

**Arses telescopthalmus** Frilled Monarch (1) D  
Many fragments of Homoptera, family Tettigonetridae; fewer Orthoptera, family Gryllidae (crickets) and Coleoptera, family Curculionidae. (1) B: many small indeterminate insect fragments.

**Rhipidura rufiventris** Northern Wagtail (1) B  
Diptera, families Stratiomyidae and Tipulidae and Coleoptera, families Chrysomelidae and Curculionidae.

**Rhipidura atra** Black Fantail (2) F  
Mainly insect material with some indeterminate plant material and many small stones. Coleoptera species and caterpillars of unknown family present, as well as other indeterminate insect matter.

**Pitohui dichrous** Black-headed Pitohui (1) D  
Pupa of Lepidoptera, family Geometridae; Hemiptera, families Lygaeidae and Membracidae, with grass seeds.

**Megalurus timoriensis** Tawny Grassbird (1) E  
Finely mashed weevils, other insect fragments (not lymantrids or geometrids) and pine needles.

**Crateroscelis murina** Lowland Fernwren (2) F  
Many small indeterminate fragments.

**Xanthotis chrysotis** Brown Xanthotis (2) B & F  
Insects; in one, Orthoptera, family Acrididae and Dictyoptera, family Blattidae (cockroaches); in other many small indeterminate insect fragments.

**Xanthotis polygamma** Spotted Xanthotis (1) F  
Insects, mainly indeterminate; also few caterpillars.

**Meliphaga montana** White-eared Mountain Meliphaga (1) A  
Plant material thought to be ginger seeds.

**Melilestes megarrhyncha** Long-billed Honeyeater (2) A  
Spiders and other arthropod fragments present.

**Melidectes torquatus** Cinnamon-breasted Wattlebird (1) E, (2) E\*  
Pine needles in one with many larvae of Lepidoptera, family Geometridae, *Boarmia* sp, Hemiptera (Heter-

optera) fragments; in the other larvae of *Boarmia* sp, fragments of adult Coleoptera.

**Oedistoma iliophum** Grey-bellied Longbill (1) F  
Indeterminate adult insect fragments.

**Toxorhamphus poliopterus** Slaty-chinned Long-bill (1) F  
Insect fragments, including indeterminate plant bug.

**Oriolus szalayii** Brown Oriole (1) D  
Grass seeds, a caterpillar.

**Sphecotheres viridis** Figbird (1) B

Grass seeds, large spherical brown seeds and indeterminate insect material.

**Dicrurus hottentottus** Spangled Drongo (1) B  
Insects including Coleoptera, families Curculionidae and Lariidae (*Timesisteinus trivittatus*); Hemiptera.

**Cracticus cassicus** Black-headed Butcherbird (1) D  
Caterpillars of Lepidoptera (either Lymantriidae or Notodontidae) and black rough-surfaced seeds thought to be ginger.

\*After the *Lymantria* population had suddenly collapsed.

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## EFFECTS OF DROUGHT ON GREEN PYGMY-GEESSE AND COMB-CRESTED JACANAS IN NORTHERN TERRITORY

### INTRODUCTION

Lack (1966) has shown that in severe winters in Britain the Grey Heron *Ardea cinerea* decreases significantly below what appear to be optimum levels. These optimum levels may then be exceeded temporarily in following years. Bock and Lepthien (1976) found a similar decrease and recovery in Cattle Egrets *Ardeola ibis* in North America. Though the Darwin area is not subject to severe winters it is subject to droughts, which could have a similar effect on the numbers of some waterbirds.

The present paper documents changes in numbers of Green Pygmy-Geese *Nettapus pulchellus* and Comb-crested Jacanas *Irediparra gallinacea* on Fogg Dam following the particularly poor rains of the 1969-70 wet season. Comparison is made between this period and two other years, 1967 and 1971.

### ENVIRONMENT AND BREEDING

The climate of the Darwin area has been described by McAlpine (1969). A feature of the climate is the almost rainless dry season, which lasts from May to September. The monsoons generally occur in

January-February. Rainfall in the 1966-67 wet season was above average with particularly heavy rains in March. During the early part of 1970 the monsoon ended in mid-February and March and April were unusually dry. In contrast, in the following wet season heavy rain was received in early December and wet weather continued intermittently until April (Crawford 1972).

A general description of the habitats of waterbirds is given by Frith and Davies (1961a) and Story (1969). During the wet season these habitats are very extensive, covering several thousand square kilometres. By the end of the dry season they may be reduced to less than two per cent of their extent during the wet season. *I. gallinacea* and *N. pulchellus* prefer fairly deep water, which does not seem to be much reduced until about three months after the end of the wet season. It is at about this time that numbers start to rise significantly in refuges like Fogg Dam (Fig. 1). This coincides with a general increase in other species in these refuges. In the wet season most of the surface of Fogg Dam was covered

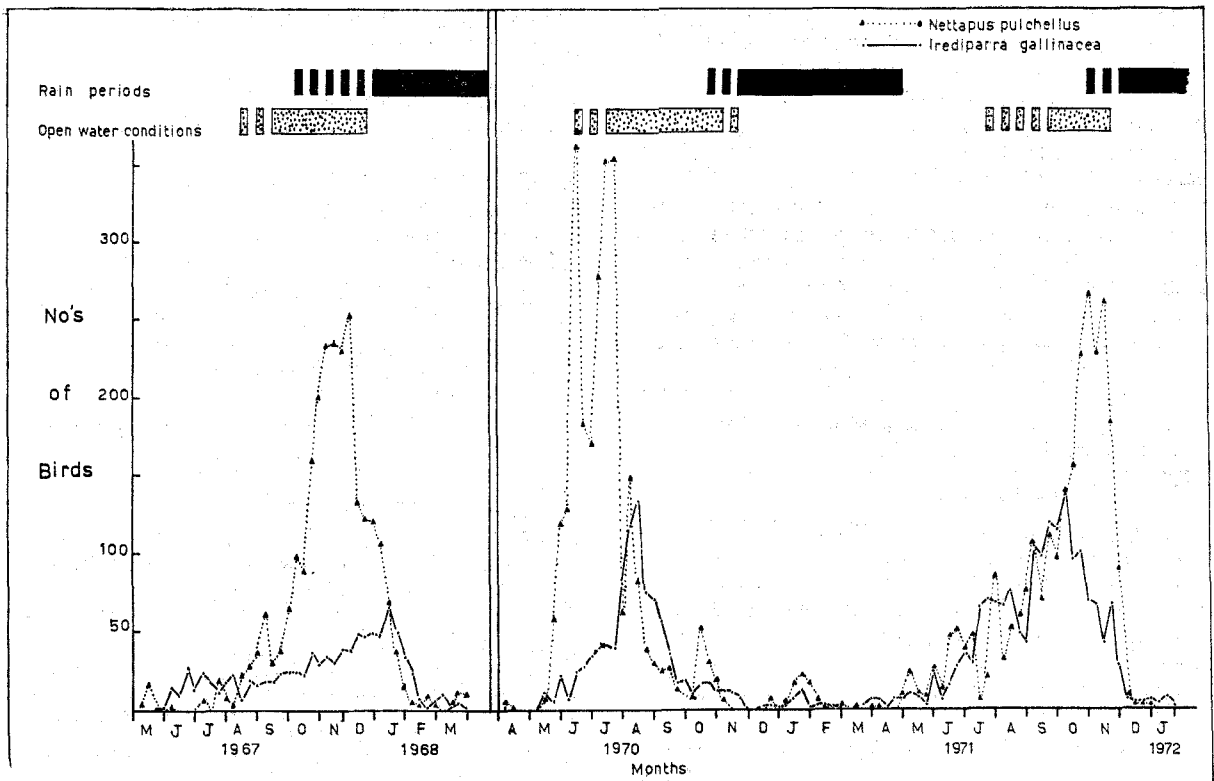


Figure 1. Seasonal fluctuations in numbers of *Nettapus pulchellus* and *Irediparra gallinacea* on Fogg Dam.

by a dense layer of water-lilies and water-fern. During the dry season, as the number and variety of birds increase, this vegetation was heavily grazed and, as evaporation occurs, the area becomes shallow muddy open-water habitat. This transition had occurred by late September and early October in 1967 and 1971. In 1970, because intense grazing started early and the level of water was at first low, transition to open muddy habitat had occurred by late July.

Both the species now considered appear to breed from about December to May (Frith and Davies 1961b; Storr 1967; Crawford 1972). The breeding areas include Fogg Dam and the deeper lagoons on the edges of the river plains as well as the seasonal lagoons scattered through the upland open-forest country (Rhodes 1944). The breeding population in the refuges is very small compared with that of the dry season.

#### RESULTS AND DISCUSSION

Figure 1 shows the results of the weekly census for 1967–68 and 1970–72, as well as indicating when rainy periods and open muddy habitat occurred. Increases in numbers are the result of incoming birds exceeding those leaving or dying. Decreases

represent the opposite. The increase due to reproduction within the census area seemed slight.

The decreases, which seemed to occur regularly at the start of each wet season, appear to represent seasonal dispersal following the rapid expansion of suitable habitat. An abnormal situation seemed to develop on Fogg Dam during the drought of 1970 when there was an early increase in the numbers of both species. This indicates that they had to rely on the refuges much earlier than in 1967 or 1971.

By July 1970 very large numbers of other species, particularly species of *Anas* and *Dendrocygna* and Magpie Geese *Anseranus semipalmata*, had moved into Fogg Dam area much earlier than in the other two years. It is not known if any of these species compete with *I. gallinacea* and *N. pulchellus* for food under severe conditions but it was certain that radical changes took place in the habitat once large numbers of birds were present. The floating vegetation was grazed down completely so that *I. gallinacea* was forced to paddle round the edges. This change in the habitat occurred in September–October in 1967 and 1971, when *I. gallinacea* was also able to feed among new grass along the water's edge, which had germinated in response to the first show-

ers of the wet season. In 1970 this species was forced off the open water by lack of floating vegetation in the middle of the dry season. There had been no rain for months and consequently no young grass about the edges. The decrease that then occurred would seem to be from a different cause from that of the early wet season. During the dry season of 1970 the population may have thoroughly overtaken its available food supply. In birds, density-dependent controls can take the form of intraspecific social interaction, which denies food (or nesting space, etc.) to the socially inferior (Carrick and Murray 1974), or predation and the distribution of food (Krebs 1971; Yoram Yom-Tov 1974). Large numbers of both species may have started to leave the refuge area at this stage but, being unable to find other habitat, perished. No dead birds were found. Their departure could have relieved the demands on the food supply, making departure of others less likely. If the data from Fogg Dam are applicable to the rest of the Darwin area, which seems likely, there could have been over ninety per cent mortality for these two species during the dry season of 1970. The general trends for other waterbirds on Fogg Dam (area A, Crawford in prep.) in July–August 1970 was for an increase or maintenance of high numbers.

Further evidence of the differences of decline between the mid-dry and early wet seasons comes from regression analyses. F tests carried out on the following regressions were highly significant:

#### *N. pulchellus*

Nos x Days: (29 Nov. 1967 to 30 Jan. 1968)

$$F = 85.19$$

Log (Nos) x Days: (27 July 1970 to 6 Oct. 1970)

$$F = 60.73$$

#### *I. gallinacea*

Nos. x Days: (8 Jan. 1968 to 13 Feb. 1968)

$$F = 44.04$$

Log (Nos) x Days: (17 Aug. 1970 to 6 Oct. 1970)

$$F = 90.34$$

$P < 0.01$  throughout

No significant F values were obtained for regressions of  $\log_e$  (Nos) x Days for the 1967–68 wet season or Nos x Days for the dry season of 1970. Data from the wet season of 1971–72 were not analysed because the rains started abruptly, which caused a rapid decrease in numbers within two or three visits. The regression analyses indicate that during the wet season of 1967–8 the decrease was linear, whereas during the dry season of 1970 it was

exponential. The level of the peak numbers of birds on Fogg Dam during the late dry season of 1971 suggested that both species had increased to such an extent in the wet season of 1970–71 that their apparent losses were restored. The numbers of *I. gallinacea* were higher than for the comparable period in 1967 (Fig. 1), which suggests there was a very much higher than normal survival of first-year birds. Evidence of this was that the frequency and numbers of young *I. gallinacea* seen during April and May 1971 was much higher than in other years. The growth of the floating vegetation was particularly prolific during the wet season of 1970–71, which suggests that good survival of young *I. gallinacea* simply reflects the excellent conditions.

Rainfall records for the Darwin Post Office show that more severe droughts than that of 1970 have occurred in the past and violent fluctuations of population are probably not uncommon.

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## FEEDING BEHAVIOUR OF A PURPLE-CROWNED LORIKEET ON FLOWERS OF EUCALYPTUS BUPRESTIUM

### INTRODUCTION

The Purple-crowned Lorikeet *Glossopsitta porphyrocephala*, a bird distributed throughout temperate and semi-arid areas of south-western and south-eastern Australia (Busby and Davies 1977), is well known for its nomadic wanderings associated with the flowering of species of *Eucalyptus* (Elliott 1916; Carter 1923; Sedgwick 1940, 1949; Serventy 1948; Ford and Stone 1957; McGill 1959; Bourke 1960; Forshaw 1969; Ford 1971; Cayley and Lendon 1973; Masters and Milhinch 1974; Dell 1977). The staple diet of Purple-crowned Lorikeets has long been assumed to be the nectar of *Eucalyptus* flowers (e.g. Gould 1865; Barrett 1949; Leach 1958; Cayley 1966; Hill 1967; Forshaw 1969; Holyoak 1973; Cayley and Lendon 1973). However, contents of stomachs examined by Cleland (1912, 1918, 1969) and by Churchill and Christensen (1970; Christensen 1971) have shown that these Lorikeets ingest the pollen of *Eucalyptus* species, as well as the nectar. Furthermore, Churchill and Christensen (1970; Christensen 1971) proposed that pollen is the principal item of diet for Purple-crowned Lorikeets when feeding on the small flowers of Karri *Eucalyptus diversicolor* and that nectar alone could not satisfy the daily energy requirements of an average-sized bird. This view, which regards nectar as, at best, a dietary supplement to pollen, is now gaining acceptance in standard texts of Australian ornithology (e.g. Serventy and Whittell 1976).

Though Churchill and Christensen (1970) presented sound evidence that Purple-crowned Lorikeets may use pollen as a major nutritional resource, the assertion that these birds could not satisfy their daily energy requirements from nectar alone when feeding on small-flowered eucalypts deserves critical scrutiny. Using data on average nectar flow and pollen production in Karri, Churchill and Christensen (1970) calculated that a fifty-gram Purple-crowned Lorikeet would have to harvest pollen from 300–500 flowers in a day to maintain basal energy metabolism and that 3,000 flowers would have to be visited to do the same using nectar as an energy source. In a twelve-hour day, this would entail harvesting pollen at the rate of one flower every 90–150 seconds, compared with harvesting nectar at the rate of one flower every fourteen seconds. Churchill and Christensen (1970) regarded the latter feeding rate as improbable and hence concluded that the lorikeets could not satisfy their basic daily energy requirements from Karri nectar alone in conditions of average flow. However, no data on feeding rates were given to support this view.

Clearly, if Purple-crowned Lorikeets can harvest nectar at a greater rate than one flower each fourteen seconds, then the energetic argument against Karri nectar being an adequate nutritional source would be questionable.

In the present article, we describe observations made at close range on a Purple-crowned Lorikeet that was feeding on Apple Mallee *Eucalyptus buprestium*, a species with small flowers approximately the same size and shape as those of Karri (Chippendale 1973). We were able to estimate the feeding rate of this bird during these observations and also to see at close quarters the precise behaviour adopted to harvest pollen and nectar.

### OBSERVATIONS

Observations were made nineteen kilometres east of Cranbrook, WA, on the northern boundary of Stirling Range National Park on 17 January 1978. There *E. buprestium* and *E. decipiens* were emergent mallees growing up to three metres high among numerous heath species. *E. buprestium* was flowering profusely on the day of observation and nectar was being harvested by large numbers of European honey-bees as well as several native hymenopterans. In addition, New Holland Honeyeaters *Phylidonyris novaehollandiae*, Western Spinebills *Acanthorhynchus superciliosus* and Brown Honeyeaters *Lichmera indistincta* were observed in the stand of *E. buprestium* but were not actually seen harvesting nectar.

The Purple-crowned Lorikeet was observed at distances of one to three metres for twenty minutes (a hide was not used), during which it visited several hundred flowers on two neighbouring *E. buprestium*. While feeding, the bird perched in dense clusters of flowers and foraged on all within reach before moving a few centimetres. The total horizontal distance moved during observation was three metres.

It appeared as though freshly opened flowers, with stamens in a tight vertical cluster round the floral cup, were selectively chosen by the bird. When feeding, the entire flower was positioned inside the beak and released one to three seconds later. Movements of the tongue, apparently in a circular sweeping motion round the floral cup, were observed on several occasions through the semi-open beak of the lorikeet. These movements would have compressed stamens between the tongue and beak and so have forced pollen out of the anthers on to the sticky surface of the tongue. At the same time, any nectar at the base of the floral cup would also have been gathered by the villous-like projections on the tip of the tongue.