England studies is to devise an economical and effective means of reducing the damage to sunflower crops by cockatoos, with a minimum effect on the viability of the birds' populations. The present study was carried out parallel with but, for logistic reasons, not in direct collaboration with the above projects. The principal aim of the present study was to document those aspects of the behaviour and ecology of the White or Sulphur-crested Cockatoo and the Galah or Rose-breasted Cockatoo that are of relevance to their status as agricultural pests in north-east New South Wales. Emphasis was placed on fluctuations in numbers, on flock size and activity and on feeding behaviour and food eaten. I also studied diurnal and seasonal variations in the social behaviour of these two species. Some breeding data was collected on the White Cockatoo.

This thesis is presented in three sections. Section A deals with aspects of the individual and social behaviour and feeding ecology of the

White Cockatoo. Section B superficially investigates aspects of the social and feeding behaviour of the Galah. Data were collected from two field areas in north-east New South Wales. Section C presents a comparison of the behaviour and ecology of the White Cockatoo and Galah, assesses their status as pests in north-east New South Wales and discusses them in relation to other parrots and bird pests. Finally suggestions are made for controlling damage to crops caused by Cockatoos and Galahs in north-east New South Wales.

## 1.3 THE BIRDS

Very little is published about the behaviour and ecology of the White Cockatoo with which this study is mostly concerned. The Galah has been studied by Pidgeon (1970) in north-east New South Wales and by Rowley (1974, 1976) in Western Australia, although to date there is little published information on its ecology. Observations of the Galah in this study are concerned with the factors relevant to their pest status, such as population fluctuations and feeding ecology.

The White Cockatoo occurs throughout northern and eastern Australia (Fig. 1a), Tasmania, New Guinea and the Aru Islands of Indonesia (Forshaw 1969). In the Australian inland they inhabit woodland and grassland. On the coast and tablelands in Australia their preferred habitat appears to be rainforest and wet sclerophyll (pers. obs.). Six races have been described for the species (Forshaw 1968, 1969); the present study concerns the nominate one.

The Galah occurs throughout Australia (Fig. 1b). Generally it does not inhabit forests. In New South Wales its preferred habitat is sparsely timbered country with a well-developed herb layer such as grassland, savannah and savannah-woodland (after Beadle and Costin 1952),(Pidgeon 1970). Over the last half century the clearing of forests and woodland, provision of water for stock and introduction of grain crops has extended the original range of this species (Pidgeon 1970). They have increased in numbers in wheat-growing rather than grazing areas. This suggests that grain crops provide a better food source than native and introduced grasses

FIGURE 1

DISTRIBUTION OF THE

WHITE COCKATOO AND GALAH IN AUSTRALIA

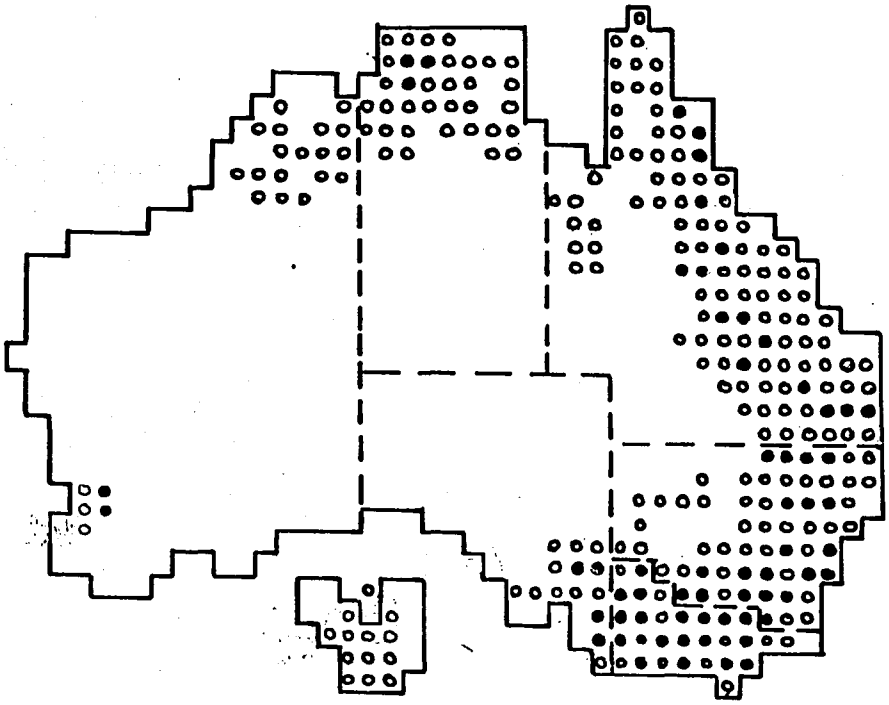
Data from the R.A.O.U. Field Atlas 1977 - 1979.

o - present in the 1° grid square

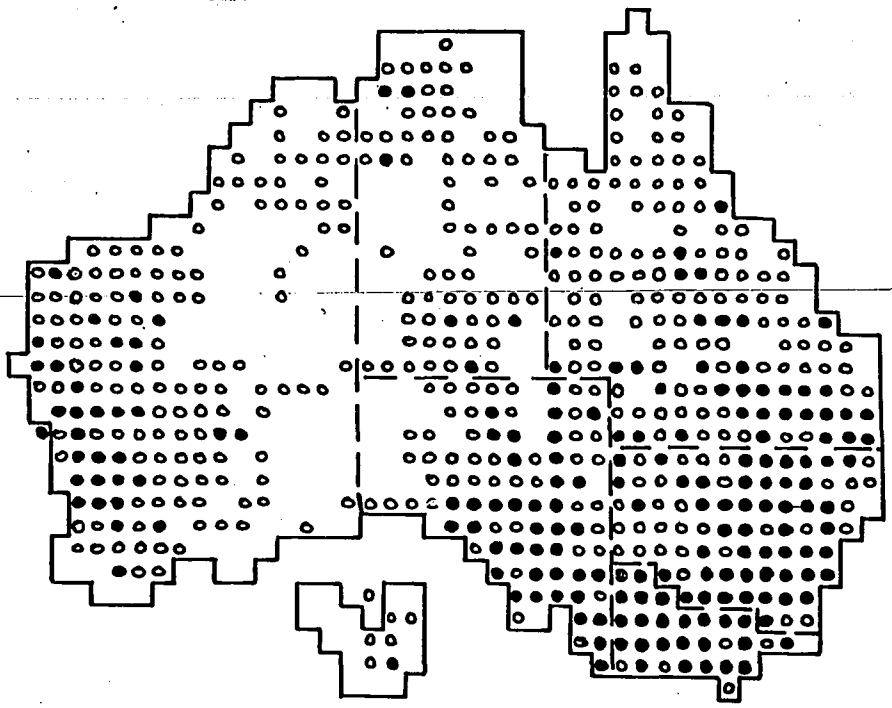
● - breeding in the 1° grid square

In the distribution of the White Cockatoo (Forshaw 1969) south-west Western Australia is not included. The White Cockatoos for that area in the Atlas Scheme were possibly introduced by man.

a WHITE COCKATOO



b GALAH



(Pidgeon 1970). Increased planting of summer crops has precipitated local concentrations of Galahs and White Cockatoos and aggravated the current pest problem in north-east New South Wales.

# CHAPTER 2

# METHODS

## 2.1 FIELD AREAS

In early March 1977 a large sector of north-east New South Wales was examined for possible field study areas. Two areas were chosen where the White Cockatoo and Galah appeared to be significant pests on crops of sunflower, sorghum, wheat and barley.

Swan Vale (Fig.2) (29°45'S, 151°29'E) lies halfway between Glen Innes and Inverell and is surrounded by hilly terrain. The region is on the western edge of the more intensive agriculture of the North-west Slopes and Plains and supports mixed farms where summer crops of sunflower and sorghum are grown. The rocky hill tops and hillsides are agriculturally unproductive and support medium to low stands of open forest, dominated by Red Stringybark (*Eucalyptus macroryncha*), Hill Red Gum (*E. dealbata*) and Narrow-leaved Ironbark (*E. crebra*). Most flat land is cleared of the tall woodland of White Box (*E. albens*). The major watercourses are lined with River Oak (*Casuarina cunninghamii*).

At Swan Vale observations were made within a field area consisting of two adjacent valleys, the Swan Brook valley to the north and the Kings Creek valley to the south. The two valleys are separated by low, partially cleared hills. High forested hills serve as a boundary to the north and south of the field area.

Wallangra (Fig.2) (29°15'S, 150°55'E) is 65 kilometres north-west of Inverell in flat to undulating country of the north-west Slopes. The land is more extensively cleared than at Swan Vale and the small patches of forest are scattered remnants of the previously widespread forests in which White Cockatoos presumably bred and roosted. Forests

FIGURE 2

LOCATION OF THE TWO FIELD AREAS,

SWAN VALE AND WALLANGRA,

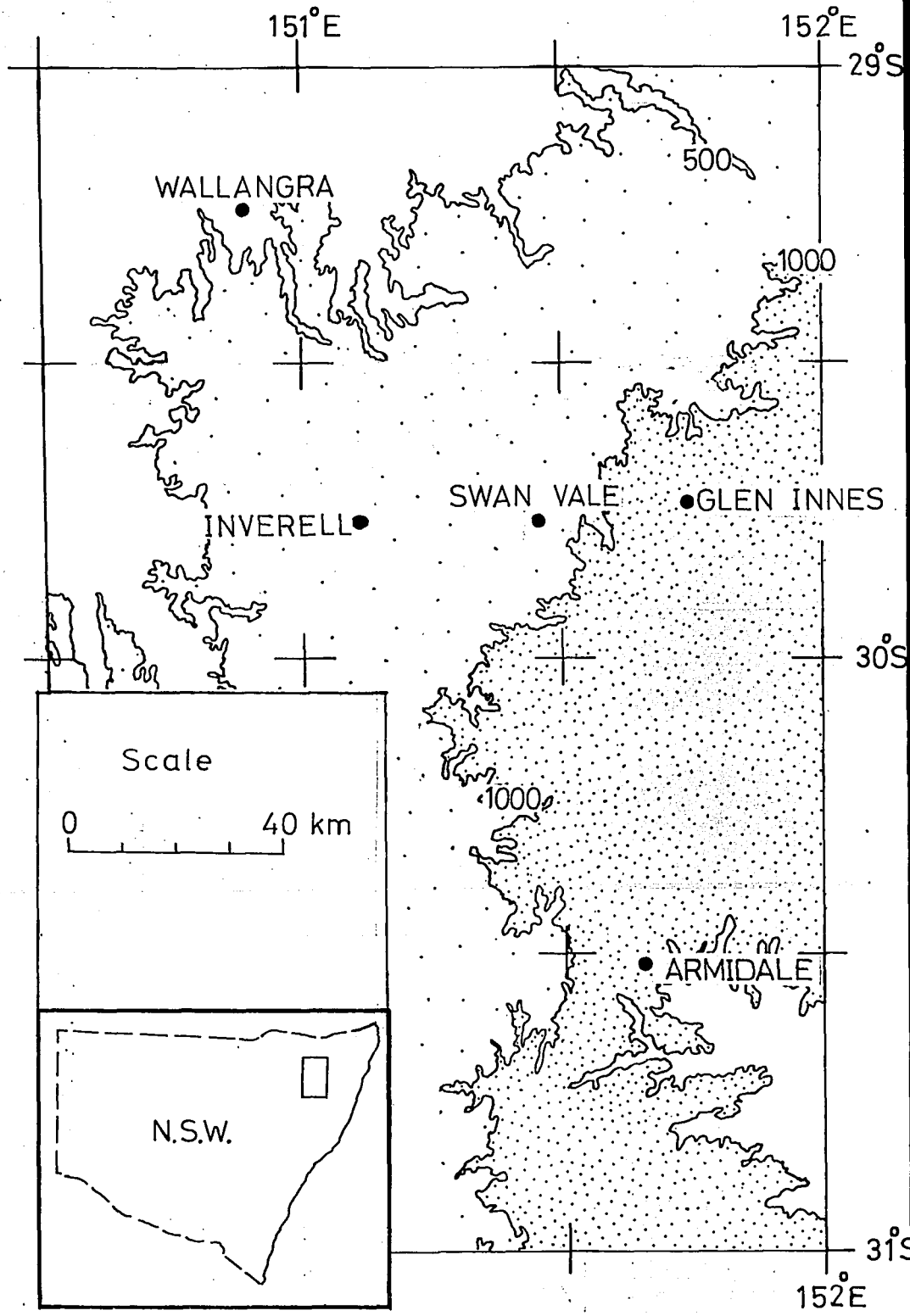
IN NORTH-EAST NEW SOUTH WALES.

1000 - 1500 metres, Northern Tablelands

500 - 1000 metres, North-west Slopes

200 - 500 metres, North-west Slopes

Inset - map of New South Wales showing general location of field areas.


151°E
152°E
29°S
500
WALLANGRA
1000
SWAN VALE
GLEN INNES
INVERELL
30°S
Scale
0
40 km
1000
ARMIDALE
N.S.W.
31°S
152°E

of Smooth-barked Apple (*Angophora costata*) and Black Cypress Pine (*Callitris endlicheri*) grow on the hills, and woodlands of Silver-leaved Ironbark (*E. melanophloia*) and White Box (*E. albens*) occur on the slopes. Many farmers abandoned sunflower growing in this region because of bird pests (J. Black and B. Johnson, pers. comm.). Sorghum is grown over large acreages.

At the Wallangra field area two sites 8 kilometres apart were used for this study. Site A near Wallangra Post Office and Station was used for major observations of flock sizes, feeding, activities of resting and breeding, and for shooting birds. At Site B (Sawpit Gully) 8 km south of Wallangra Post Office breeding data were collected and minor observations of feeding, resting and roosting made.

The vegetation of the two field areas of Swan Vale and Wallangra is discussed in detail in Chapter 3. Table 2 compares the general characteristics of the two areas.

Swan Vale had a higher rainfall than Wallangra (Fig. 3). The monthly rainfall trends were similar at both field areas with heavy summer falls and drier winters. At both areas the annual rainfall was about average in 1977, above average in 1978 and below average in 1979. Wallangra (Fig.4) was generally warmer than Swan Vale, having a milder winter.

## 2.2 FIELD OBSERVATION

The data collected were written in code and included bird numbers and activities, calls, behaviour and landmarks. A pair of 10 x 40 binoculars and sometimes a Unitron 80 mm telescope with magnifications x 20, x 30, x 40 and x 60 were used to observe the birds. Calls were recorded using a Uher 4000 Report-L tape recorder via a Uher dynamic microphone.

TABLE 2

GENERAL DESCRIPTION OF THE TWO FIELD AREAS

| | SWAN VALE | WALLANGRA |
|---|---|---|
| Altitude | 780-940 metres | 440-500 metres |
| Annual rainfall for: | | |
| 1977 | 834.5 mm | 722 mm |
| 1978 | 1255.6 mm | 1067 mm |
| 1979 | 532.6 mm | 560 mm |
| Mean annual rainfall: | | |
| 1974 - 1979 | 833 mm | 812 mm |
| Topography | hilly - undulating | undulating - flat |
| Wooded habitats |  |  |
| Farming | small mixed | large mixed - cropping |
| % area cultivated | 20 - 40 | 40 - 70 |
| Crops (in order of decreasing cropping area) | Wheat<br>Barley<br>Sorghum<br>Sunflower<br>Oats | Sorghum<br>Wheat<br>Barley<br>Oats<br>Sunflower (Site B 1 season) |

FIGURE 3

MONTHLY RAINFALL AT:

SWAN VALE - recorded by M.G.M. Woods

WALLANGRA - recorded by J.R. Black

INVERELL - 90 year average (Anon, 1966a)

1 - maximum recorded rainfall

2 - 90% probability of occurrence

3 - 70% probability of occurrence

4 - 50% probability of occurrence

5 - 30% probability of occurrence

6 - 10% probability of occurrence

7 - minimum recorded rainfall

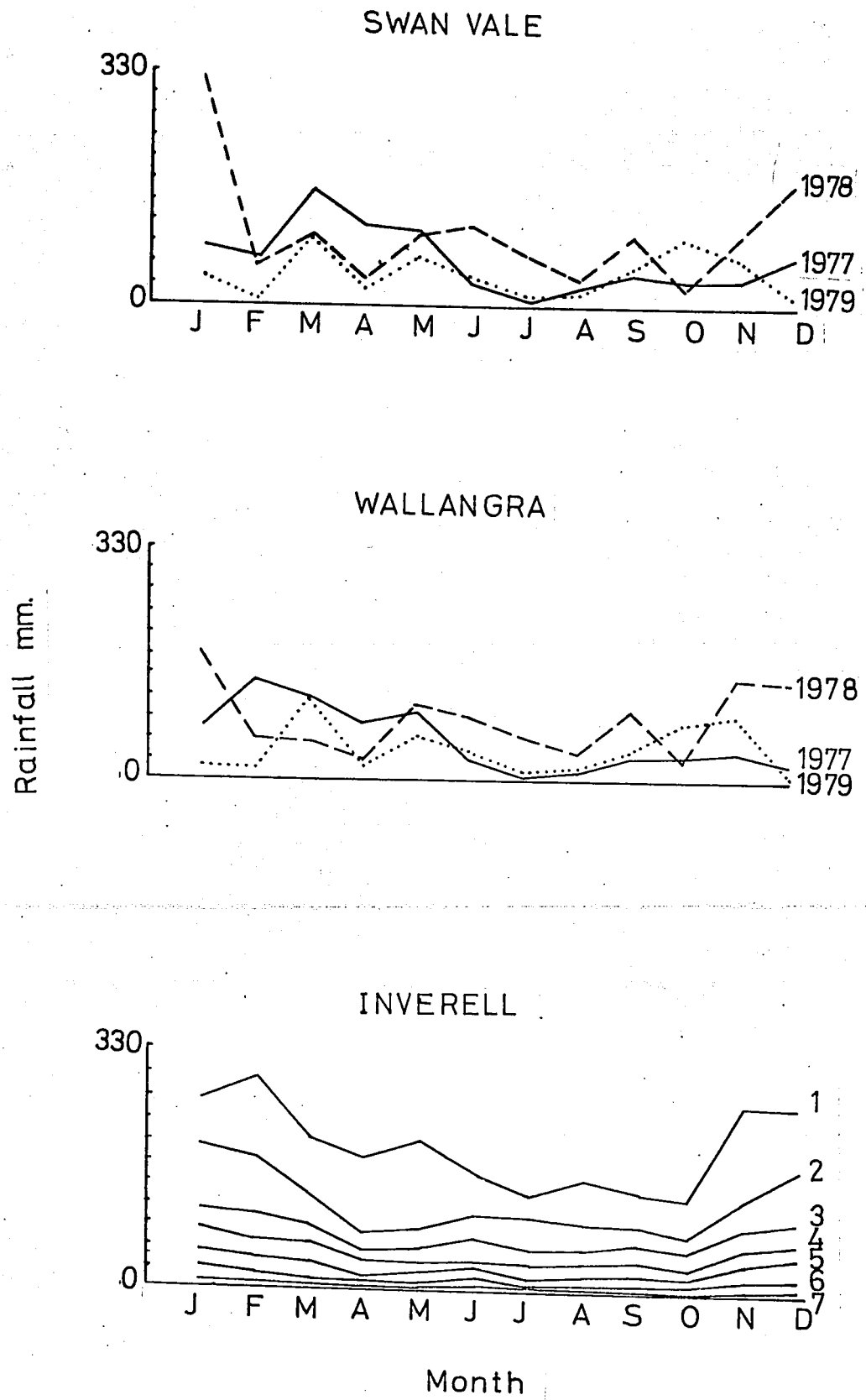

SWAN VALE
330
0
1978
1977
1979
J F M A M J J A S O N D
WALLANGRA
330
0
Rainfall mm.
1978
1977
1979
INVERELL
330
0
1
2
3
4
5
6
7
J F M A M J J A S O N D
Month

FIGURE 4

MINIMUM AND MAXIMUM MONTHLY TEMPERATURES AT

SWAN VALE AND WALLANGRA

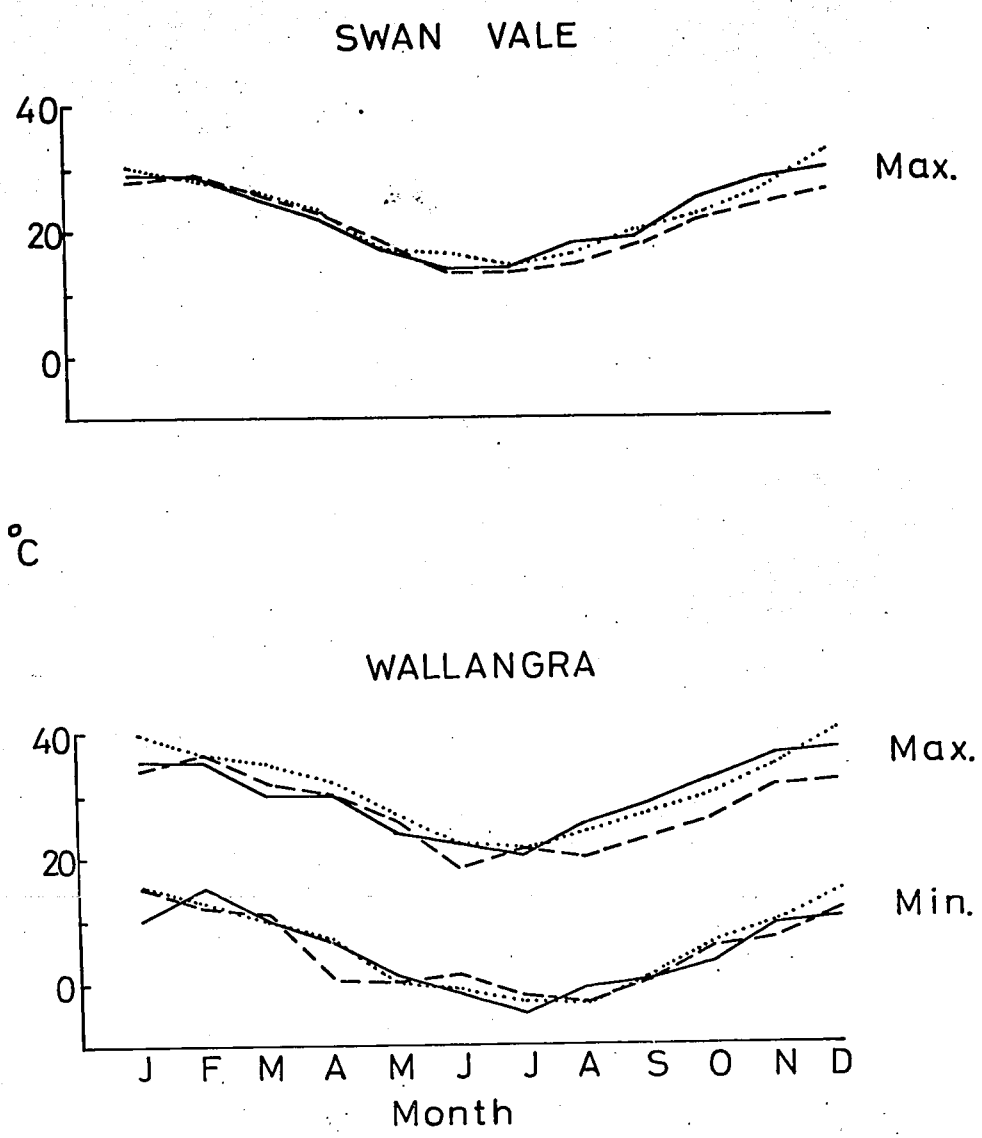
(recorded by J.R. Black and Soil Conservation

Service Research Station at Inverell)

_____ 1977

- - - 1978

..... 1979


SWAN VALE
40
20
0
Max.
°C
WALLANGRA
40
20
0
Max.
Min.
J F M A M J J A S O N D
Month

Perched Galahs could be approached to within 50 metres. White Cockatoos were wary and were rarely observed at a distance of less than 100 metres. Both species were more wary when feeding on and near the ground than when perched in trees. On some occasions temporary hides of hollow stumps and branches were used. Both species allowed closer approach by vehicle than by foot, so many observations were made from within or on top of a vehicle. Some long distance flights by birds could also be followed by vehicle.

Each month I made field trips of 3-8 days from March 1977 to March 1979. Shorter trips of 2-3 days were continued each month until December 1979. I spent a total of 112 days at Swan Vale and 60 days at Wallangra. More time was allotted to the Swan Vale area where the terrain made observations more difficult than at Wallangra. Once the birds were located it was easier to collect data at Swan Vale as the terrain enabled closer approach without detection. I transcribed 597 hours of observations of White Cockatoos and Galahs from Swan Vale and 351 hours of data from Wallangra distributed throughout the daylight hours (Appendix C). Remaining hours were spent searching for birds, examining and noting the condition of crops and native and modified grassland, collecting samples of plants and seeds, inspecting nests and consulting local farmers.

On each field trip I followed White Cockatoos, noting flock size and activity throughout the day, location of feeding areas and numbers at night roosts. I described and sometimes sketched the behaviour. Galahs were observed while feeding and notes were made opportunistically on flock size and activity, movements and behaviour.

At Swan Vale numbers of White Cockatoos could be counted accurately at feeding and roosting times, but the large numbers of White Cockatoos at Wallangra could only be estimated approximately, as they flew from afternoon feeding sites to roosts. Numbers of Galahs were estimated at Swan Vale. Estimates of large flock sizes were made, usually with the aid of binoculars, by counting in multiples of 5, 10 or 20, depending on the general size of the flock.

A double extension ladder was used to climb to nests of White Cockatoos up to 10.2 metres above the ground. A rope lasso and long tongs were used to pull nestlings from deep ( > 70 cm) nest holes. Nestlings were weighed and measurements were made of bill width and length, wings and leg bones, skull width, body length and feather growth. The fullness and composition of 'crops' of nestlings was noted where possible and calls were recorded on the Uher tape recorder. Note here that 'crop' (when in inverted commas) refers to the thin-walled distensible portion of the oesophagus where food is stored for subsequent digestion or feeding of the young by regurgitation.
A Suunto Clinometer (PM-5/360 PC) was used to obtain heights of trees and nests.

## 2.3 SHOOTING

During 1977 and 1978 20 White Cockatoos and 41 Galahs were collected opportunistically by R. Beeton in north-east New South Wales and several farmers at Swan Vale. As shooting disturbed the birds I did not shoot while collecting field notes in 1977 and 1978. During 1979 birds were collected when possible each month at both field areas. In total I examined 39 Cockatoos and 62 Galahs in 1979.

A 410 and a 12 gauge shotgun with No. 6 shot were used to shoot Galahs. The 12 gauge shotgun with No. 4 shot and a 22 rifle were used to shoot Cockatoos. Successful shooting was difficult owing to the wariness of the birds especially after the first shot was fired. Greatest success was achieved shooting at the night roost.

Each specimen was weighed and measurements were made of bill width and length and the external diameter of orbital skin. I also noted wing, tail, crest and body moult, orbital skin colour and texture, eye colour and presence of juvenile or immature plumage. Full 'crops' were weighed. All 'crop' contents were preserved in 70% alcohol. It would have been preferable to sun-dry seeds as alcohol dissolves

certain fats and thus affects final dry weights of seeds (E. Wyndham pers. comm.), but weather conditions sometimes prevented sun drying and seeds became mouldy if not preserved in alcohol. Some stomach contents were preserved in alcohol and gonads placed in Bouin's solution.

Data collected on plumage, moult, age and sex characteristics of White Cockatoos and Galahs are presented in Appendix A.

## 2.4 TRAPPING AND DYEING

At Swan Vale J.E. Courtney banded 404 Galahs using funnel and drop traps between September 1965 and August 1971. During this time he never caught White Cockatoos. In the initial stages of my study the use of rocket nets and traps for capturing White Cockatoos was considered. Bins containing seeds were placed in an attempt to attract White Cockatoos. So few Cockatoos were attracted that the plan to convert them into traps was not implemented. Individual wing-tagging of several species of cockatoos (Pidgeon 1970, Rowley 1974) and parrots (the late J.Le Gay Brereton pers. comm., pers. obs.) has been successful in several long-term studies. However, it was decided to abandon attempts to capture and mark White Cockatoos in this study because:-

1. the cost in time would have been prohibitive in a study involving one observer studying two species over two and a half years (the other studies had used a team of workers),
2. early indications were that White Cockatoos are harder to capture than other parrots,
3. observations on flock behaviour, particularly foraging, were considered of higher priority than those on individual behaviour,
4. White Cockatoos are very wary and attempts to capture them would have disrupted their "normal" behaviour.

During the 1978 breeding season three nestling White Cockatoos were colour-marked at Swan Vale and another three at Wallangra. I applied Eosin red and Methylene blue dyes dissolved in 70% ethanol to wing and tail feathers in different combinations for each nest. However, only one such marked bird was re-sighted two days post-fledging. At least two others were removed before fledging by humans, possibly to sell or rear as pets. Presumably the others dispersed from the field sites or died.

## 2.5 PLANT AND SEED COLLECTION

I collected plants and seeds from both field areas and particularly from the specific sites where Cockatoos and Galahs fed. This aided identification of seeds found in the 'crops' of birds collected.

I made a subjective assessment of the composition and state of native and modified grasslands each month noting species composition, amount of green growth and proportion of flowers, green and ripe seeds. Planting and harvesting times and areas of cropping were noted along with any comments by farmers on crop growth, yield and bird damage. Assessment of the development of each crop and the damage done by birds were also subjective. Factors which might affect the susceptibility of crops to damage by birds were also noted.

## 2.6 BIRD 'CROP' ANALYSIS

The seeds, husks and green matter collected from the 'crops' of 53 Cockatoos and 91 Galahs were room-dried and sorted by eye and a x 10 microscope. The numbers of each type of seed were counted for each individual 'crop'; broken seeds were pieced together so 'whole' seed numbers were calculated. Each bird 'crop' was oven-dried for 7 days at 50$^{o}$C and each seed type and whole 'crop' weighed on a Mettler .01 gram balance.

Seeds and husks from agriculturally grown crops were identified. Identification of other exotic and native plant seeds was more difficult, although I listed most seeds to genera using my plant and seed collection and consultation with S. Bowen of the Botany Department at the University of New England.

## 2.7 DATA ANALYSIS

After each trip field notes were transcribed onto data sheets and

field books indexed. Major flight routes and feeding, resting and roosting areas were mapped after each trip. I estimated the total numbers at both field areas each month, and listed foods eaten by birds based on field observations.

I extracted specific data on flock size, activity and daily timing, feeding numbers and various behaviour and calls. Parish maps and enlarged aerial photographs of the two field areas purchased from the Lands Department were used for mapping the birds' movements, habitats and nest trees. Using a planimeter the areas of certain habitat types, cropped fields and birds' ranges were calculated.

On mapping all flocks of White Cockatoos and Galahs and their movements at Swan Vale and Wallangra after each monthly trip, it became apparent that the 'populations' of each species roosted, fed and rested within a defined area which I called a range.

Some calls were recorded on sonograph tracings using a Kay Sonograph model R 662-B set on a wide band filter at the 85C - 6KC frequency setting.

# SECTION A

## THE WHITE COCKATOO (*Cacatua galerita*)

(Latham 1790)

# CHAPTER 3

# HABITAT

## 3.1 HABITAT PREFERENCES

The White Cockatoo in north-east New South Wales has more specific habitat requirements than the Galah (Bennett 1978, pers. obs.). Highest densities of Cockatoos were found in the extensive heterogeneous mixed farming areas on the North-west Slopes.

Bennet (1978) found that Cockatoos favoured tall open forests such as those dominated by *Angophora costata* but apparently avoided "heavily structured" shrub woodland. They were also associated with riverine woodland on the north-west Slopes and Plains. Cockatoos also inhabit tall sclerophyll forests on the Tablelands although populations are very localized (pers. obs.).

Bennett (1978) claimed that the White Cockatoo demonstrates the "edge effect", which occurs when farmland is adjacent to the preferred or natural habitat of a pest species. The natural habitat provides many of the resource requirements of the animal such as shelter and breeding sites, and agriculture provides an additional food supply. As food is more concentrated in farmland, local populations increase due to concentration, immigration and perhaps in the long term overall population increase.

The home ranges of the Cockatoo populations at my two field areas included four main habitat types which are described below. These four habitats were recognizable at both field areas on structural grounds, but the specific composition of each habitat differed between sites. Table 3 lists the dominant species in each habitat at Swan Vale and Wallangra.

TABLE 3

SPECIFIC HABITAT COMPOSITION

| SWAN VALE | WALLANGRA |
|---|---|
| FOREST | FOREST |
| *Eucalyptus macrorhyncha* | *Angophora costata* |
| *E. dealbata* | *Callitris endlicheri* |
| *E. crebra* | *Eucalyptus dealbata* |
| *E. albens* | *E. blakelyi* |
| *E. andrewsii* | *E. crebra* |
| *E. banksii* | |
| *E. melliodora* | |
| *E. blakelyi* | |
| *E. viminalis* | |
| *E. bridgesiana* | |
| *E. bancroftii* | |
| WOODLAND | WOODLAND |
| *E. albens* | *E. albens* |
| *Angophora floribunda* | *E. melanophloia* |
| *E. viminalis* | *E. melliodora* |
| *E. melliodora* | *E. blakelyi* |
| *Casuarina cunninghamii* | *A. floribunda* |
| | *Casuarina cunninghamii* |
| NATIVE GRASSLAND | NATIVE GRASSLAND |
| *Danthonia richardsonii* | *Bothriocloa macra* |
| *Bothriocloa macra* | *Eragrostis* sp. |
| *Dicanthium sericeum* | *Dicanthium sericeum* |
| *Themeda australis* | *Digitaria brownii* |
| *Sporobolus elongatus* | *Stipa* sp. |
| *Sorghum leiocladum* | *Cymbopogon refractus* |
| *Bromus uniloides* | *Sporobolus elongatus* |
| *Stipa aristigluminis* | *Enneapogon nigricans* |
| *Lolium* sp. | *Lolium multiflorum* |
| *Chloris truncata* | *Chloris truncata* |
| *Iseilema membranaceum* | *Cynodon dactylon* |
| | *Paspalidium* sp. |
| | *Cyparus* sp. |

TABLE 3 (Cont'd)

SPECIFIC HABITAT COMPOSITION

| SWAN VALE | WALLANGRA |
|---|---|
| | NATIVE GRASSLAND (Cont'd) |
| | *Carex inversa* |
| | *Tragus australianus* |
| | *Cenchrus australis* |
| MODIFIED LAND | MODIFIED LAND |
| 1. Modified Grassland | 1. Modified Grassland |
| *Hordeum leporinum* | *Avena fatua* |
| *Hypochoeris* | *Paspalum dilatatum* |
| *Plantago lanceolata* | *Echinocloa crus-galli* |
| *P. gaudichaudii* | *Hypochoeris glabra* |
| *Trifolium* sp. | *Hypochoeris radicata* |
| *Medicago polimorpha* | *Medicago polimorpha* |
| *Senecio* sp. | *Eleusine tristichya* |
| *Amaranthus retroflexus* | *Hordeum* sp. |
| *Eleusine tristichya* | *Silybum marianum* |
| *Paspalum dilatatum* | *Cirsium vulgare* |
| *Rumex brownii* | *Centaurea calcitrapa* |
| *Setaria* sp. | |
| *Echinocloa crus-galli* | |
| *Capsella bursa-pastoris* | |
| *Cirsium vulgare* | |
| *Phalaris* sp. | |
| *Taraxacum officinale* | |
| *Lolium* sp. | |
| *Centaurea calcitrapa* | |
| *Centaurea solstitialis* | |
| 2. Crops | 2. Crops |
| Wheat *Triticum aestivum* | Wheat *Triticum aestivum* |
| Barley *Hordeum vulgare* | Barley *Hordeum vulgare* |
| Oats *Avena sativa* | Oats *Avena sativa* |
| Sorghum *Sorghum* sp | Sorghum *Sorghum* sp. |
| Sunflower *Helianthus annuus* | |

Plants identified using Gray (1961) and help of S. Bowen of the Botany Department, University of New England.

The forest habitat at both field areas was dry sclerophyll (Beadle and Costin 1952) (Plates 1 and 2). At Wallangra it was represented by tall (15 to 28 metre) stands of Smooth-barked Apple (*Angophora costata*) and Cypress Pine (*Callitris endlicheri*); at Swan Vale it consisted predominantly of 10 to 15 metre Red Stringybark - Hill Red Gum - Narrow-leaved Ironbark (*Eucalyptus macrorhyncha, E. dealbata* and *E. crebra*)association although Ironbark was replaced by White or Yellow-box (*E. albens, E. melliodora*) in many areas. Habitats characterized by a sparsely continuous canopy were defined as woodland. Almost pure stands of White Box occurred at both areas; and large stands of Silver-leaved Ironbark (*E. melanophloia*) also grew at Wallangra.

Native grasslands occurred where annual and perennial native grasses and herbs were dominant (Plates 1 and 2). Modified land was dominated by exotics or introduced, planted or naturalized grasses and herbs. These areas included (1) standing crops and stubble of wheat, oats, barley, sorghum and sunflower; and (2) modified grassland which included contour banks and ploughed and fallow fields (Plates 1 and 2). At both field areas grasslands and crops incorporated both treeless areas and "savannah", in which scattered trees (mostly White Box) grew.

The areas of the four habitats at each field area are shown in Table 4. The composition of forest, woodland and native grassland areas remained constant over the study period, whilst modified areas changed with cropping cycles. At both field areas native grassland and modified land covered over 60% of the total area. At Wallangra the area of modified land was greater than that of Swan Vale where native grassland was more extensive. The relatively smaller area of modified land at Swan Vale is due to the terrain and the smaller mixed farming units.

# PLATE 1

## SWAN VALE HABITATS

a. Native grassland

Woodland and Forest

b. Modified grassland

Forest

c. Modified land - sunflower crop

a

b

c

# PLATE 2

## WALLANGRA HABITATS

a. Forest - *Angophora costata*

b. Native grassland

Woodland

c. Native grassland

Modified land - sorghum stubble

a

b

c

TABLE 4

AREAS* OF THE FOUR MAJOR HABITATS AT EACH FIELD AREA

| HABITAT | SWAN VALE | WALLANGRA |
|---|---|---|
| Forest | 11 | 10 |
| Woodland | 21 | 30 |
| Native Grassland | 45 | 20 |
| Modified Land | 23 | 40 |
| Total area (ha) | 2,500 | 3,060 |

* Figures are expressed as percentages of the total area. Areas were calculated from aerial photographs (purchased from the Lands Department) using a planimeter. Aerial photographs taken in July and August 1975.

## 3.2 HABITAT USE

Throughout the year forest and woodland were used for nocturnal roosting and diurnal resting for periods of 9 to 13 hours and 4.5 to 9 hours of the 24 hour day respectively. Sometimes White Cockatoos roosted in savannah at Swan Vale (Table 5). In addition birds at Wallangra and Swan Vale rested in trees (e.g. *Casuarina cunninghamii* and *Angophora floribunda*) along water courses. Feeding occurred in all habitats (Table55). Intensive or "major feeding", which is defined as feeding by large stable flocks on areas providing the primary food source at the time, was concentrated on the crops and stubble of modified land. Selective or "minor feeding", where birds foraged on the ground in small unstable flocks, took place in all habitats but especially in native and modified grassland. Here items were picked up infrequently and possibly items providing specific requirements were being sought.

The actual sites used within each habitat, especially for feeding, changed seasonally or monthly depending on cropping cycles, human interference and the birds' preferences. Such changes caused a related change in bird movements. Major flight paths used by the majority of White Cockatoos between roosting, feeding and resting areas were usually direct and predictable each month. Minor paths were evident from these areas to nest sites.

## 3.3 SPECIFIC USE OF SOME HABITAT FEATURES

White Cockatoos assemble in dead or sparsely foliaged trees before, during and immediately after feeding, and commonly post and prior to roosting. Many flights are interrupted by landings in certain "special" trees along major flight paths. These trees are usually taller than the surrounding trees and thus command extensive views. White Cockatoos roost and rest in trees with denser foliage. A roost area is protected and not too close to human habitation. Dams, rivers, troughs and temporary pools are used for drinking.

TABLE 5

HABITAT USE BY THE WHITE COCKATOO

| Habitat | Activity | % flocks* in each habitat in each activity | | Range of flock# sizes in each habitat in each activity | |
|---|---|---|---|---|---|
| | | SWAN VALE | WALLANGRA | SWAN VALE | WALLANGRA |
| Forest | Roost | 2 | 5 | 2 - 50 | 2 - 100 |
| | Rest | 1 | 2 | 1 - 50 | 1 - 100 |
| | "Minor feed" | 0 | 0.5 | | 1 - 10 |
| | All | 3 | 7.5 | | |
| Woodland | Roost | 1 | 0 | 2 - 30 | |
| | Rest | 16 | 20 | 1 - 100 | 1 - 500 |
| | "Minor feed" | 0.5 | 0.5 | 1 - 20 | 1 - 30 |
| | All | 17.5 | 20.5 | | |
| Native Grassland | Perch | 22 | 21 | 1 - 100 | 1 - 300 |
| | "Minor feed" | 9.5 | 8 | 1 - 100 | 1 - 300 |
| | All | 31.5 | 29 | | |
| Modified land | Perch | 20 | 24 | 1 - 150 | 1 - 600 |
| | "Minor feed" | 9 | 7 | 1 - 100 | 1 - 300 |
| | "Major feed" | 19 | 12 | 1 - 200 | 1 - 600+ |
| | All | 48 | 43 | | |
| Total no. of flocks* | | 1466 | 873 | | |

*Feeding and perching flocks only included, where specific habitat also noted in data 1977-1978.

#Range of aggregations of feeding, perching and flying flocks within each habitat in each activity included from observations 1977-1979.

No statistical test to find habitat preferences was applied to this data as flock observations were heavily biased towards open habitats.

# CHAPTER 4

# INDIVIDUAL AND SOCIAL BEHAVIOUR

## 4.1 INTRODUCTION

Behaviour involving an individual bird responding to stimuli not directly connected with other individuals is described first. Such individual behaviour includes locomotion and maintenance. Secondly, social behaviour which concerns all behaviour which involves exchange of information between conspecifics is described. In this chapter I consider aspects of social behaviour in the study populations other than those associated with feeding and breeding. These two topics are dealt with in Chapters 6 and 7.

## 4.2 MODES OF LOCOMOTION

Flight: During long distance flights (e.g. greater than 500 metres) Cockatoos use a continuous, regular wing beat. On flights of one kilometre or more the birds may attain altitudes greater than 300 metres. Speeds of 40 to 55 km per hour were attained when tested by driving a vehicle beside the Cockatoo in flight. Short distance flights (less than 500 metres) consist of alternating flaps and glides. When descending to trees or directly to the ground from altitudes greater than 200 metres they move in wide (30 to 100 metre diameter) circles of decreasing altitude or drop rapidly by twisting the body into the vertical plane with wings outspread. This tumble is terminated by a sudden switch to the horizontal plane. When flying between trees, Cockatoos used a distinctive low swooping glide.

Walking, Hopping and Sidling: Cockatoos walk slowly in a swaying fashion over the ground or on logs and branches. On occasions they hop

for short distances on the ground or walk quickly almost to a running speed especially during aggressive encounters. Cockatoos sometimes "strut" along jerking their head forward and raising their crest. This is most often seen when birds initially land on the ground or a wide log or branch. Cockatoos may hop between or sidle along branches.

Climbing and Hanging: In trees, Cockatoos use both legs and bill to move in and between branches. Sometimes individuals hang upside-down from a branch by the legs or by the beak; the wings are often outspread during such behaviour. They may take-off from such an upside-down position, or use the bill and wings to struggle back onto the branch.

Landing and Take-off: Landing on trees or the ground is usually preceded by a short glide. Immediately after landing Cockatoos often bend forward and raise their crests. Sometimes "head nodding" follows, in which the head is quickly lowered then jerked up again several times with the crest raised. This behaviour is performed by stationary perching birds or as mentioned previously by birds strutting along simultaneously. Before take-off Cockatoos lean forward slightly in the direction of intended flight.

## 4.3 MAINTENANCE

Methods of feeding: Cockatoos feed by perching on the heads of sturdy plants (such as sorghum and sunflower) or walking on the ground. To gain access to less sturdy tall seed heads (such as wheat or thistle) they cut down or bend the stalks by manipulation with the bill and foot. Cockatoos consume seeds from seed-heads *in situ*, or they break off the seed head and carry it in the bill to nearby trees or open ground. The stalk of the seed head is held in the left foot (in 98% of observed cases N = 48) while the seeds are extracted with the bill. Most seeds are

husked before swallowing. The remains of the plant are dropped sometimes before all seeds are extracted. Although Cockatoos may fill their bills with many seeds during feeding only one seed is husked at a time: the others are held until they too are ingested. This has been observed in caged birds (Mathews 1973, pers. obs.).

Sometimes Cockatoos dig with the bill for sown seed or to gain access to the bulbs and roots of non-crop plants such as bear's ear (*Cymbonotus* sp.) (pers. obs.). Cow pads may be picked apart to extract the seeds. Despite their large bills and destructiveness Cockatoos are meticulous when discarding pappus from catsear (*Hypochoeris* sp.) heads and husking their small seeds.

Throughout the year Cockatoos chew the green, flowering or mature buds and fruits of eucalypts and apples (*Angophora* spp.). This and the following behaviour is not necessarily concerned with feeding. They break off branches containing leaves, fruits, or flowers. At times these branches are extremely numerous beneath favoured trees and are indicators of Cockatoo resting or roosting areas.

Drinking: Cockatoos walk to the edge of still or flowing water, or fly onto half submerged logs or rocks and immerse the bill one to ten times. After each immersion they raise the head to swallow the water.

Defaecation: Cockatoos defaecate while in trees or on the ground by raising the tail. Often the body feathers are ruffled immediately after defeacation.

Auto-Preening: Cockatoos use the bill to nibble body feathers and the oil gland. They draw large feathers such as those of the wing and tail through the bill. Cockatoos scratch around the face and crest by lifting the foot under the wing. The bill is scratched with the claws or rubbed across branches. During preening they often lift one foot and lower the head to chew the foot. They raise and shake the body, head and

crest feathers and gradually sleek them down. Often the cheek feathers remain ruffled almost covering the bill. In addition wings are arched and stretched, legs are stretched and the tail fanned or shaken.

Preening was recorded for each hour of the day, but was less frequent during the middle of the day (1100-1400) than in the morning and afternoon periods (Fig. 5). This corresponded with the major midday rest period.

Resting and Sleeping: Cockatoos are inactive for much of the middle of the day, resting in forest or woodland, or in trees lining water-courses. Birds sit on one or both legs for up to 2 hours with little movement. Occasionally they yawn, shake or preen. Although the eyes are sometimes half closed Cockatoos appear to remain awake and alert during these periods.

The Cockatoo sleeps with its head tucked over its shoulder and hidden in the scapulars and back feathers. Cockatoos sleep in the upper branches of trees such as White Box and Smooth-barked Apple, usually under foliage. When settling after dusk they make soft noises which resemble those heard during the day in caged Cockatoos (Courtney 1974, pers. obs.). A grating noise is produced as the edge of the mandible is rubbed from side to side against the inside tip of the maxilla; another sound is produced when the tongue is moved anteriorly and posteriorly as the bill opens slightly and closes.

## 4.4 EFFECTS OF WEATHER ON INDIVIDUAL BEHAVIOUR

Rain fell during field trips in 13 months at Swan Vale and 4 at Wallangra. Heavy continuous rain of 10-42 mm over 24 hours altered the patterns of daily activity of Cockatoos on 5 days at Swan Vale and one at Wallangra. On these days the birds did not feed at all during normal feeding periods on rainy mornings. They remained perched for long periods

FIGURE 5

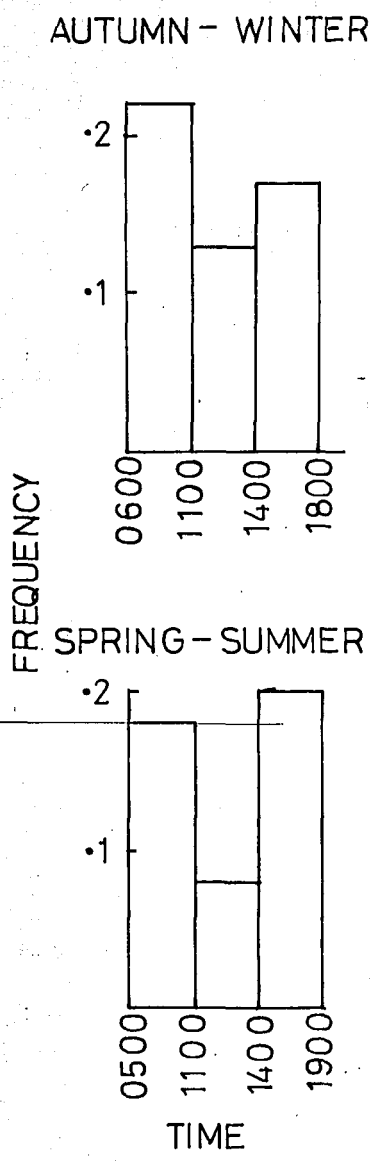
DIURNAL VARIATION IN PREENING

N = 171 (100 incidences of auto-preening)

( 71 incidences of allo-preening)

Data are incidence of preening at both field areas during each hourly interval, divided by the total number of observation hours made in each time interval.

Values for mid-day may not be realistic due to the difficulty of observing birds during their day rest period.


AUTUMN - WINTER
·2
·1
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1100
1400
1800
FREQUENCY
SPRING - SUMMER
·2
·1
0500
1100
1400
1900
TIME

in trees in roost or rest areas apparently not moving until the rain eased or ceased. Light drizzle or sporadic showers of 0.4 - 10 mm in 24 hours did not appear to affect the usual daily activities so dramatically.

I observed Cockatoos "bathing" in light rain on six occasions. The birds hung upside-down with outspread wings or leant forward over a branch with wings partly or fully stretched. This was often followed by preening.

Panting was observed on hot 28-38°C dry days in December, January and February. The birds sat with bill open, head raised, body feathers sleeked and cheek feathers ruffled. The folded wings were held out slightly from the body. On such hot days the Cockatoos fed in the afternoon and flew to roost up to three-quarters of an hour later than usual for that month.

## 4.5 ALLO-PREENING

Allo-preening occurs throughout the year but most frequently during the breeding season from August to December ($t = 3{\cdot}14$, $df = 10$, $P < 0{\cdot}05$) (Fig. 6). During this behaviour one bird sidles to a second which lowers its head submissively and closes its eyes. The approaching bird nibbles around the neck, eyes, bill, crest and less often the breast, flanks, vent and feet of the recipient bird. The situation may then be reversed as recipient becomes donor and occasionally the two preen each other simultaneously. Allo-preening was observed only between pairs of birds. When a third bird approached the allo-preening pair it was always threatened or displaced by one member of the pair. The longest and most intense allo-preening sessions of up to three-quarters of an hour were seen in Cockatoo nest trees. Pairs may also sit close together or touching without allo-preening.

FIGURE 6

MONTHLY CHANGES IN THE REINFORCEMENT

OF PAIR BONDING

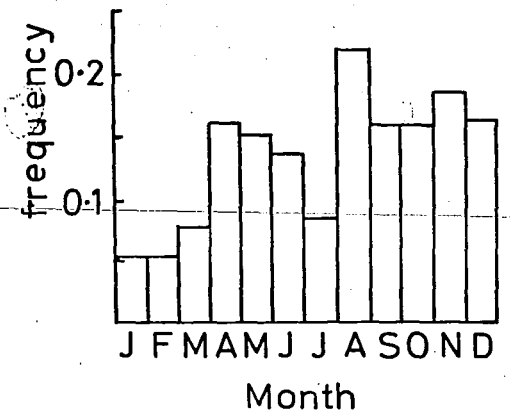
N = 125

Data are the frequency of observations of presumed pairs allo-preening or close-perching, (less than one body length apart), per hour of observation each month, at both field areas.

January - July $\bar{X} = 0.10$

August - December $\bar{X} = 0.18$

( $t = 3.14$, $df = 10$, $P < 0.05$)


frequency
0·2
0·1
J F M A M J J A S O N D
Month

## 4.6 THREAT AND ALARM

One White Cockatoo may threaten another by walking, hopping or sidling up to it while leaning forward with crest raised and bill gaping. This usually results in one of the two birds being supplanted without physical contact. Very rarely do Cockatoos parry or lock bills before separating. Frequently a flight chase results when one bird continues to fly and supplant another from its perch; this continues until the subordinate bird flies some distance away. This behaviour was more prevalent in the breeding season. Occasionally one bird will fly at another in the air and both tumble separately 2 to 10 metres before resuming normal flight.

White Cockatoos occasionally threatened other species. They flew towards Galahs when the latter were near their nest holes in the non-breeding and especially in the breeding season. Galahs responded similarly toward Cockatoos approaching their nests. J.E. Courtney (pers. comm.) observed a Cockatoo in the non-breeding season chase a Kookaburra away from its nest tree. Perching Corvids, Australian Raven (*Corvus coronoides*) and Crow (*Corvus orru*) were observed to be displaced by Cockatoos. In turn Corvids chased Cockatoos close to Corvid nest sites. I have observed Nankeen Kestrel (*Falco cenchroides*) and Magpie (*Gymnorhina tibicen*) fly at weak Cockatoos which had lost many feathers.

On five occasions I observed two to six Cockatoos displaying simultaneously at the entrance of tree hollows and at an object on the ground. They stared at the object with crest raised, wings outspread and bill open while screeching loudly. On three occasions this behaviour was directed towards a Lace Monitor (*Varanus varius*); in the other instances no cause for alarm was evident. I observed single birds adopting this wing-spread posture in a presumed threat display on twelve occasions. The display was directed at the ground, at nest holes or towards birds such as Galahs, Straw-necked Ibis (*Threskiornis spinicollis*) and a Little

Pied Cormorant (*Phalacrocorax melanoleucos*) perched in nest or rest trees.

In summary, it appears that aggression directed at conspecifics consisted of bill gaping and crest-raising, while threats towards allospecifics included wing-spreading.

When alert, Cockatoos perch erect with feathers sleeked and crest half or fully raised. Often a loud alarm call is given when fully alarmed and the bird flies sometimes with the erect crest maintained. Alarm screeches from wounded Cockatoos or handled nestlings usually attract many Cockatoos which circle directly above, screeching loudly. Such behaviour could be interpreted as mobbing.

I have never witnessed predation of the White Cockatoo although local farmers claim that foxes eat weak or dead birds. The proximity of potential birds of prey usually elicits an escape response. Cockatoos often respond to raptors such as the Brown Goshawk (*Accipiter fasciatus*), Brown Falcon (*Falco berigora*), Little Falcon (*Falco longipennis*), Whistling Kite (*Haliastur sphenurus*), Little Eagle (*Haliaetus morphnoides*) and especially Wedge-tailed Eagle (*Aquila audax*) (Table 6), but rarely react to the presence of Nankeen Kestrels. Cockatoos rarely mobbed raptors, the chief response being to fly away from the raptor towards cover. This is done silently in open areas but alarm calls are often given in or adjacent to woodland. During their 'escape' Cockatoos may circle high in a tight flock close to the raptor.

## 4.7 LONGEVITY AND MORTALITY

White Cockatoos are reputed to live up to a century in captivity (North 1912, Lendon 1973); no information is available for wild birds. In common with most birds mortality is probably highest in juvenile or non-breeding birds (Lack 1968).

'Mangey' birds were occasionally seen at both field areas. These birds exhibit varying degrees of baldness with feathers lost from the

TABLE 6

NUMBER OF TIMES WHITE COCKATOOS RESPONDED

TO PREDATORS 'HUNTING' IN THEIR VICINITY

| POTENTIAL PREDATOR | SWAN VALE NUMBER OF TIMES PREDATOR IN VICINITY | SWAN VALE NUMBER OF TIMES COCKATOOS RESPOND | WALLANGRA NUMBER OF TIMES PREDATOR IN VICINITY | WALLANGRA NUMBER OF TIMES COCKATOOS RESPOND |
|---|---|---|---|---|
| Wedge-tailed eagle | 22 | 22 | 19 | 19 |
| Little Eagle | 5 | 5 | | |
| Whistling Kite | 3 | 3 | | |
| Little Falcon | 1 | 1 | 4 | 4 |
| Brown Falcon | 5 | 5 | 1 | 1 |
| Brown Goshawk | 4 | 3 | | |
| Nankeen Kestrel | 45 | 2 | 20 | 3 |
| Goanna | | | 3 | 3 |
| Fox | 8 | 1 | | |
| Human - Day shooting | 24 | 24 | 20 | 20 |
| Human - Night shooting | 6 | 0 | 5 | 0 |
| Unknown | | 4 | | 3 |

head, crest and body and sometimes from the tail and wings. Some birds reach such an advanced state of baldness that they cannot fly (M.G.M. Woods pers. comm.). Presumably they fall prey to ground predators. Some 'mangey' birds also possess an elongated upper mandible which often twists across the lower mandible. Beeton (1977a) ascribed this "feather-losing syndrome" in Little Corella (*Cacatua sanguinea*) to parasitism by *Leucocytozoan* or *Plasmodium* species. In two 'mangey' Cockatoos I examined and two examined by Smith (1977) and Rann (1977), the kidneys and spleen were enlarged and the liver necrotic and mottled in colour. The birds had degenerate gonads and one had the convoluted oviduct of an aged female. Smith (1977) and Rann (1977) found large numbers of microfilaria in the mangey birds they examined. It is not known if this causes the 'mangey' condition of birds.

Of 9 parrot species collected in north-east New South Wales the White Cockatoo was the most heavily infested with parasites (Smith 1977). These Cockatoos contained cestodes (family Anoplocephalidae) in the intestine and stomach; nematodes were found in the perivisceral cavity and near the spinal column of one bird. The White Cockatoo is the type host of one cestode species (Schmidt 1972). As the larvae of such cestodes are found in arthropods, presumably the latter are ingested by Cockatoos. However, Cockatoos infected with cestodes and nematodes did not suffer from feather loss and appeared otherwise healthy.

## 4.8 GENERAL FLOCK BEHAVIOUR

Flocks performed and changed activities with a certain coordination. In flight birds constantly changed height and proximity in relation to other members of the flock. Single birds, pairs and small groups were seen at times to divert their course to join others that were perched or feeding. Often when going to the ground to feed or entering a roost site birds moved in a "stream" one behind the other.

Despite this coordination groups sometimes displayed "intention movements". Individuals in a flock would become restless and take off from perching or feeding, but returned and settled after some seconds. Successful execution of the various activities seemed to require the adoption of an appropriate mood by the consensus of birds in the flock.

Individual distances of one to two body lengths were maintained in all activities between presumed non-related members of a flock. Threat, bill gape and flight chases were sometimes observed in order to maintain these distances. Pairs however often perched together, side by side, but such pairs always maintained a distance of one to two body lengths from other birds. No hierarchical system was evident in Cockatoos, but there is no evidence to support this as no individual marking was attempted. It is unlikely however, that a dominance structure exists in such a gregarious species.

## 4.9 "SENTINEL" BEHAVIOUR

Mention is made repeatedly in the literature of a "sentinel warning system" used by the White Cockatoo. According to Forshaw (1969) this is prevalent "wherever the Cockatoos inhabit open country .... While a flock is feeding on the ground a few birds remain perched atop nearby trees ... At the approach of danger these 'sentinels' rise into the air screeching loudly and the entire flock flies off."

My observations did not support this behaviour pattern. Frequently all members of a flock fed on the ground simultaneously and no overhead 'sentinels' were posted to warn the flock. During such feeding at least one bird had its head raised in an alert manner at any one time. When flushed the birds left the ground simultaneously in silence. Loud screeching commenced after all were airborne. On other occasions individuals perched overhead or carried food from the ground to perch in nearby

trees where they ate. Such birds may have been functioning as 'sentinels', although there was no evidence that this was the principal reason for perching above the flock.

## 4.10 ROOSTING

Cockatoos roosted communally in flocks of up to 30 per tree, settling under foliage and occasionally on exposed branches. Frequently prior to settling in roost trees Cockatoos circled the roost area one to five times in a large mob of 50 to 100 birds. They called, flew and climbed about in the trees before settling to sleep. On moonlit nights Cockatoos often appeared restless, calling and moving about in the roost area throughout much of the night.

Cockatoos settled to roost at night up to 45 minutes after their arrival at the roost area (Fig. 7). The times of arrival and of settling were significantly correlated at both field areas: ($r = 0.94$, $df = 21$, $P < 0.01$) for Swan Vale and ($r = 0.91$, $df = 15$, $P < 0.01$) for Wallangra. Cockatoos presumably slept for approximately 9 and 13 hours in summer and winter respectively. Entering, settling and awakening times at night roost followed sunset and sunrise hours. At Wallangra monthly awakening times were similar in 1977 and 1978 ($r = 0.91$, $df = 5$, $P < 0.01$) (Fig. 8).

## 4.11 VOCAL COMMUNICATION

Vocal signals in the White Cockatoo were a most conspicuous form of social communication. The greatest variety and number of calls were produced by Cockatoos in or near their roost area in the early morning and late afternoon. During feeding and day resting periods they were silent except when disturbed, and during activity changes.

FIGURE 7

TIMES AT WHICH WHITE COCKATOOS:

ARRIVE AT ROOST AREA ----------

SETTLE TO SLEEP _____

AT SWAN VALE AND WALLANGRA.

Inset: Linear regression of arrival at roost against settling to roost for -

SWAN VALE $y = 1.02x + 10.69$

$(r = 0.94, df = 21, P < 0.01)$

WALLANGRA $y = 0.89x + 261.20$

$(r = 0.91, df = 15, P < 0.01)$

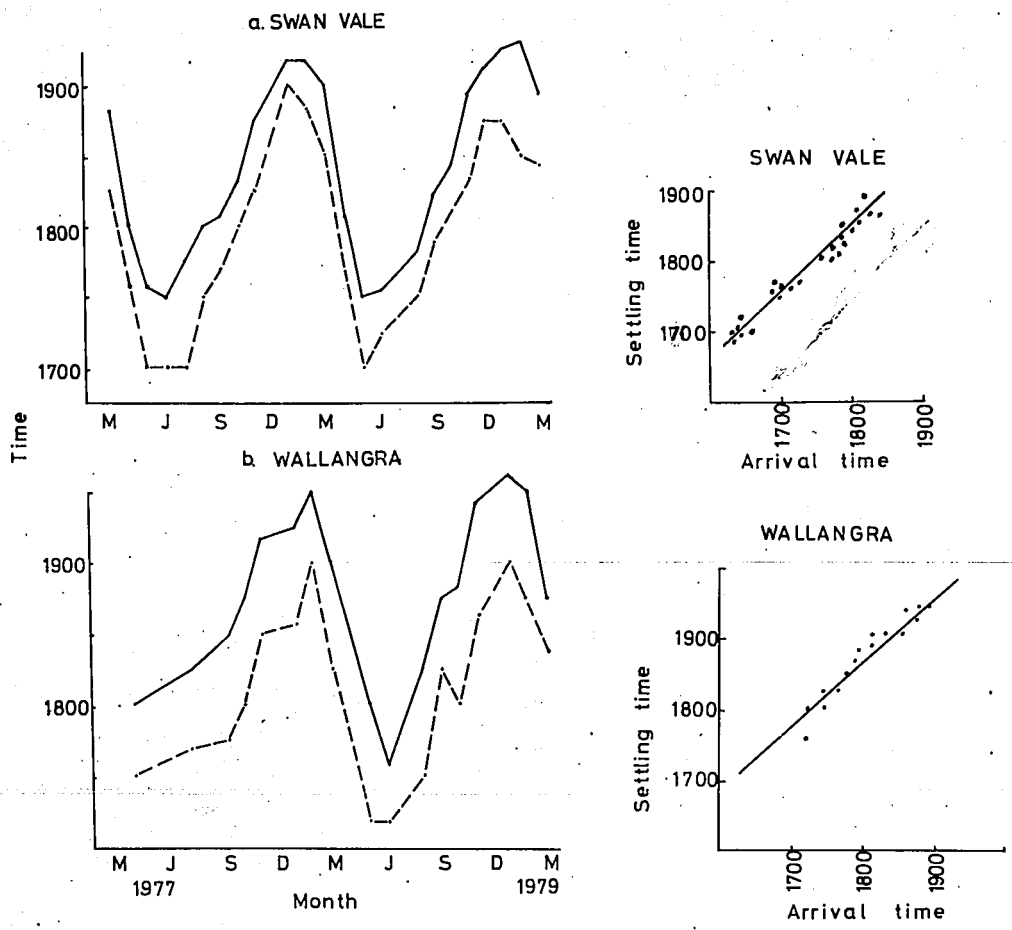
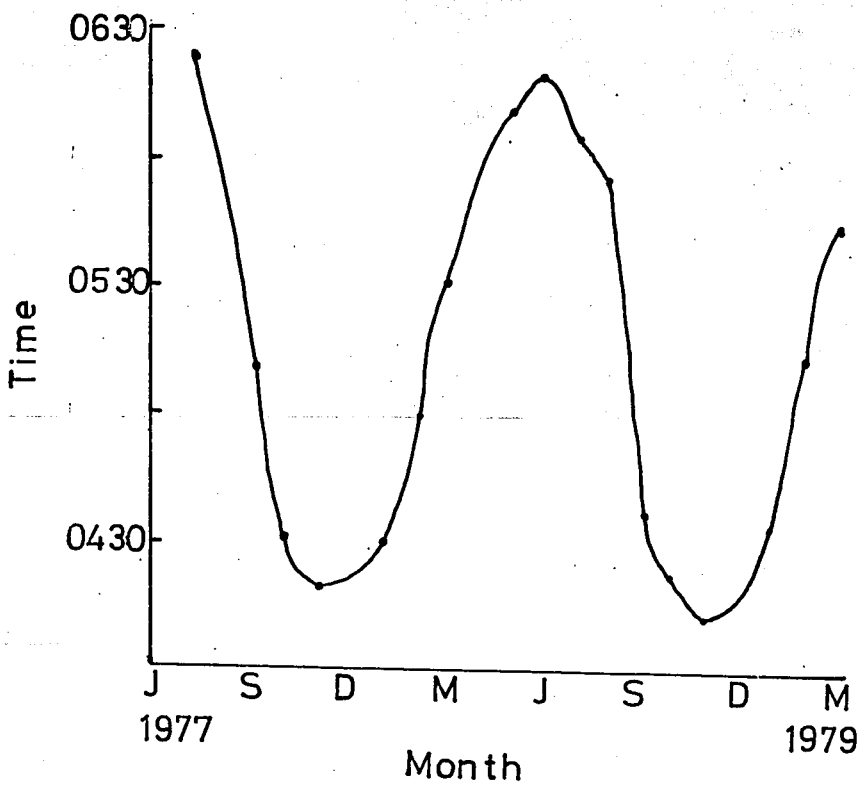

a. SWAN VALE
1900
1800
1700
Time
M J S D M J S D M
b. WALLANGRA
1900
1800
M J S D M J S D M
1977
1979
Month
SWAN VALE
Settling time
1900
1800
1700
1700
1800
1900
Arrival time
WALLANGRA
Settling time
1900
1800
1700
1700
1800
1900
Arrival time

FIGURE 8

AWAKENING TIMES FOR WHITE COCKATOOS AT WALLANGRA SITE A.


0630
0530
0430
Time
J
S
D
M
J
S
D
M
1977
1979
Month

The White Cockatoo appeared to have about 13 distinct vocal signals, with variations on at least two of these. The behaviour and context associated with each vocal signal, and the possible function of some of them are presented in Table 7. Sonographs of some calls are shown in Fig. 9. Most calls were between 0.5 and 2 seconds in duration, and incorporated frequencies between 1 and 6 KC. Calls were not analysed further as recordings were all made in the field and contained much background noise.

There was considerable variation (possibly even between individuals) in many of the basic calls of the White Cockatoo. However all the distinct calls were heard at both field areas. The yodel/whistle call (6 in Table 7) was very different between Swan Vale and Wallangra, although it was accompanied by the same behaviour and produced in similar situations at both field areas. The Wallangra yodel call was never heard at Swan Vale, although a call similar to the Swan Vale whistle was possibly heard once at Wallangra.

The White Cockatoo had a similar repetoire to that of the Galah (Pidgeon 1970, pers. obs.). The Galah has 9 distinct calls with variations on one of them. At least 6 calls of the White Cockatoo (the squawk, screech (long and short), croak, yodel/whistle, food-begging and food-swallowing calls, Table 7) have equivalent calls, in both context and associated behaviour, in the Galah. The similarity of nestling food-begging and swallowing calls may be an important criterion of taxonomic affinities in Australian parrots (J.E. Courtney pers. comm.).

TABLE 7

VOCALIZATIONS OF THE WHITE COCKATOO

| Call | Description: Associated Behaviour | Possible Purpose |
|---|---|---|
| 1. Squawk | Most common call, harsh and loud, one syllabic- uttered once or many times. | |
| 1a.* | While perched, crest down or raised, head moves up and down with each call, when pair call alternately or together two tones detected? ♂/♀ or individual variation. | Location<br>Low intensity alarm |
| 1b. | Flight call, crest up or down, normal flight. | Flight call<br>Location |
| 1c. | Perch or fly, alert or alarm, call harsher sound, crest up and fast wing beat. | Alarm |
| 2. Screech | Loud harsh screech. | |
| 2a. | Short call, one syllabic uttered once or many times, crest raised, wing-spread threat toward interspecifics. | Intense alarm<br>Intense threat |
| 2b.* | Long call uttered many times when wounded or caught. | Alarm/Distress |
| 3. Croak | One to two syllabic soft call, crest down, head jerks up and forward slightly when perched, also given in flight, given by caged bird when cease rest and begin to feed or preen. | Location<br>Change of mood |
| 4. Bark/<br>a. croak*<br>b./whistle | *One to two syllabic harsh call, has at least two variations. | ? |
| 5. Rasp* | Long harsh rasping call | ? |
| 6. Yodel/<br>whistle | | |

* Sonographs of these calls presented in Fig. 9.

TABLE 7 (Cont'd

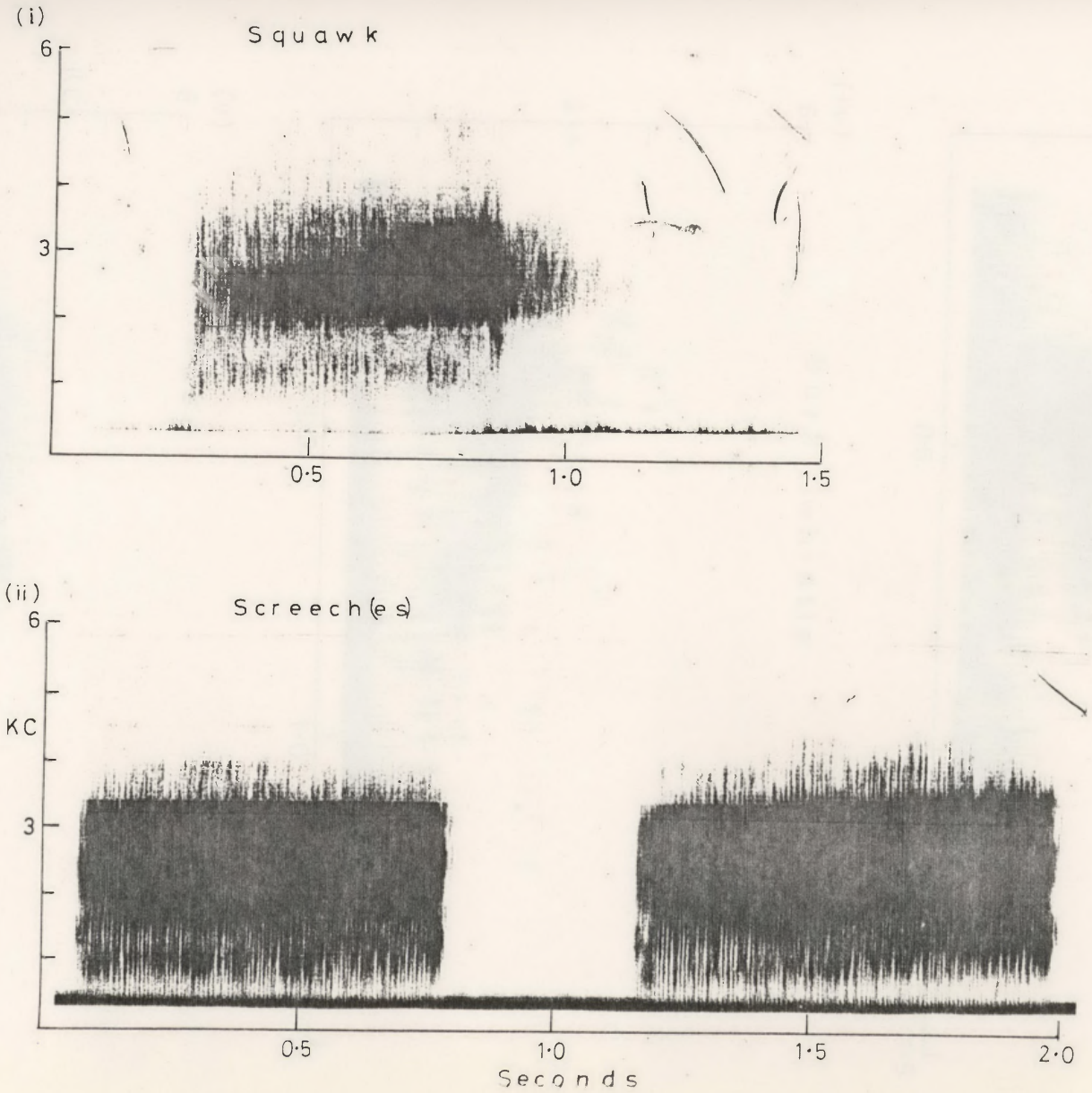
| Call | Description: Associated Behaviour | Possible Purpose |
|---|---|---|
| 6a. Yodel* | When perched - forest at Wallangra. Wings lifted out from body at shoulder, head nodded. One bird gives the call and often its mate and others will follow with the same call. | Location<br>Nest proclamation |
| 6b. Whistle | Heard at Swan Vale when perched at roost or nest area. Same behaviour as for above call at Wallangra. | Perhaps given by sedentary adult pairs only. |
| 7. Cry* | High cry-whistle. | ? |
| 8. Chatter | Soft chattering noises in roost trees. | ? |
| 9. Graze | Soft graze | ? |
| 10. Grate | Harsh call. Wings lifted out from body at shoulder, head bent forward, crest up or down. Sometimes associated with call 6 at both areas. | ? |
| 11. Whirr/ wheeze* | Given by nestlings soliciting feeding from parents. Is a continuous high call with wheezing when a breath is taken. | Food-begging |
| 12. Chuckle* | Repetitive pulsating noise given by nestling and fledgling, while jerking head up and down with bill interlocked with parents' during feeding.<br>Elicited in nestling by finger against or inside the bill. | Food-swallowing |
| 13. Hiss | Breathy expulsion of air accompanying bill gaping. Given by nestlings over 2-3 weeks of age, and by untamed caged adult. | Threat (low intensity) |

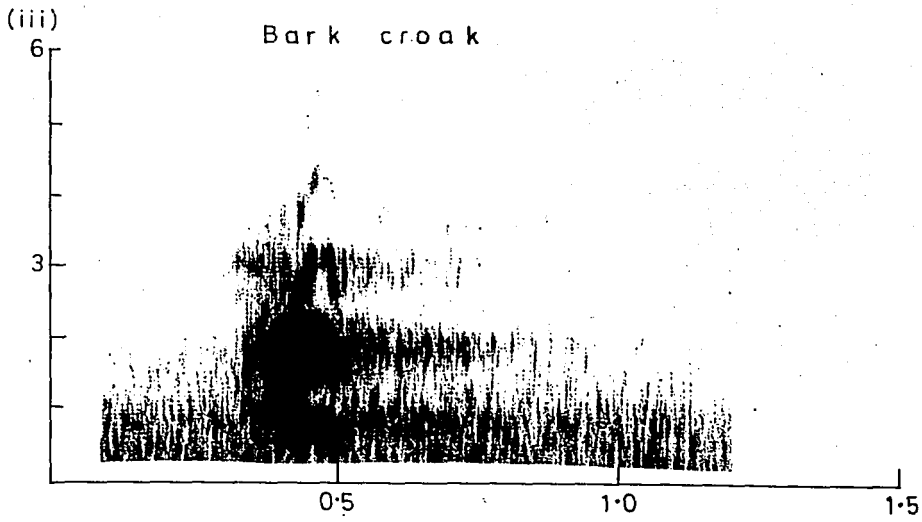
* Sonographs of these calls presented in Fig. 9.

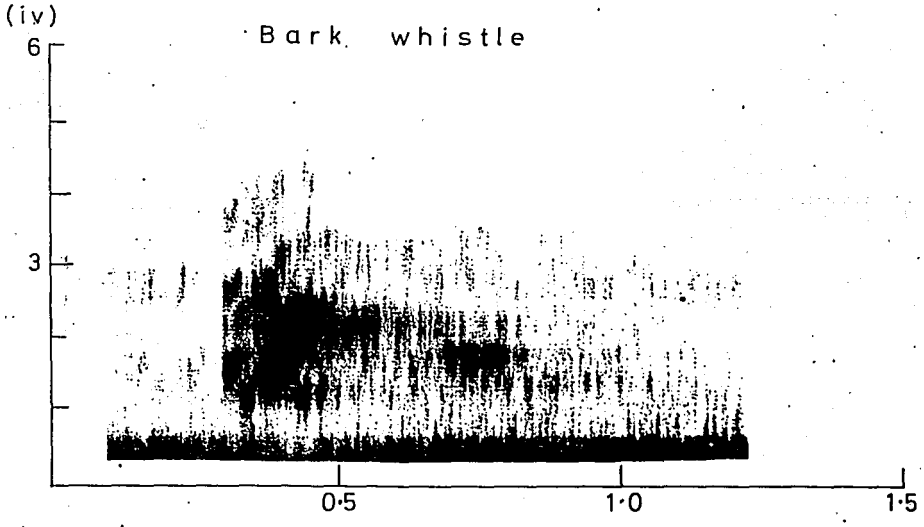
FIGURE 9

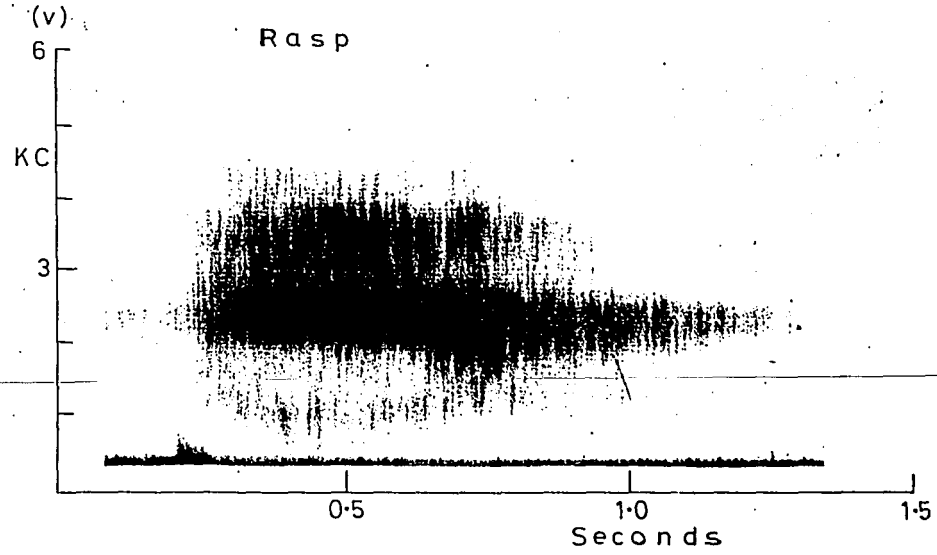
SONOGRAPHS OF NINE WHITE COCKATOO CALLS

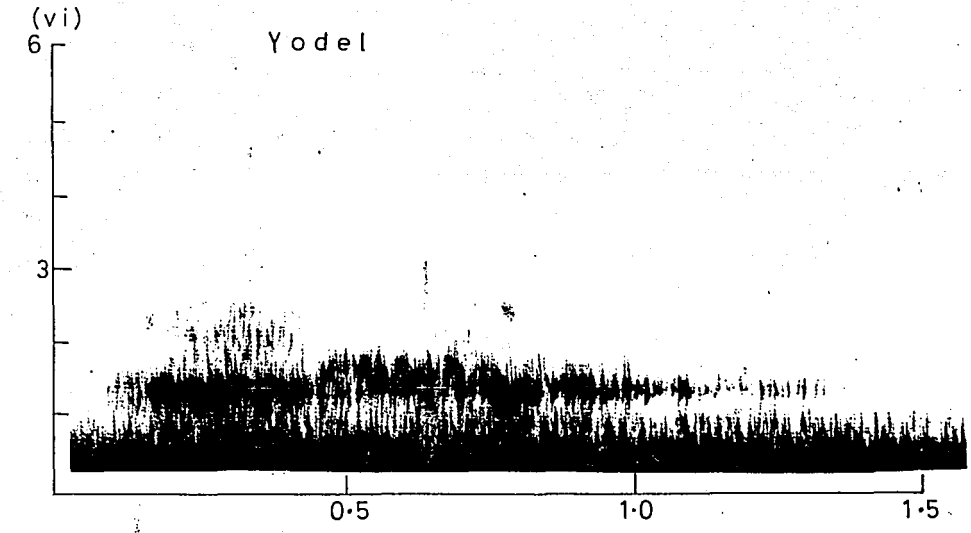
| | | |
|---|---|---|
| (i) | Squawk | (1 in Table 7) |
| (ii) | Two screeches | (2b in Table 7) |
| (iii) | Bark croak | (4a in Table 7) |
| (iv) | Bark whistle | (4b in Table 7) |
| (v) | Rasp | (5 in Table 7) |
| (vi) | Yodel | (6a in Table 7) |
| (vii) | Cry | (7 in Table 7) |
| (viii) | Food-swallowing | (12 in Table 7) |
| (ix) | Food-begging | (11 in Table 7) |

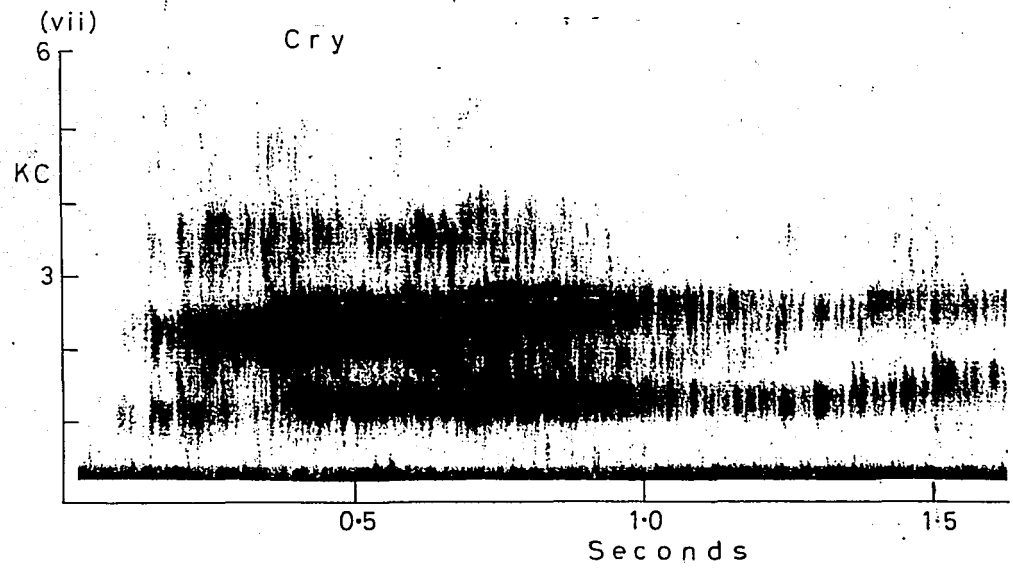

(i)
Squawk
6
3
0·5
1·0
1·5
(ii)
Screech(es)
6
KC
3
0·5
1·0
1·5
2·0
Seconds

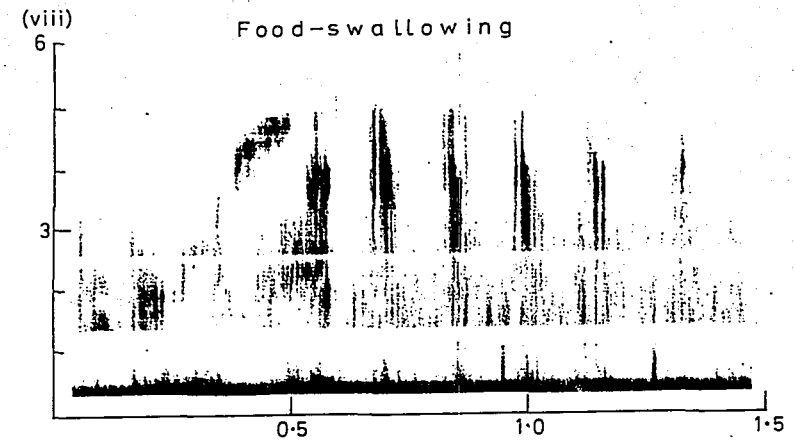

(iii)
Bark croak
6
3
0·5
1·0
1·5

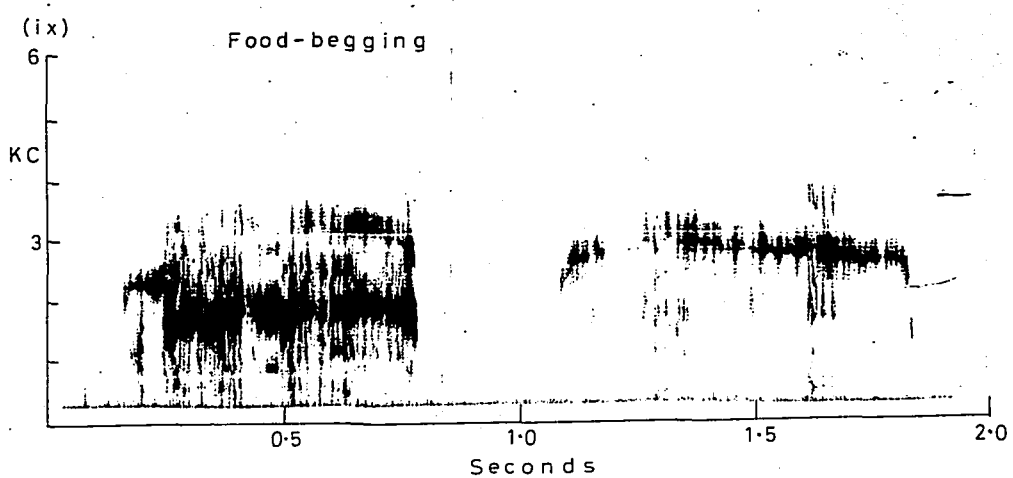

(iv)
Bark whistle
6
3
0·5
1·0
1·5


(v)
Rasp
6
KC
3
0·5
1·0
1·5
Seconds


(vi)
Yodel
6
3
0·5
1·0
1·5


(vii)
Cry
6
KC
3
0·5
1·0
1·5
Seconds


(viii)
Food-swallowing
6
3
0·5
1·0
1·5


(ix)
Food-begging
6
KC
3
0·5
1·0
1·5
2·0
Seconds