QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
FAUNA CONSERVATION BRANCH BULLETIN No. 6

STUDIES OF WATERFOWL (ANATIDAE) IN NORTH QUEENSLAND

9. GREY TEAL (ANAS GIBBERIFRONS GRACILIS BULLER) AT SALTWATER HABITAT

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SUMMARY

During 1959-1969, grey teal (*Anas gibberifrons gracilis* Buller) utilized saltwater habitat in north Queensland mainly for feeding purposes during the frequent prolonged periods of low rainfall.

The diet of these non-breeding predominantly adult birds changed seasonally, according to availability of foods, from brackish-water material (mostly plant seeds) to marine organisms (mainly molluscs). This change was effected by birds moving down rivers through marginal saltpans to confluent estuary tidal flats and eventually to open bays. Under these circumstances there was an abundant suitable dry season food supply, and birds remained in good condition.

The birds stayed close to freshwaters for drinking purposes.

I. INTRODUCTION

Grey teal (*Anas gibberifrons gracilis* Buller) in north Queensland are usually resident populations moving from inland shallow-water breeding grounds to customary coastal saltwater localities during frequent prolonged periods of relatively low rainfall (Lavery 1970).

The habits of birds at the saltwater habitat are described in this paper.

II. MATERIALS AND METHODS

Data on sex, breeding condition and food habits of grey teal collected by shooting during 1959–1969 were obtained as described elsewhere (Lavery 1972); the study areas designated Charters Towers, Ross River Plains, Cleveland Bay and Lake Buchanan in that paper were involved. Flocks of some 900 birds were recorded occasionally in the Cleveland Bay Study Area; because of the inaccessibility of some habitat, no attempt was made to count numbers accurately.

Thirty-seven different behavioural actions (after Thorpe 1951) were seen amongst 2,257 actions by individual grey teal during 25 hours of observation at saltwaters. These actions, interrelated as action patterns after the method described by Davies (1963), were placed in broad categories of behaviour (after Johnsgard (1965) and McKinney (1965)). Accordingly, pooling of the single actions of individuals on every fifth minute of observation throughout the day provided data on flock behaviour.

Availability in the field of the two marine mollusc species that constituted the main diet at saltwaters was measured as follows. Samples were collected using a flat 0·25 m x 0·25 m x 3 cm metal tray slid into the substrate at the

water's edge at different places at 12 localities spaced throughout the Cleveland Bay Study Area. For data on tidal distribution, six samples were taken randomly from each zone (below mean low water spring tide (< MLWS), mean low water spring tide to mean low water neap tide (MLWS-MLWN), mean low water neap tide to mean sea level (MLWN-MSL), mean sea level to mean high water neap tide (MSL-MHWN), and above mean high water neap tide (> MHWN)) along each of four transects throughout the area. For seasonal distribution, six samples were taken from < MLWS at an estuary transect and from MLWS-MLWN at an open bay transect each month from September 1968 to March 1969. For local geographical distribution, six samples were taken from the main zones and in the principal seasons of occurrence of each species at each locality during 1968–1969. Samples were sieved and all food species present were weighed wet and counted using subsamples of 100 individuals of each species.

Monthly samples of the principal ultimate food source were measured by mean weight and by mean length of the longitudinal axis of 100 shells, and analysed for nutritive values by standard bomb calorimeter and Kjeldahl procedures. These values were compared with those from energy and nitrogen balance tests of laying pellets on which captive birds were maintained. Crude minimum quantities of the ultimate marine diet required for maintenance of grey teal thus were calculated by the following formulae:

$$V = (q_1 \times c_1) - (q_2 \times c_2) \quad \ldots\ldots\ldots \quad (1),$$

where V = calorific value of food used daily to maintain 100 g body-weight of bird
q_1 and q_2 = mean daily weights of material ingested and defaecated respectively per 100 g body-weight of bird,
and c_1 and c_2 = mean calorific values of material ingested and defaecated respectively per 100 g body-weight of bird;

$$n = \frac{V}{v} \times \frac{100}{m} \quad \ldots\ldots\ldots\ldots\ldots \quad (2),$$

where n = number of shells required daily for maintenance of 100 g body-weight of bird in one month,
v = calorific value of shells in that month,
and m = mean weight of 100 shells in that month;

$$\text{and } Q_1 = n \times \frac{W_1}{100} \quad \ldots\ldots\ldots\ldots\ldots \quad (3),$$

$$\text{and } Q_2 = n = \frac{W_2}{100} \quad \ldots\ldots\ldots\ldots \quad (4),$$

where Q_1 and Q_2 = numbers of shells required for maintenance of adult male and female birds respectively,
W_1 and W_2 = average weight of adult male and female birds respectively.

Minimum area—by 3 cm in depth—providing daily a sufficient number of shells for maintenance of an adult pair during one month was calculated as follows

$$A = \frac{Q_1 + Q_2}{16 \times s} \quad \ldots\ldots\ldots\ldots \quad (5),$$

where A = area in square metres,
s = mean number of shells in sample tray.

The condition of all birds collected was determined by weight and by allocation to individuals of a fat class ranging from I (i.e. no fat), to V (i.e. extremely fat) after the method of McCabe (1943).

III. RESULTS

Occurrence.—Saltwater habitat was used by grey teal during the drier months of each year, the extent of use coinciding with the timing and quantity of annual rainfall, particularly in adjacent hinterland areas. In 1968, when flooding

occurred in north Queensland, birds appeared much later than in the drought year 1961; in the small late wet season of 1968-1969, grey teal departed much later and returned much sooner than in the average wet season of 1961-1962. During years of later arrival, i.e. after more extended or extremely heavy wet season rainfall, open season shooting caused unseasonal temporary use of these saline areas.

Social organization.—Sex and age compositions in grey teal flocks in Cleveland Bay Study Area during 1959–1969 are given in Tables 1 and 2 respectively and compositions for all birds in this area and the area and the adjacent Ross River Plains Study Area in 1965 are given in Table 3.

TABLE 1

SEX COMPOSITIONS OF SAMPLES FROM 32 FLOCKS OF GREY TEAL COLLECTED IN CLEVELAND BAY STUDY AREA, Q., 1959–1969

Sex Present in Sample	No. of Times Encountered
Males and females	23
Males only	9
Females only	Nil

TABLE 2

AGE COMPOSITIONS OF SAMPLES FROM 60 FLOCKS OF GREY TEAL COLLECTED IN NORTH QUEENSLAND, 1959–1969

Study Area	No. of Flocks Sampled	No. of Times Age Class Encountered		
		Adults and Immatures	Adults only	Immatures only
Ross River Plains ..	28	17	10	1
Cleveland Bay ..	32	12	20	Nil

TABLE 3

COMPARISONS OF SEX AND AGE COMPOSITIONS OF GREY TEAL COLLECTED AT SALINE AND ADJACENT FRESHWATER HABITAT IN NORTH QUEENSLAND, 1959–1969

Study Area and Period	Sex			Age		
	No. of Males	No. of Females	Composition (Males : Females)	No. of Adults	No. of Immatures	Composition (Adults : Immatures)
1959–1969 Cleveland Bay .	124	77	62% males	163	29	85% adults
1965 Ross River Plains	18	18	1 : 1	25	11	2·3 : 1
Cleveland Bay ..	44	37	1·2 : 1	65	16	4·1 : 1

All birds were capable of flight and were in non-breeding condition except for some males exhibiting spermatogenetic development of gonads following early wet season rainfall immediately prior to seasonal departure of all birds from saltwaters.

Flock behaviour.—The behaviour of grey teal at non-tidal saltwater habitat (Lake Buchanan) is illustrated in Figure 1; individual variation about this mean was considerable. At tidal areas, the two daily periods of feeding corresponded with low tides, while at other times birds retreated to a relatively few roosting grounds.

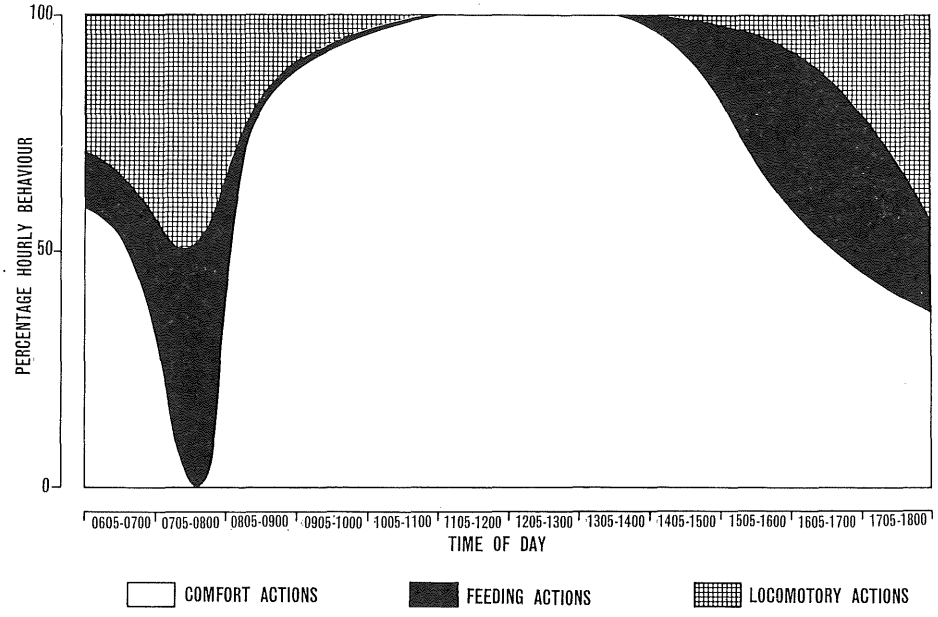

Fig. 1.—Behaviour of grey teal at non-tidal saltwater habitat, Lake Buchanan Study Area, Q.

Birds fed at the water's edge in estuarine and marine localities; unlike many local wading birds, especially Charadriiformes, grey teal did not run up and down the beach with movement of waves, which was small in Cleveland Bay Study Area. Birds moved out to sea when disturbed, and rafts of many hundreds were encountered occasionally, even in rough seas, swimming and floating up to 10 miles from shore.

Regular attention to other grey teal, and frequent movement in relation to these, indicated that a spatial relationship was maintained; some sexual/agonistic actions, perhaps sex call, could have occurred from time to time but were not observed.

Diet.—The diet during 1959-1961 of grey teal collected respectively at freshwater habitat adjacent to saltwaters and at the saline habitat is shown in Table 4.

TABLE 4

DIET OF 149 GREY TEAL COLLECTED IN NORTH QUEENSLAND, 1959–1961

Food (% volume)	Ross River Plains Study Area	Cleveland Bay Study Area	
		Ross River Estuary	Cleveland Bay
Seeds of freshwater plants	72	36	1
Freshwater animals	6	35	Nil
Seeds of brackish-water plants	22	Nil	Nil
Sewage effluents (plant seeds)	Nil	Nil	33
Marine animals	Nil	28	38
Necklace neritina	Nil	19	23
Elongate little wedge shell	Nil	1	12
Indet.*	Nil	1	28
No. of gizzards examined	107	26	16

* Probably marine animals.

The foods eaten by grey teal depended on period of arrival at saltwater habitat. In years of early arrival, birds usually first consumed seeds of coastal club rush (*Scirpus littoralis* Schrad.), widgeon grass (*Ruppia maritima* L.), bushy pondweed (*Najas graminea* Del.), alga (*Chara* sp.) and other brackish-water plants then abundant (Table 4). For example, coastal club rush is distributed widely in brackish-waters in tropical and temperate regions of Australia (Bailey 1902); the species seeded in north Queensland during 1959-1969 from April (most) to October (least).

Subsequently the birds, including later arrivals at coastal areas, inhabited localities increasingly saline and more distant from freshwaters. The commonest marine foods consumed in all years 1959-1969 were the necklace neritina (*Pictoneritina oulanensis* Lesson) and the elongate little wedge shell (*Amphidesma angusta* (Reeve)), respectively eaten early and late in each dry season (Table 5). There were smaller quantities and a shorter period of consumption of saltwater foods in the flood year 1968 compared with the drought year 1961 (Figure 2).

TABLE 5

SEASONAL OCCURRENCES OF MAJOR MARINE FOODS IN GIZZARDS OF 46 GREY TEAL COLLECTED IN CLEVELAND BAY STUDY AREA, Q., 1959–1969

Period	No. of Gizzards Examined	No. of Gizzards Containing Food Species	
		Necklace Neritina	Elongate Little Wedge Shell
May–September	23	16	7
October–December	23	4	19

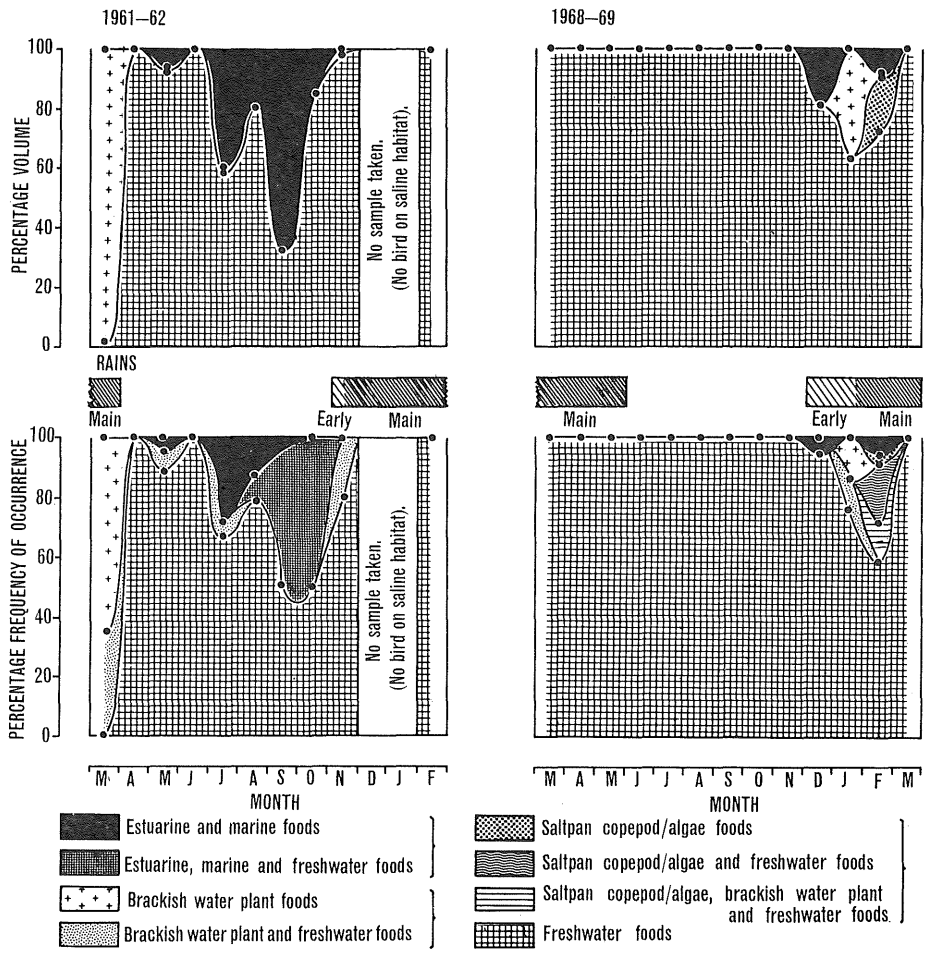

Fig. 2.—Seasonal distribution of saltwater foods in the diet of grey teal collected in north Queensland, 1961–1962 and 1968–1969.

In those poor wet seasons when birds still occurred at saltwaters, annual spring tide flooding for several weeks of adjacent saltpans provided large amounts of copepods (*Harpactacoida*) and blue-green algae (*Microcoleus ?chthonoplastes* Thuret ex Gomont) that were exploited as foods (Figure 2). Thereafter, sufficient freshwater plant material usually seeded to provide food for the birds, and estuarine and marine foods also became available at appropriate tides (Tables 4 and 5, Figures 2, 3 and 4).

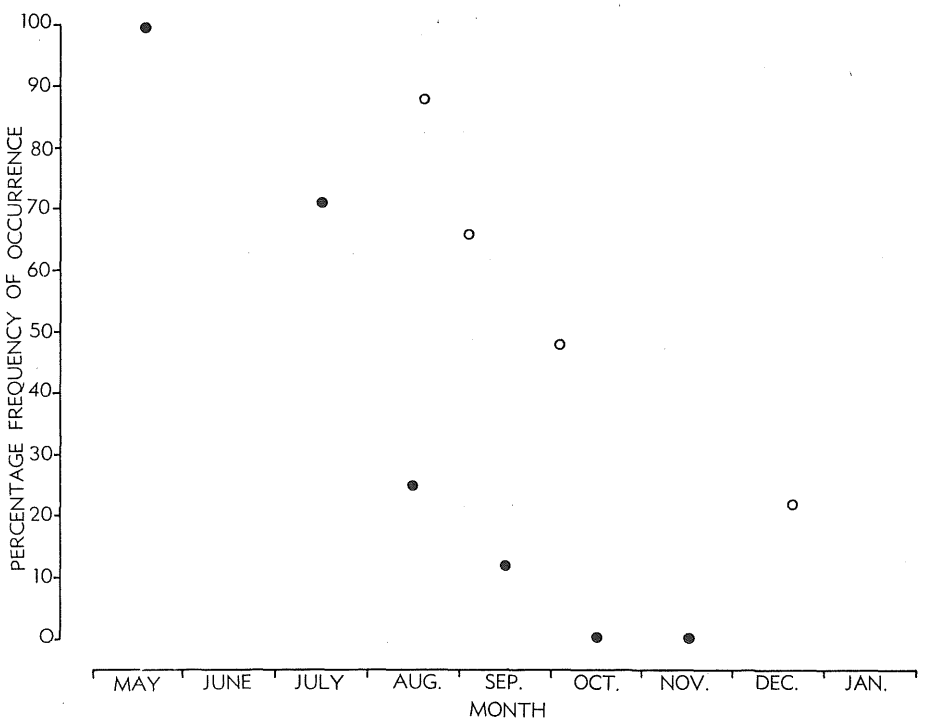

Fig. 3.—Seasonal incidence of necklace neritinas (*P. oualanensis*) in grey teal gizzards (●) and of these shells of similar size (i.e. < 6·6 mm length) in the field (o).

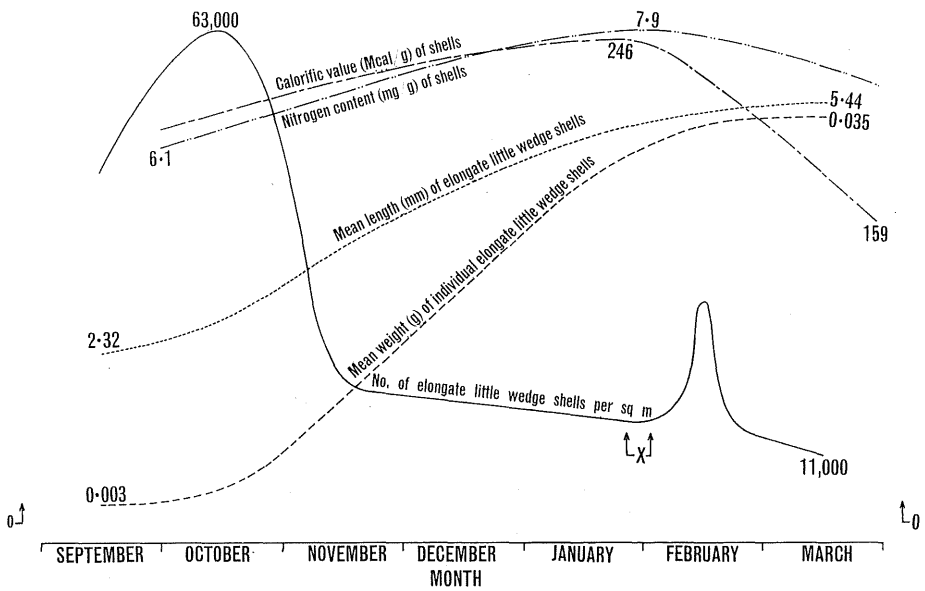

Fig. 4.—Seasonal changes in mean numbers, sizes, and nutritive values of elongate little wedge shells (*A. angusta*), Cleveland Bay Study Area, Q., 1968–1969: period marked X was week of highest rainfall, when shells were uncovered.

Availability of food.—Tidal, seasonal and local geographical distributions of necklace neritinas and elongate little wedge shells are given in Tables 6, 7, and 8 respectively.

TABLE 6

TIDAL DISTRIBUTION OF NECKLACE NERITINAS (P. OUALANENSIS) AND ELONGATE LITTLE WEDGE SHELLS (A. ANGUSTA) IN CLEVELAND BAY STUDY AREA, Q., SEPTEMBER 1968

Tide Level	Water Height (m)	No. of Samples	Mean (± S.E.) Number of Necklace Neritinas per Sample	No. of Samples	Mean (± S.E.) Number of Elongate Little Wedge Shells per Sample
<MLWS	<0·43	6	66·0 ± 17·8	6	58·5 ± 27·2
MLWS–MLWN	0·43–1·16	9	1·0 ± 0·7	6	2,825·3 ± 682·8
MLWN–MSL	1·16–1·58	3	Nil	6	3·7 ± 1·4
MSL–MHWN	1·58–1·95	6	Nil	Nil	..
>MHWN	>1·95	3	Nil	Nil	..

TABLE 7

SEASONAL DISTRIBUTION OF NECKLACE NERITINAS (P. OUALANENSIS) AND ELONGATE LITTLE WEDGE SHELLS (A. ANGUSTA) IN CLEVELAND BAY STUDY AREA, Q., 1968–1969

Month	No. of Samples	Mean (± S.E.) Number of Necklace Neritinas per Sample	No. of Samples	Mean (± S.E.) Number of Elongate Little Wedge Shells per Sample
September	9	52·0 ± 17·4	6	2,825·3 ± 682·8
October	6	35·3 ± 8·4	6	3,946·5 ± 350·5
November	Nil*	..	6	1,173·5 ± 238·3
December	Nil*	..	1	1,073
January	Nil*	..	6	881·3 ± 62·1
February	Nil*	..	6	1,859·8 ± 155·4
March	Nil*	..	6	676·0 ± 127·4

* No tide <MLWS; a sample taken in darkness at 0500 hours on 21.xii.68 comprised a mean number of 14·2 ± 3·8 necklace neritinas per sample (n = 6).

TABLE 8

LOCAL GEOGRAPHICAL DISTRIBUTION (LOCALITY AND SUBSTRATE) OF NECKLACE NERITINAS (P. OUALANENSIS) AND ELONGATE LITTLE WEDGE SHELLS (A. ANGUSTA) IN CLEVELAND BAY STUDY AREA, Q., SEPTEMBER 1968

Locality	No. of Samples	Substrate	Mean (± S.E.) Number of Necklace Neritinas per Sample	Mean (± S.E.) Number of Elongate Little Wedge Shells per Sample
Tidal river	9	Gravel, some rocks	0·1 ± 0·1	Nil
Tidal river	9	Gravel, some rocks and mud	57·8 ± 13·0	Nil
Tidal river	9	Gravel, some rocks and mud	52·0 ± 16·4	Nil
River estuary	6	Gravel	Nil	13·2 ± 8·2
River estuary	6	Sand	Nil	2·5 ± 1·4
Bay	9	Sand, some mud	0·2 ± 0·2	2,649·3 ± 1,218·5
Bay	3	Sand	Nil	3,001·3 ± 902·6
River estuary	6	Gravel, some rocks	Nil	Nil
Bay	6	Sand	Nil	3,204·1 ± 695·8
Bay	6	Gravel	Nil	Nil
Bay	6	Sand	Nil	1,069·5 ± 141·1
River estuary	6	Sand, some mud	Nil	Nil

Insufficiently low tides to provide accessibility to necklace neritinas by birds, particularly during daylight hours, occurred during much of the period of feeding at saltwater habitat (Table 9). Moreover, other species fed on the same mollusc (Table 10), which mostly became exceptionally large as a food item for grey teal (Figure 3).

TABLE 9

TIDAL PATTERN IN CLEVELAND BAY STUDY AREA, Q., 1968–1969*

Month	Total No. of Low Tides	No. of Tides < MLWS (Day : Night)	No. of Tides MLWS—MLWN (Day : Night)
July, 1968	59	14 : 0	19 : 20
August	61	12 : 0	16 : 24
September	58	12 : 1	13 : 28
October	60	6 : 11	20 : 18
November	56	1 : 13	21 : 18
December	60	0 : 9	20 : 22
January, 1969	60	0 : 12	14 : 19
February	54	0 : 5	16 : 16
March	60	0 : 4	25 : 18

* From *Queensland Department of Harbours and Marine Tide Tables* 1968, 1969.

TABLE 10

MEAN SIZE OF NECKLACE NERITINAS (P. OUALANENSIS) IN GIZZARDS OF GREY TEAL COMPARED WITH SIZES IN THE FIELD AND IN GIZZARDS OF BLACK DUCKS (ANAS SUPERCILIOSA ROGERSI MATHEWS), AUGUST–SEPTEMBER, 1959–1969

Source of Sample	No. of Necklace Neritinas Measured	Mean Shell Heights (± S.E.) (mm)	Mean Difference
Grey teal gizzards	118	3·4 ± 0·10	3·2 ± 0·53**
Black duck gizzards	11	6·6 ± 0·52	
Field	203	5·8 ± 0·10	

** P = 1%

The calorific value of food used daily to maintain 100 g body-weight of bird (formula 1) was V = (8·21 × 3,680) — (4·13 × 2,951) = approx. 17,500 Mcal. Accordingly, applying formulae 2, 3 and 4, where v and m are as given in Figure 4, the approximate numbers of elongate little wedge shells required for maintenance of the reasonably inactive wild grey teal, and the area to be searched in order to yield these, relative to the birds' occurrence at the appropriate saltwater habitat are shown in Table 11.

TABLE 11

CALCULATED SEASONAL ELONGATE LITTLE WEDGE SHELL FOOD REQUIREMENTS OF ADULT GREY TEAL IN CLEVELAND BAY STUDY AREA, Q., SEPTEMBER 1968–MARCH 1969

Month	Minimum No. of Shells Required Daily for Maintenance of Average Adult Male Grey Teal	Minimum No. of Shells Required Daily for Maintenance of Average Adult Female Grey Teal	Minimum Area (sq m) X 3 cm in Depth Providing Enough Shells for One Pair of Grey Teal	Grey Teal Predominantly at Saltwater Habitat (X)
September, 1968 ..	120,000	110,000	5	o
October	115,000	100,000	3·4	o
November	27,000	24,000	2·7	o
December	21,000	19,000	2·3	x
January, 1969	13,000	11,000	1·7	x
February	9,900	8,800	0·1	o
March	16,000	14,000	2·8	o

Drinking.—No drinking behaviour (after Johnsgard 1965) was seen at saltwater habitat; when drinking actions were counted relative to the incidence of the associated filter feeding action at freshwaters and at saltwaters, the frequencies were respectively 6/237 and 0/143. Birds maintained under cage conditions on either saltwater-saturated or freshwater-saturated foods died after approximately 1 week.

Figure 5 shows distribution of the nearest remaining freshwaters to saltwater habitat in the Cleveland Bay Study Area during the study period.

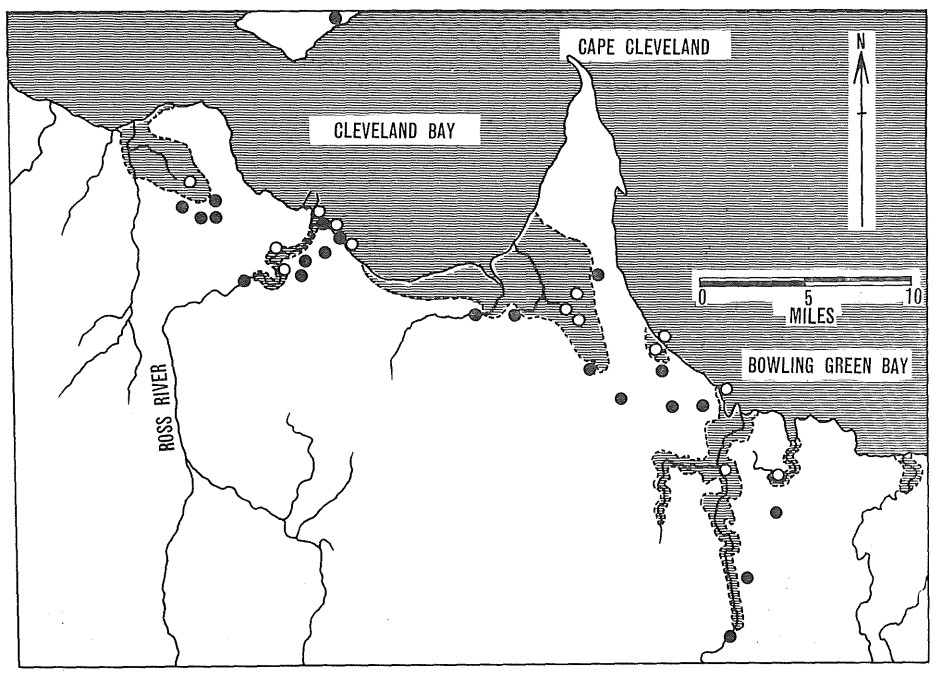

Fig 5.—Locations of saltwater habitat (o) and nearest permanent freshwater habitat (●), Cleveland Bay and Ross River Plains Study Areas, Q.

Condition of birds.—The seasonal condition of birds at saltwater and at freshwater habitat is illustrated in Figure 6.

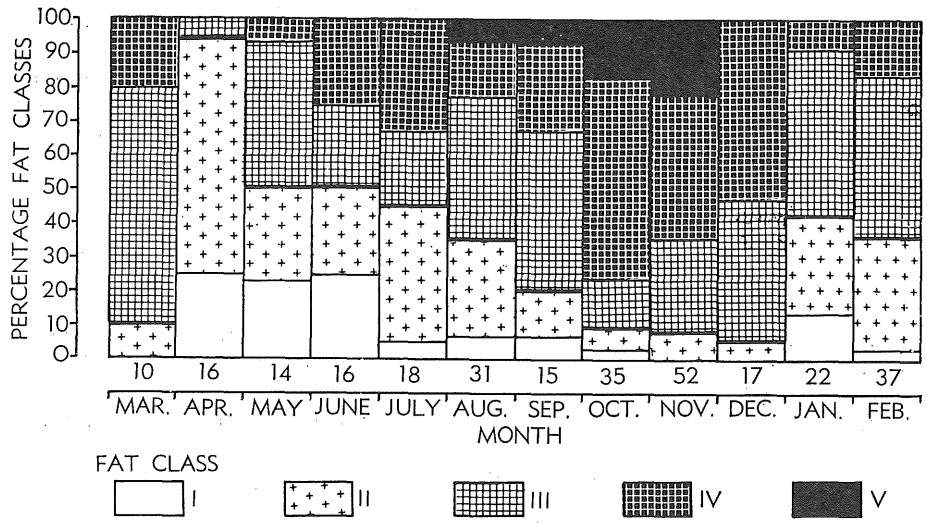

Fig. 6.—Seasonal condition, according to extent of fat deposition in monthly samples, of grey teal collected in north Queensland, 1968-1969.

The improvement in condition of birds reflected by the increase in fat deposition during the dry season period of saltwater utilization occurred also, though less noticeably, in body-weights. Moreover, the proportion of progressive monthly samples containing birds above average weight for the species (after Frith 1967) increased at saltwater and diminished at freshwater habitat, while, at the individual level, adult male grey teal mean weights, for example, declined at the Ross River Plains Study Area during 1968 and improved concurrently at the Cleveland Bay Study Area. At saltwater habitat parasitism by intestinal helminths and disfunction of the alimentary canal caused by intestinal impactions of fine sand occurred at unimportant levels (in 35% and 4% of individuals respectively) as in freshwater birds.

IV. DISCUSSION

Grey teal first occurred at saltwater habitat each year nearest to freshwaters, i.e. usually at saltpans and upper estuaries (see also Lavery 1970). The major actions, action patterns and hence behaviour of grey teal at saltwater habitat, and nearby freshwaters, were those of non-breeding birds occupied with feeding, locomotion and comfort (Figure 1).

The social organization at saline areas was that of loosely bound flocks of pairs and of some unpaired adult and young birds, predominantly males (Tables 1 and 2). Although immature grey teal would still have been readily recognizable from plumage (Lavery 1972), there was a significant decline in the proportion of this age class occurring at saltwaters compared with freshwaters (Tables 2 and 3).

The principal behaviour at saltwater habitat was feeding, and other activities were arranged accordingly. At non-tidal areas birds fed for approximately 5 hours before sunset and, with less intensity, for some 3 hours after sunrise. Thereafter, there was movement to suitable roosting grounds from which feeding eventually was recommenced (Figure 1 and Table 4). At tidal localities, feeding occurred at low tide irrespective of time of daylight.

Two marine molluscs predominated in the diet (Table 4) and in the field (Table 8). The extent of marine foods in the diet as illustrated (Figure 2) was minimal because of the difficulty in collecting an appropriate proportion of the population utilizing saline areas, and because of the occurrence in the diet of freshwater plant seeds, not normally preferred and of poor quality, ingested when drinking (Table 4).

Necklace neritinas were distributed in river estuaries confluent with saltpans (Table 8). The molluscs were distributed mostly at below mean low water spring tide level (Table 6) and, for sizes consumed by grey teal rather than other birds (see Tables 7 and 10), mostly early in the dry season; there was eventual lack of availability of this food because of unsuitable tides (Table 9) rather than the decreasing incidence of acceptably small shells (Figure 3.)

Ultimately, birds moved down the estuaries to the tidal flats of open bays where other molluscs, notably elongate little wedge shalls, predominated in the diet (Tables 4 and 5) and in the field (Table 8).

Elongate little wedge shells increased in size yet remained sufficiently small to be consumed, and seasonal nutritive values also increased although there was a decline in population density (Figure 4). The estimated numbers of shells required to be eaten during the birds' period of residence at open bays in 1968-1969 (Table 11) were of a feasible order when compared with those taken by the rock pipit (*Anthus spinoletta* (L.)), a Palaearctic species that daily can consume 14,300 marine molluscs as well as other foods (Gibb 1956), but which does not take as many items at once, does not ingest foods as rapidly, does not have such a concentrated food source so much in excess of the birds' requirements and does not move to new food sources in the course of feeding.

The general improvement in condition of birds during the period of drought refuge (Figure 6) is in accordance with the limited and appropriate activity of individuals (including absence of fighting for food), the protracted occurrence of food supplies of suitable quantity and quality, and the absence of deleterious other factors.

No deliberate drinking of sea water was observed although the stereotyped actions involved at freshwater are obvious. Saltwater would have been ingested with marine molluscs and could also have been drunk comparatively infrequently. Drinking of saltwater by associated waterfowl (e.g. black swans (*Cygnus atratus* (Latham)) was seen often. Free freshwater was required by grey teal probably as by other primarily gramivorous species (see e.g. Irwin 1956).

Although freshwater habitat lacked plant foods during drought, an abundance of localities remained for drinking purposes (Figure 5). Sewage outlets to saline areas were a convenient source of freshwater also used by grey teal. The movement of saltwater birds, especially on nights of strong moonlight when duck shooting also was practised, would have been the result of birds seeking drinking water. There was no evidence of dehydration in individual grey teal.

Movements between saltwater and freshwater habitat were seen rarely during daylight hours and then at dusk and dawn and following disturbance by shooters. Habits of flocks at night were difficult to determine; night shooting of grey teal

at some coastal freshwater swamps where no bird was present in daylight was reasonably successful, while, alternatively, some individual grey teal were observed roosting at the same place at non-tidal saltwater edges at dusk and the following dawn.

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