

STUDIES OF WATERFOWL (ANATIDAE) IN NORTH QUEENSLAND. 5. BREEDING

By H. J. LAVERY, M.Sc.

SUMMARY

The 12 species of waterfowl that bred either frequently or occasionally in north Queensland during 1959–1969 nested almost entirely during the wet seasons, usually December–April, when suitable habitat was abundant and widespread and vegetation cover for nests and available food for young were at a maximum.

Nesting requirements and habits were generally similar for all species except the colony-nesting magpie goose (*Anseranas semipalmata* (Latham)) and black swan (*Cygnus atratus* (Latham)). Results of reproduction nevertheless were broadly similar because colonies were readily destroyed by flooding.

Reproductive activity in all species was curtailed during 1961, when there was relatively little rainfall; clutch and brood sizes were comparatively small and there was little eventual population increment. Many young birds were added to the population, mainly as a result of greater survival of young in the first broods, after the extensive wet-season flooding of 1968, when there was prolonged reproductive activity.

I. INTRODUCTION

Water-birds in north-eastern Australia breed throughout the year, with peaks of reproductive activity in late summer (February–March) and early summer (October–November) (Lavery, Seton and Bravery 1968).

During 1959–1969, investigations of the breeding and breeding seasons of waterfowl (Anatidae) were undertaken as part of a long-term study of this group of birds in north Queensland.

II. MATERIALS AND METHODS

The study areas were the Coastal and the Inland Study Areas of the Townsville Study Region (see Lavery 1966).

Waterfowl were collected by shooting in these areas at monthly intervals from January 1959 to December 1963, from August 1965 to January 1967, and from March 1968 to March 1969. Samples were taken less regularly from both study areas in the intervening times. During the periods of intensive study, when widespread field observations for breeding birds also were attempted regularly, comprehensive continuous samples of fledged birds were obtainable

for the coastal-breeding water whistling-duck (*Dendrocygna arcuata australis* Reichenbach), the inland-breeding grey teal (*Anas gibberifrons gracilis* Buller), and the widespread black duck (*Anas superciliosa rogersi* Mathews). Extensive breeding season samples were made also of the colony-nesting magpie goose (*Anseranas semipalmata* (Latham)) and black swan (*Cygnus atratus* (Latham)). Samples of other species were taken whenever possible, providing supplementary data particularly on the coastal-breeding grass whistling-duck (*Dendrocygna eytoni* (Eyton)), green pygmy goose (*Nettapus pulchellus* Gould) and Australian pygmy goose (*Nettapus coromandelianus albipennis* Gould).

The breeding season, i.e. when eggs were present in nests, was determined by field observations of clutches and broods and of behaviour of adult birds, and by the appearance of the gonads of sampled birds. Spermatozoa in tubules of testes indicated breeding in male birds; enlarged size, darker colour and condition of follicles, and presence of eggs, were taken as evidence of breeding activities in females.

Magpie geese, water whistling-ducks, black swans and black ducks were secured as eggs and hatched and reared under covered aviary conditions at the Department of Primary Industries' Animal Health Station, Townsville. Criteria of growth used in these birds were increases in weight and in wing-length (from proximal end of carpus to tip of longest primary feather of closed wing). Results were related to the occurrence of the young age classes of these species in the field.

Gizzard contents of all birds were examined to provide data on foods.

Estimates of the availability of the principal food of young birds was based on monthly measurements during July 1962 to August 1963, using 1 sq yd quadrats every 5 yd for 30 yd along four random radial traverses at "Ooononba swamp", and every 5 yd for 100 yd along three random traverses from the middle of "Ooononba lagoon", Townsville. Cover for dry-land nests provided by vegetation also was estimated at these two nesting localities at the same time using point quadrats, i.e. a 6 mm stainless-steel rod marked at 1 ft above ground level, every 18 in. for 100 yd along four random radial traverses.

Rainfall in the Study Region for the periods of intensive sampling are given in Figure 1. The years 1959, 1960, 1962, 1963, 1965, and 1966 are here termed the years of average rainfall, i.e. when 10–35 in. of rain fell in any one wet season month; 1961 was a year of drought, and 1968 was a year of heavy rainfall and subsequent widespread flooding.

III. RESULTS

(a) Magpie Goose

Breeding condition.—The incidences of birds in breeding condition during the wet seasons and the dry seasons of 1959–1967 are shown in Table 1.

Clutch and brood sizes, and growth.—Nests were mostly mounds of either bulkuru sedge (*Eleocharis dulcis* (Burm. f.) Trin.), coastal club rush (*Scirpus littoralis* Schrad.) or *Monochoria cyanea* F. Muell. built in water. Colonies of as many as 40 nests were located in the Coastal Study Area. Mean clutch size in 40 completed nests was 7.42 ± 0.45 eggs, with two females sometimes laying in the same nest. Mean brood sizes were as shown in Table 2. Growth of 20 magpie geese (11 males, 9 females) was as illustrated in Figure 2.

TABLE 1

INCIDENCE OF BREEDING CONDITION IN SAMPLES OF ADULTS OF SOME WATERFOWL SPECIES FROM THE COASTAL STUDY AREA, NORTH QUEENSLAND, IN THE WET SEASONS AND THE DRY SEASONS, 1959-1967

Species	Incidence of Birds in Breeding Condition	
	Nov.-Apr.	May-Oct.
Magpie goose	15 of 47	1 of 16
Black swan	13 ,, 27	7 ,, 28
Grass whistling-duck	61 ,, 155	3 ,, 59
Green pygmy goose	7 ,, 37	Nil ,, 8
Australian pygmy goose	7 ,, 24	Nil ,, 48

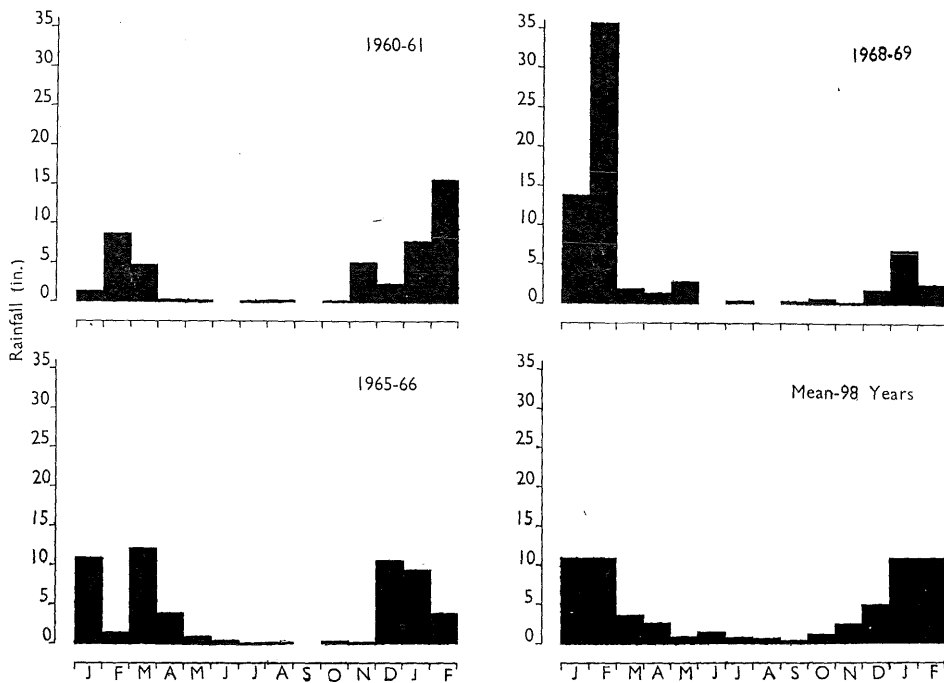


Fig. 1.—Monthly rainfall recorded at Garbutt, Townsville, Q.

TABLE 2

MEAN SIZES OF BROODS OF MAGPIE GEESE, WATER WHISTLING-DUCKS AND BLACK SWANS OBSERVED IN THE COASTAL STUDY AREA, AND OF BLACK DUCKS OBSERVED IN THE COASTAL AND THE INLAND STUDY AREAS, NORTH QUEENSLAND, 1959-1963

Species	Age Class (age in weeks)	No. of Broods Examined	Mean Brood Size (\pm S.E.)	Significant Differences
Magpie goose	I. Downy (0-4)	3	8.67 \pm 1.669	N.S.
	II. Downy-flapper (5-8)	1	6.00 \pm 2.891	
	III. Flapper (9-11)	11	5.82 \pm 0.872	
Water whistling-duck	I. Downy (0-6)	26	10.65 \pm 0.655	I > II*, III* II > III**
	II. Downy-flapper (7-10)	31	7.68 \pm 0.600	
	III. Flapper (11-14)	14	4.64 \pm 0.892	
Black swan	I. Downy (0-12)	40	4.38 \pm 0.241	N.S.
	II. Downy-flapper (13-20)	11	4.09 \pm 0.460	
	III. Flapper (21-24)	Nil observed		
Black duck	I. Downy (0-6)	21	6.95 \pm 0.518	I > II*, III*
	II. Downy-flapper (7-10)	11	4.09 \pm 0.716	
	III. Flapper (11-14)	5	2.00 \pm 1.062	

* 1%

** 5%

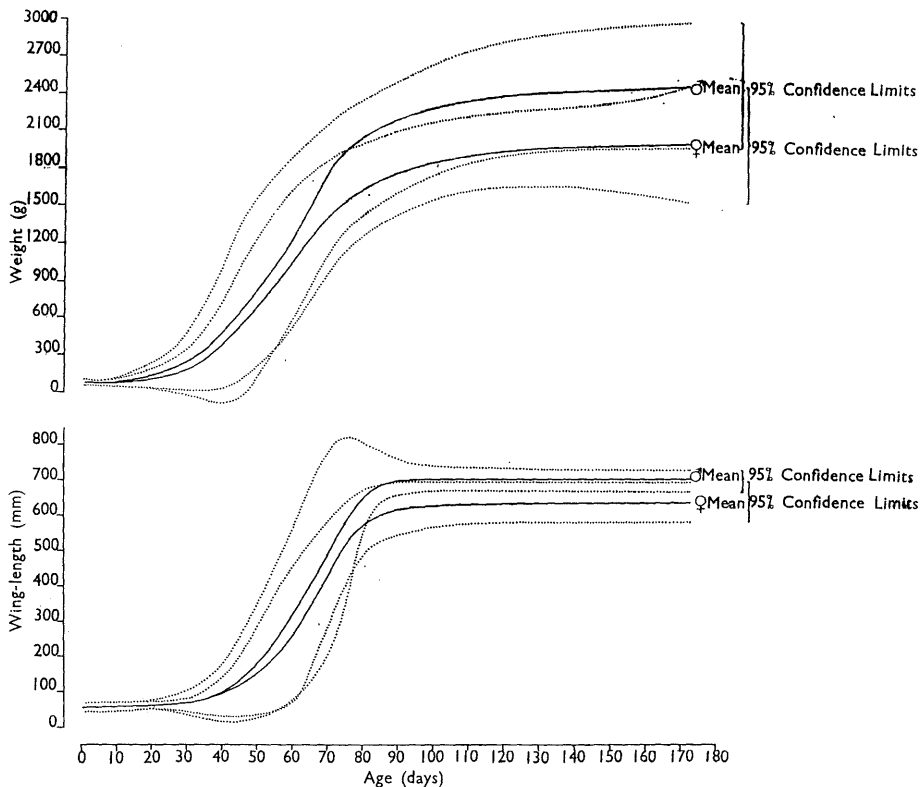


Fig. 2.—Growth of young magpie geese: weight and mean length of wings plotted against age. Dotted lines show 95% confidence limits for the means. Mean period of fledging, 76 days.

Breeding seasons.—Colonies were susceptible to flooding even during years of average rainfall; thus on February 25, 1962, following 4 in. of rain overnight, 20 of 32 nests were abandoned and the remainder, all floating, were saturated and eventually these were abandoned also.

(b) Water Whistling-duck

Breeding condition.—Figure 3 illustrates seasonal distribution of birds in breeding condition in the Coastal Study Area during the years of average rainfall.

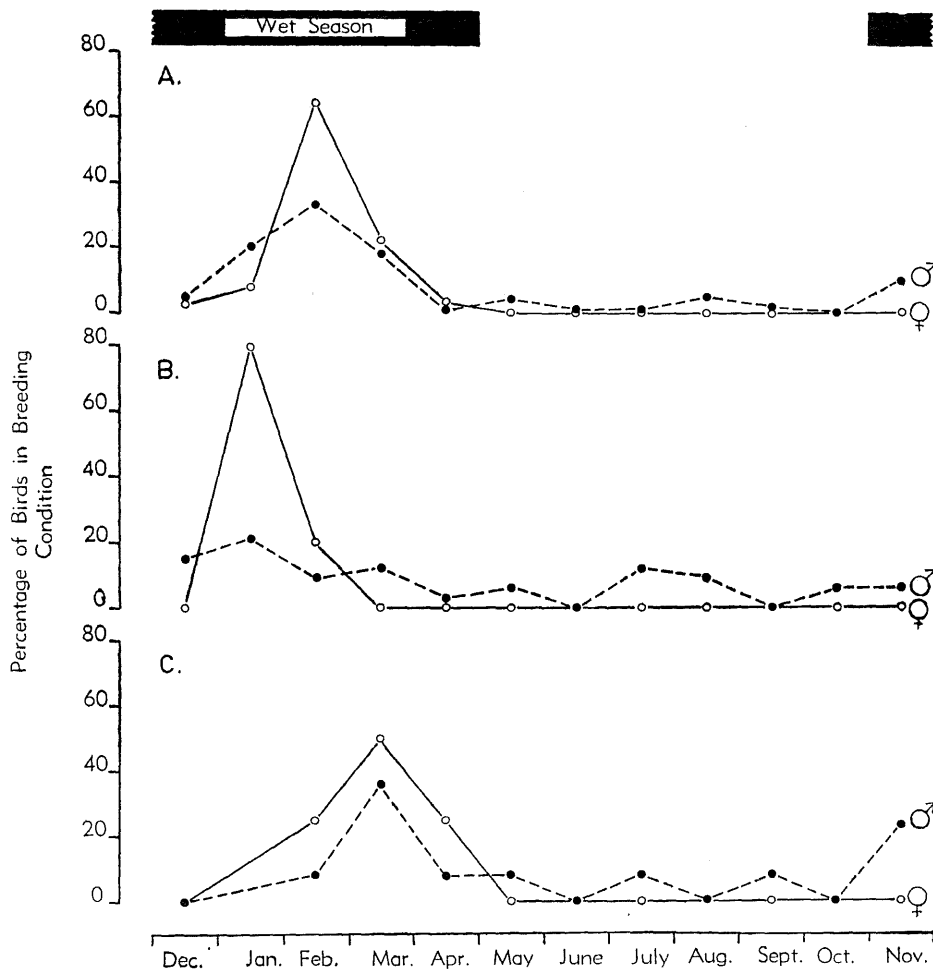


Fig. 3.—Seasonal distributions of (A) 119 birds in breeding condition from a sample of 360 adult water whistling-ducks collected in the Coastal Study Area; (B) 38 birds in breeding condition from a sample of 243 adult black ducks collected in the Coastal and the Inland Study Areas; and (C) 17 birds in breeding condition from a sample of 217 adult grey teal collected in the Inland Study Area, north Queensland, 1959, 1960, 1962, 1963, 1965 and 1966.

Clutch and brood sizes, and growth.—Isolated simple ground-nests were recorded mostly at the bases of clumps of blue grass (*Bothriochloa* species). One clutch contained 14 eggs, another 10, and five each contained 12. Mean sizes of broods observed in the Coastal Study Area during 1959–1963 are shown in Table 2. The mean duration of fledging in two birds reared to flight was 98 days.

Foods of young.—The diet of young birds in the Coastal Study Area during 1959–1963 is illustrated in Table 3.

TABLE 3

FOODS OF YOUNG OF SOME WATERFOWL SPECIES COLLECTED IN THE COASTAL AND INLAND STUDY AREAS, NORTH QUEENSLAND, 1959–1969

Species and Source of Food	Volume of Food Eaten by Each Age Class (%)		
	Downy	Downy-flapper	Flapper
<i>Water whistling-duck</i>			
Plants (seeds)			
From temporary wetlands			
e.g. <i>Echinochloa coloum</i> (L.) Link	64.1	30.2	27.5
From seasonal wetlands			
e.g. <i>Polygonum lapathifolium</i> L.	33.5	57.5	61.0
From permanent wetlands			
e.g. <i>Nymphaea</i> species	Nil	5.5	10.6
Animals (insects)	2.4	6.8	0.9
No. of gizzards examined	44	18	10
<i>Black swan</i>			
Plants			
From seasonal wetlands (seeds)			
e.g. <i>Scirpus littoralis</i> Schrad.	72.6	58.7	—
From permanent wetlands (seeds and submerged aquatic material)			
e.g. <i>Chara</i> species	27.4	40.7	—
Animals (insects)	Nil	0.6	—
No. of gizzards examined	14	13	Nil
<i>Black duck</i>			
Plants (seeds)			
From temporary wetlands			
e.g. <i>Brachiaria</i> species	15.6	8.1	0.3
From seasonal wetlands			
e.g. <i>Fimbristylis</i> species	64.4	29.0	14.2
From permanent wetlands			
e.g. <i>Nymphaea</i> species	11.5	0.2	28.8
Animals (insects, spiders, molluscs)	8.5	62.7	56.7
No. of gizzards examined	31	12	6
<i>Grey teal</i>			
Plants (seeds)			
From temporary wetlands			
e.g. <i>Pseudoraphis spinescens</i> (R.Br.) Vickery ..	0.7	39.2	Nil
From seasonal wetlands			
e.g. <i>Monochoria cyanea</i> F. Muell.	97.0	25.1	98.6
From permanent wetlands			
e.g. <i>Nymphaea</i> species	2.1	Nil	1.4
Animals (insects)	0.2	35.7	Nil
No. of gizzards examined	16	5	13

Breeding seasons.—Figure 4 shows the relationship of breeding season, i.e. occurrence of most birds in breeding condition and of clutches and broods, to rainfall, water level in the wetland habitat, vegetation cover for nests, and duckling food availability at two nesting localities at Townsville (Coastal Study Area) in 1962-1963.

Tables 4 and 5 illustrate the effect of drought conditions during 1961 on extent of reproductive activity in the Coastal Study Area.

TABLE 4

SEASONAL DISTRIBUTION OF WATER WHISTLING-DUCKS IN BREEDING CONDITION COLLECTED IN THE COASTAL STUDY AREA, AND BLACK DUCKS IN BREEDING CONDITION COLLECTED IN THE COASTAL AND THE INLAND STUDY AREAS, NORTH QUEENSLAND, JANUARY-DECEMBER 1961

Period	Water Whistling-ducks in Breeding Condition		Black Ducks in Breeding Condition	
	Estimated* (%)	Observed 1961 (%)	Estimated* (%)	Observed 1961 (%)
Jan.-Feb.	71	17	83	25
Mar.-Apr.	35	27	26	56
May-June	18	Nil	10	Nil
July-Aug.	11	Nil	9	Nil
Sept.-Oct.	7	Nil	4	Nil
Nov.-Dec.	13	19	13	Nil

* Based on data from years of average rainfall.

TABLE 5

DURATION OF BREEDING SEASONS OF THE BLACK DUCK AND THE WATER WHISTLING-DUCK IN THE COASTAL STUDY AREA, NORTH QUEENSLAND, 1961-1963

Breeding Season	Estimated Date of First Egg		Estimated Date of Last Egg	
	Black Duck	Water Whistling-duck	Black Duck	Water Whistling-duck
1960-1961	Jan. 2	Jan. 4	Feb. 14	Feb. 17
1961-1962	Dec. 13	Dec. 10	Apr. 3	Mar. 1
1962-1963	Jan. 3	Dec. 21	Mar. 22	Apr. 1

(c) Black Swan

Breeding condition.—The incidences of birds in breeding condition during the wet seasons and dry seasons, 1959-1967, are given in Table 1.

Clutch and brood sizes, and growth.—Nests were mostly mounds of coastal club rush situated on dry ground; colonies occurred particularly on islands in fresh-water and brackish-water swamps. Mean clutch sizes of 187 completed nests were as shown in Table 6. Mean brood sizes also from the Coastal Study Area are given in Table 2. Mean duration of flightlessness in two young was 170 days.

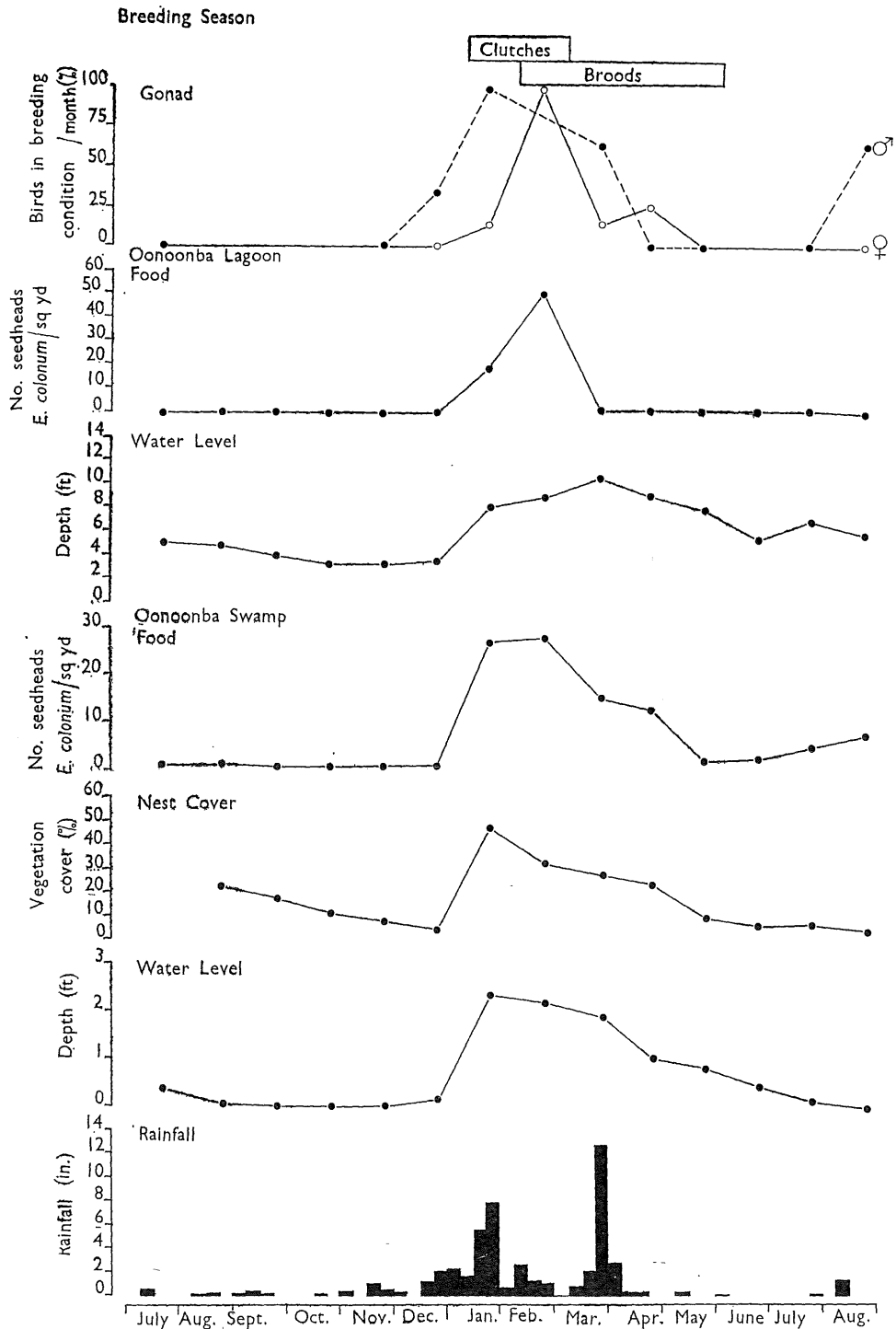


Fig. 4.—Breeding condition and breeding season of water whistling-ducks in relation to rainfall, water level, availability of vegetation cover for nests and of food for the young, at Townsville (Coastal Study Area), north Queensland, 1962-1963.

TABLE 6
MEAN SIZES OF CLUTCHES OF BLACK SWANS OBSERVED
IN THE COASTAL STUDY AREA, NORTH QUEENSLAND,
1961-1963

Year	No. of Clutches Examined	Mean Clutch Size
1961	24	3.50 ± 0.380
1962	58	5.12 ± 0.245
1963	101	4.25 ± 0.185
Significant differences (5%)	1962, 1963 > 1961	

Foods of young.—The diet of cygnets is shown in Table 3.

Breeding seasons.—Mean clutch size in 1961 compared with sizes in years of higher (average) rainfall is illustrated in Table 6. On May 23, 1961, there was no water remaining at the major colony at "Caley Valley", near Bowen (Coastal Study Area); all nests were empty, two adult birds were found dead near nests, and all the young presumably had perished by this time because none was present at the small area of adjacent habitat to which flightless young might have moved.

(d) Black Duck

Breeding condition.—The seasonal distribution of birds in breeding condition in both study areas during the years of average rainfall is shown in Figure 3.

Clutch and brood sizes, and growth.—Nests were isolated and of simple construction on the ground. Only one with a completed clutch, of eight eggs, was located. Mean sizes of broods observed in both study areas during 1959-1963 are given in Table 2. Mean duration of fledging in three birds was 100 days.

Foods of young.—The diet of young birds in both study areas during 1959-1963 is shown in Table 3.

Breeding seasons.—The effect of the 1961 drought on the extent of breeding is illustrated in Tables 4 and 5; in Table 5 the durations of breeding seasons of black duck in the Coastal Study Area during 1961-1963 are compared with those of water whistling-duck in the same years.

(e) Grey Teal

Breeding condition.—Figure 3 shows seasonal distribution of birds in breeding condition in the Inland Study Area during the years of average rainfall.

Foods of young.—The diet of young birds in the Inland Study Area during 1962-1969 is given in Table 3.

Breeding seasons.—Of 91 adult birds collected during the 1961 drought, only four males were in breeding condition and two of these were late in the year; no clutch or brood was seen. The effect of the 1968 floods on the extent of breeding is illustrated in Table 7. Recruitment of young to the population during 1968 compared with years of average rainfall and of drought is shown in Table 8.

TABLE 7

SEASONAL DISTRIBUTION OF GREY TEAL IN BREEDING CONDITION COLLECTED IN THE INLAND STUDY AREA, NORTH QUEENSLAND, MARCH 1968-FEBRUARY 1969

Period	Grey Teal in Breeding Condition	
	Expected* (%)	Observed 1968-1969 (%)
Mar.-Apr.	69	62
May-June	11	39
July-Aug.	3	75
Sept.-Oct.	1	64
Nov.-Dec.	4	11
Jan.-Feb.	67	29

* Based on data from years of average rainfall.

TABLE 8

ANNUAL INCREMENT IN GREY TEAL POPULATIONS IN THE INLAND STUDY AREA, NORTH QUEENSLAND, 1968, COMPARED WITH 1961

Period	Young Birds in Samples (%)		
	Expected*	Observed 1961	Observed 1968
Mar.-Apr.	43	7	57
May-June	63	29	70
July-Aug.	27	15	82

* Based on data from years of average rainfall.

Table 9 gives departures of grey teal from drought-refuge areas, such as in the Coastal Study Area, to remote breeding grounds, such as in the Inland Study Area, in relation to rainfall at the former area.

TABLE 9

DEPARTURES OF GREY TEAL FROM DROUGHT-REFUGE, CLEVELAND BAY, RELATIVE TO RAINFALL, COASTAL STUDY AREA, NORTH QUEENSLAND, 1958-1969

Breeding Season	Wet-season Rainfall Prior to Period of Departure (in.)		Additional Rainfall at Period of Departure (in.)	
	Total	Largest Single Fall	Total	Largest Single Fall
1958-1959	1	..	7	2
1959-1960	3	2	7	4
1960-1961	2	..	5	1
1961-1962	1	..	5	2
1962-1963	3	1	2	2
1966-1967	6	2	3	3
1968-1969	5	3	8	3

(f) Other Species

Breeding condition.—Table 1 gives the incidences of grass whistling-ducks, green pygmy geese and Australian pygmy geese in breeding condition in the Coastal Study Area during the wet and the dry seasons of 1959–1967.

Other species with individuals in breeding condition were the radjah shelduck (*Tadorna radjah rufitergum* Hartert) in the Coastal Study Area, white-eyed duck (*Aythya australis* (Eyton)) in the Coastal and the Inland Study Areas, and pink-eared duck (*Malacorhynchus membranaceus* (Latham)) and maned wood duck (*Chenonetta jubata* (Latham)) in the Inland Study Area; all of these birds were collected during wet-season months.

Breeding seasons.—The effects of drought and of flooding on the breeding seasons of these species also were respectively to curtail reproduction during the poor conditions following relatively little rainfall and to extend the duration of breeding during heavy rains. Thus of grass whistling-ducks, for example, only a few broods were observed until May 1961, while downy ducklings were seen frequently until November 1968.

IV. DISCUSSION

In the course of a year, individuals of all waterfowl species in both the Coastal and the Inland Study Areas of north Queensland were in breeding condition predominantly during the months of higher rainfall, i.e. November–April (Figures 3 and 4, Tables 1, 4 and 7). Otherwise, only a few birds, mostly males, had gonads in breeding state and these birds could be grouped as follows: (i) individuals taken immediately prior to, and after, the usual wet-season months, e.g. of grass whistling-duck and black swan respectively; (ii) individuals taken following localized unseasonal rain, e.g. of magpie goose and water whistling-duck collected at Townsville and Woodstock (Coastal Study Area) after heavy rain in August 1963; and (iii) individuals taken during July–September, e.g. of black duck. No female in this last group was found to be reproductively active and the birds may represent populations from southern Australia.

Timing of commencement of nesting was the same in many species (see e.g. Table 5). The initiation of breeding condition is of particular interest in grey teal, where breeding grounds are separated in type and by considerable distances from drought refuges. At the latter, water levels changed less from seasonal flooding than from daily tides; at least as much food was available after departure of the birds as before; time of year for departure varied; and the area was not subjected to wet-season weather conditions such as large wave action that might cause birds to leave. Eventual departure was related to rainfall in that birds always left with a heavy fall of some 2 in. subsequent upon some 6 in. of general wet-season rain (Table 9). The gonads of some males were in breeding condition before departure and before rain had produced noticeable changes in freshwater habitat. Birds in captivity nearby responded also to these rains, to the extent of producing eggs. Preliminary data show that males respond reproductively first, females becoming active during the return to the breeding grounds.

Nests of all species were of relatively simple construction and occupied only a small part of the widespread habitat of the wet season. Only the slower-maturing magpie goose and black swan differed markedly in breeding habits from the other waterfowl in that these birds nested in colonies; the nests of these larger birds

also were more solidly built and hence appeared later when vegetation was more substantial. Wet-season rainfall provided almost the only available vegetation cover for dry-land nests in the course of a year (Figure 4).

Brood sizes diminished with age; those of the colony-nesting species were relatively more successful than those of the species with isolated nests (Table 2), but many more of the former group were completely destroyed by flooding even during years of average rainfall. Marking of broods was impracticable; field observations indicated that complete losses of broods were otherwise similar in extent for all species, varying with years.

Wet-season rainfall provided the maximum amount of food annually available for young (Figure 4). This peak was about 1 month after the peak of vegetation cover for nests, i.e. the approximate incubation period for all non-vagrant species (see Frith 1967). The principal food of young birds was seed material that required some time to develop and mature after the initial wet-season rains; insects were eaten later as the ducklings moved to open water and became adept collectors (Table 3).

There were considerable variations in the rates of growth within the species even under constant cage conditions (see e.g. Figure 2). The duration of flightlessness in the young may have been extended in captivity. Nevertheless, growth of young regardless of the size of the species was similar except in vagrant species, e.g. black swan, where fledging took almost twice as long. Northern coastal and inland species move soon after the breeding season because of evaporation of this habitat (Lavery 1970).

During years of drought, as in 1961, reproduction was minimal and soon ceased, and the recruitment of young to the population was small (Tables 4, 5, 6 and 8); at Townsville, a rainfall pattern as in 1961 occurs approximately once in 10 years. During years of flooding as in 1968, occurring about once in 6 years, the period of reproductive activity was prolonged and the increment was much larger than usual (Tables 7 and 8). Some birds nested for the first time late in the year and others re-nested; the consequent contribution of young to the population by these birds was negligible and hence the most successful annual reproduction resulted from greater survival of larger clutches and broods rather than multiple breeding.

V. ACKNOWLEDGEMENT

The Botany Section of the Department of Primary Industries identified the reference collection of plants from which all identifications in this study were made.

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(Received for publication October 2, 1970)

The author is an officer of the Entomology Branch, Queensland Department of Primary Industries, and is stationed at Animal Health Station, Oonoonba, Q.