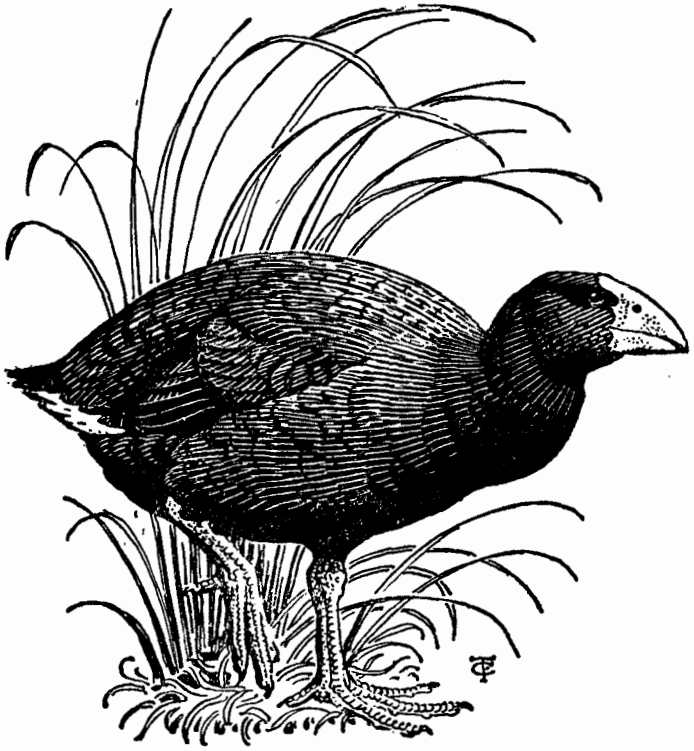
NOTORNIS

Journal of the Ornithological Society of New Zealand



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BLACK-FRONTED TERNS WINTERING IN THE BAY OF PLENTY

By P. C. M. LATHAM

ABSTRACT

The habits, feeding and plumage variations of the Black-fronted Tern *(Sterna albostriata)* were studied during their April to August wintering period in the Bay of Plenty, from 1977 to 1981. Their migration to and from, and occurrence in, the North Island is discussed. The possibility of numbers visiting the Bay of Plenty being on the decline is raised. The study of the plumage variations led to the conclusion that two age-groups are present and readily recognisable during their entire stay in the Bay of Plenty and a third is recognisable for at least 3 months of the wintering period. The extent of time over which the autumn-winter moult of the adult takes place is discussed.

INTRODUCTION

The Bay of Plenty, and in particular the small coastal area between Matata and Whakatane, is the northernmost known regular wintering ground for the Black fronted Tern *(Sterna albostriata)*. It is present in varying numbers from the end of March to early August, at rest at the mouths of the Rangitaiki and Tarawera Rivers, foraging over the flat low-lying Rangitaiki Plains, or feeding at sea. The following pages record observations made during my frequent visits to this wintering ground from 1977 to 1981.

OCCURRENCE

That the Black-fronted Tern has been wintering in the Bay of Plenty for at least a century is evident from Buller's record of a flock at Maketu in about 1880 and from two birds collected by Liardet at

Whakatane in the winter of 1897 (Sibson 1948). Unfortunately the size of the flocks occurring at this time is not known.

The next Bay of Plenty records are of two immature birds seen at the Rangitaiki mouth on 8 September 1940 and four birds seen near Thornton on 15 May 1947 (Sibson 1948). From 1950 to 1960, winter records exist for every year except 1956; 1952 and 1953 being particularly well detailed by Sladden (1953, 1954). Except for six birds seen at the Tarawera mouth in April 1968 (Jackson, CSN 1972), I am not aware of any sightings between 1960 and my first visit to the area in 1972. Winter records exist for every year from 1972 to 1981, although the only 1974 record that I know of is of a single bird seen by me off Mayor Island. I did not revisit the Matata-Whakatane coastal area until 1977.

The birds are difficult to count accurately because the flock is usually fragmented, some birds being at sea, some perhaps at roost on the beach, and some feeding inland. I had to make frequent and lengthy visits to the places they occur, during a winter season, to obtain an accurate total. Recently I have formed the opinion that the Black-fronted Tern to some extent uses the Rurima Islets, 8 km offshore, as a day and a night roost. Some days very few birds are to be found on shore, particularly when periods of fine, calm weather coincide with heavy human disturbance on the beach, especially by dune buggies and trail bikes.

Annual numbers are very variable. The following is a list of the highest number seen each year in which any were recorded. Those marked with an asterisk are probably close to the correct winter totals for the district.

8/9/40	2 (imm) Rangitaiki mouth (Sibson 1948)
15/5/47	4 near Thornton (Sibson 1948)
1950	" The odd bird or two " (Sladden 1953)
1951	" A few more than last year " (Sladden 1953)
*19/7/52	129 Matata (Sladden 1953)
*21/7/53	83 Matata (Sladden, CSN 1954)
*26/6/54	60+ Matata & Rangitaiki mouth (Sladden, d'Auvergne & Blomfield, CSN 1955)
2/9/55	8 (imm) Rangitaiki mouth (Sibson, CSN 1956)
10/5/57	31 Tarawera mouth (Merton, CSN 1958)
28/3/58	12+ Tarawera mouth (Black, Blomfield & McKenzie, CSN 1959)
23/5/59	18 Rangitaiki mouth (Sibson, CSN Jan. 1960)
8/3/60	4 Tarawera mouth (McKenzie & McKenzie, CSN Dec. 1960)
4/68	6 Tarawera mouth (Jackson, CSN 1972)
13/8/72	20+ Rangitaiki & Tarawera mouths combined (pers. obs.)
18/8/73	2 Tarawera mouth (Jackson, CSN 1974)

30/6/74 1 off Mayor Island (pers. obs.), the only recorded sighting for the Bay of Plenty this winter. The Matata-Whakatane coast was not visited by me and apparently not by others.

*Winter 1975 38 Rangitaiki mouth (Palliser, CSN 1976)

12/6/76 2 Tarawera mouth (Weston, CSN 1976)

*15/7/77 29 Rangitaiki & Tarawera mouths combined (pers. obs.)

*13/5/78 58 Tarawera & Rangitaiki mouths combined (pers. obs.)

*20/5/79 14 Tarawera mouth (pers. obs)

*18/5/80 48 Tarawera mouth (pers. obs.)

*6/6/81 35 Tarawera & Rangitaiki mouths combined (pers. obs.)

In addition, there are the following sightings in other parts of the Bay of Plenty.

21/2/53 2 Mt Maunganui beach (Hodgkins, CSN 1954)

23/3/54 1 Waiaua River mouth, near Opotiki (A. J. Goodwin, pers. comm.)

28/2/54 1 Mayor Island (Watson, CSN 1955)

28/5/58 2 Pongakawa (Black, Blomfield & McKenzie, CSN 1959)

12/12/59 12 Rurimu Rocks (= Rurima Islets?) (Parham, CSN Dec. 1960)

30/6/74 1 five kilometres NE of Mayor Island (pers. obs.)

12/11/77 1 Sulphur Point, Tauranga (H. D. Anderson, pers. comm.)

28/3/81 1 Matahui Point, Tauranga Harbour (pers. obs.)

These records show that, although its numbers vary, the Black-fronted Tern is in the Bay of Plenty, particularly the Tarawera-Rangitaiki area, every autumn and winter. Years with few or no recorded sightings reflect, in my view, a lack of observers rather than of birds.

Before Sladden's visits to the Matata area in the 1950s, we know nothing of the numbers of Black-fronted Terns visiting the Bay of Plenty. Almost the same is true of the years 1955-1976, when no one visited the area and counted Black-fronted Terns regularly and most of what visits were made were in off-peak months, i.e. months other than May, June and July, the peak months. See Fig. 1.

The only meaningful comparison possible is therefore between the period 1952-1954 and the period 1977-1981. The difference in numbers between these periods suggests a decline in the numbers of Black-fronted Terns wintering in the Bay of Plenty. This may reflect a continuing decline of the total population, as Hutton & Drummond (1923), Stead (1932) and Oliver (1955) reported a noticeable decline in numbers. Buller's remarks, too, seem to indicate that the Black-

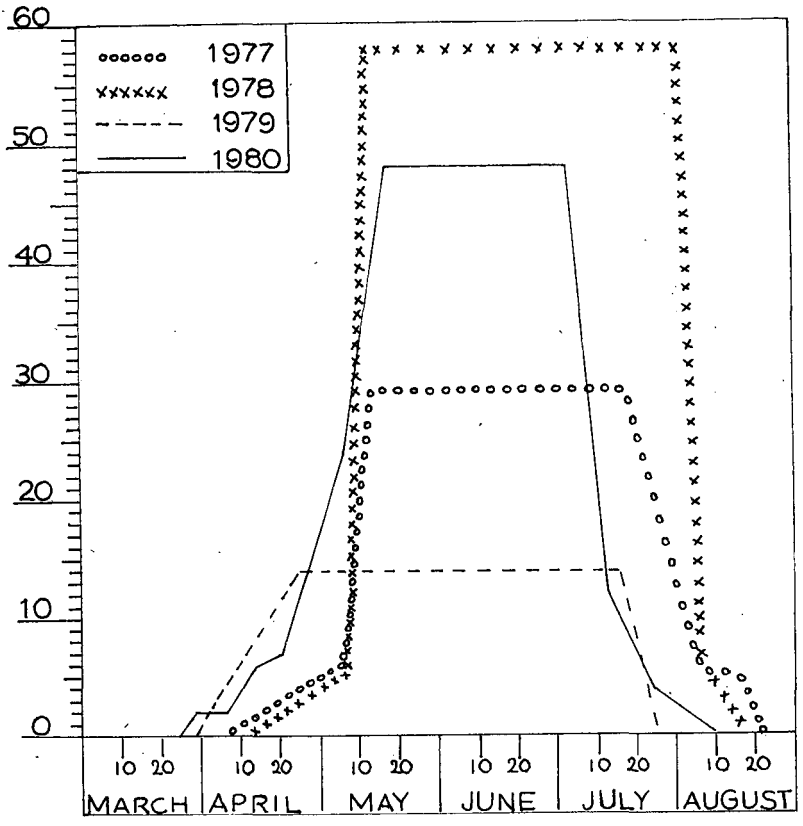


FIGURE 1 — The arrival, stay, and departure of the Black-fronted Tern in the Bay of Plenty, 1977 to 1980.

fronted Tern was, in his day, far more common in the North Island than it is today.

Other points of interest arise from these records. It is evident that, occasionally at least, birds arrive in Bay of Plenty waters earlier than late March, when the first arrivals are usually recorded. Parham's sighting of 12 birds in December 1959 and Anderson's one in November 1977 are the second and third records of Black-fronted Terns over-summering in the Bay of Plenty. Sladden was the first to note this (CSN 1955), when he found 14 near Matata in the summer of 1953-54. One is tempted to speculate on whether these over-summering birds were immature. Parham's flock seen on the Rurimu Rocks, which I take to be the Rurima Islets off the Rangitaiki River mouth, lends support to the idea that the Black-fronted Tern makes some use of these

islets when disturbance is heavy at the rivermouth roosts, as it would be in summer.

The route they use to and from the Bay of Plenty is not known, although sightings suggest along the east coast. The Black-fronted Tern has been recorded from Palliser Bay-Onoke Lake (Stidolph 1971), Whakataki, near Castle Point (Stidolph 1971), Porangahau (Cunningham 1957), the Napier area, where very similar numbers to those found in the Bay of Plenty spend the winter (K. V. Todd, pers. comm.), Wairoa (Cunningham, CSN 1954), Gisborne (Blackburn & Henley, CSN 1979), and the Waiapu River mouth, near Tikitiki (A. J. Goodwin, pers. comm.). It then presumably passes round East Cape and Cape Runaway into the Bay of Plenty.

They almost certainly come from the South Island, even though Buller and Stead recorded the Black-fronted Tern from the central North Island. Indeed, Buller quoted Capt. Mair as saying that in Nov-Dec 1879 he found young up the Wangaehu River, which has its origin on the southern slopes of Mt Ruapehu. Sibson (1948) raised the possibility that a few pairs may still nest on the Volcanic Plateau, but Black-fronted Terns have not been recorded, however, any distance inland for at least 50 years.

In no area north of the Bay of Plenty has the Black-fronted Tern been recorded often enough to show regular wintering, although Lalas (1979) shows Kaipara Harbour as a wintering site on his distribution map. As it has been recorded from this harbour on at least nine occasions, twice a flock of over 10 birds, the inclusion of Kaipara on the map is acceptable. However, I do not agree with the inclusion of the stretch of coastline from Tauranga to Whitianga. The only Black-fronted Tern seen on this piece of coast, to my knowledge, is the one seen by me at Matahui Point, near Katikati, on Tauranga Harbour in March 1981.

The Black-fronted Tern was recorded from the Manukau on at least three occasions between 1879 and 1886, but not until 10 November 1921 was another recorded in the Auckland area, in the Waitemata Harbour (Sibson 1948). Since 1921 the following are the records of Black-fronted Terns north of the Bay of Plenty:

10/3/40	5 Muriwai (Sibson 1948)
17/11/40	1 (imm) Muriwai (Sibson 1948)
6/5/41	1 (imm) Poutu, Kaipara (Sibson 1948)
5/5/43	1 Te Henga, Kaipara (Sibson 1948)
16/5/48	1 (imm) one mile off Clevedon coast (Urquhart, Murray & McKenzie, CSN 1949)
3/7/49	4 Kawakawa Bay, Clevedon (McKenzie, CSN 1950)
23/4/55	16 Tangaihi, Kaipara (A. & J. Prickett 1956)
15/6/57	14 Tangaihi, Kaipara (Prickett, Kidd & McKenzie, CSN 1958)
11/11/62	1 (imm) Kaipara (Sibson 1963)

30/3/63	1 Kidd's, Manukau (McKenzie & Sibson 1963)
1964-70	South Auckland coast, a few winter reports: not every year (McKenzie, CSN 1972)
1/3/75	1 Miranda (pers. obs.)
28/10/76	1 (imm) Rangiputa, Rangaunu Harbour (Edgar & Seddon, CSN 1977)
11/2/77	2 off Ruawai, Kaipara (Cooksey, CSN 1977)
26/3/78	3 Kaipara (Veitch 1979)

Note that most of these sightings were on or near the Kaipara Harbour but that only three of these were of flocks. The rest were mostly singles and immatures. However, considering the vastness of Kaipara Harbour, perhaps just more observers are required to prove regular wintering there.

Among the above records are three single immature birds seen in late spring, October and November. As this is the height of the breeding season on the Black-fronted Tern's South Island nesting grounds, these must be young of the previous season, i.e. birds beginning their second year, over-summering in the north.

HABITS

Arrival and departure

The first birds usually arrive in late March/early April. The numbers slowly increase in the Bay of Plenty until the main body arrives in late April/early May, and a peak is reached by mid-May (Fig. 1). Departure is more sudden, most of the flock leaving in the last week of July or the first week of August. These arrival and departure times, the same in Hawke's Bay (K. V. Todd, pers. comm.), coincide with the times of departure from, and arrival on, the breeding grounds in the area studied by Lalas (1979). Lalas gives December-March as the main departure period, and so Black-fronted Terns arriving in the Bay of Plenty and Hawke's Bay in April-May would have a fairly leisurely journey north. However, the return to the breeding grounds would be more hurried as Lalas's return date is August.

The earliest arrivals are usually adults, although first-winter birds may arrive early also, as in 1979 when two adults arrived with a first-winter bird. The last to leave are usually first-winter birds, sometimes weeks after all the adults have left. K. V. Todd (pers. comm.) found that from 11 to 19 August, 1981, only immature birds were present in the Napier area, most of the adults having left some time in July. Black-fronted Terns seen in the Bay of Plenty in late August or later are usually first-winter birds, still visibly different from the rest, which by then are all in adult breeding plumage. My own records show the following events:

1977	Adults left during the first week of August and five first-winter birds remained until the second half of the month.
1978	Most birds left during the first week of August, leaving

two first-winter birds with six adults. These had all gone by 19 August, except for one first-winter, which left a week later.

1979 All birds gone by 22 July.

1980 All birds had gone by 26 July, except for three adults and one first-winter, which had left by 23 August.

1981 The last birds I saw were an adult and two first-winter birds, on 25 July.

The ratio of first-winter birds to adults varies from year to year but they are usually few, as can be seen from the following:

1972 7 first-winter birds in a flock of 21. As this count was made on 13 August, many of the adults may have left already.

1977 5 out of 29 were first winter.

1978 8 out of 58 were first-winter.

1979 1 out of 14 was first-winter.

1980 3 out of 48 were first-winter.

1981 2 out of 35 were first-winter.

Feeding

During the early part of their winter sojourn, March to early June, the Black-fronted Terns feed mostly at sea, sometimes some distance from the shore, for example, twice recorded from Mayor Island waters, 35 km from the mainland at its nearest point but 100 km from the Matata area. As winter progresses, they spend more time feeding inland.

Where they feed seems largely to depend on the weather. In autumn and early winter, March-May, the fields are often very dry and do not seem to be attractive to Black-fronted Terns. This part of the year often brings calm settled weather in the Bay of Plenty, the conditions that suit them best for feeding at sea. For example, the bird I saw off Mayor Island could not have chosen a finer and calmer day.

During stormy weather and after heavy rain they forage in and over the low-lying Rangitaiki Plains, although never, in my experience, more than 2 or 3 km from the coast. Virtually the same inland feeding grounds as those marked on Sladden's (1953) sketch map were used by the Black-fronted Tern during the winters of 1977-1981. A marked preference is shown for short sward and often the company of cattle. For example, I found them on 18 May 1980, after two days of heavy rain, foraging mainly over a field newly sown with grass and an adjacent field occupied by cattle. Large numbers of Red-billed Gulls *(Larus novaehollandiae)*, Pied Stilts *(Himantopus himantopus)*, Welcome Swallows *(Hirundo tahitica)* and Starlings *(Sturnus vulgaris)* and a flock of Cattle Egrets *(Bubulcus ibis)* were also present; a scene of great activity, particularly when a Harrier *(Circus approximans)* flew

over. That day I did not see a single Black-fronted Tern venture out to sea to brave the stiff north-easterly wind and choppy waters.

In general, when the fields are wet and the sea calm, the terns feed both at sea and inland. They do not move about as a flock but, seemingly, according to individual whim. The following are the details of two short periods of movement, on different days, to and from the beach roost at the Tarawera River mouth. They are given to show the individuality of movement of the birds as well as their preference of feeding sites in certain weather. Awaiti refers to the pasture-land adjacent to the stream and wetlands reserve of the same name, near Matata.

18/5/80: Day overcast with the occasional light shower; north-easterly wind; sea rough; fields sodden from previous two days of heavy rain.

12 noon — 36 Black-fronted Terns roosting at the Tarawera mouth
12.01 — 1 bird flew inland towards Awaiti
12.06 — 1 flew inland towards Awaiti
12.10 — 6 arrived from inland, from the direction of Awaiti
12.15 — 4 left for and one arrived from Awaiti
12.18 — 6 arrived from the direction of Awaiti
12.20 — 3 flew towards Awaiti
12.25 — 1 left for and two arrived from Awaiti
12.30 — 2 arrived from the direction of Awaiti
12.35 — 3 arrived from the direction of Awaiti

15/6/80: A fine clear day with a cool southerly breeze; sea calm; fields still wet from previous rain.

11.45 — 3 Black-fronted Terns at the Tarawera River mouth
11.47 — 3 arrived from at sea
11.53 — 4 arrived from at sea
11.55 — 2 arrived from at sea but continued on over the beach roost, heading inland in the direction of Awaiti. One of those on the beach went with them.
12 noon — 3 arrived from at sea, one continuing on inland while two alighted at the beach roost.
12.05 — A Harrier passed overhead, putting everything on the beach to flight, 6 of the remaining Black-fronted Terns going inland, 5 gradually dropping back to the roost.

The birds feed over water either by dipping down gracefully to pick food such as floating insects, planktonic crustacea (Lalas 1979), or small fish deftly from the surface or by shallow diving like that of the White-fronted Tern *(Sterna striata)*. I have also watched Black-fronted Terns hawking insects on the wing over the surf when an offshore wind is blowing.

Inland feeding is done almost entirely on the wing. I have seen them hawking flying insects, sometimes to a height of 200 metres

and more. Even when taking food from the ground the terns dip down to pick up their prey, usually without touching down with their feet. They do, however, quite often touch down, sometimes for as much as 3 seconds, almost always keeping their wings held aloft. Several times I have seen a bird settle for 5-6 seconds, fold its wings, and tug at something on the ground, probably an earthworm. Earthworms form at least a part of their diet, as I found when one of a flock roosting at the Tarawera mouth regurgitated a meaty gobbet, which on closer examination proved to be four earthworms, each about 80 mm long.

During the second half of June and early July 1980 I found that some of the Black-fronted Tern flock, including two first-winter birds and some first-winter White-fronted Terns were feeding on tiny elvers, 60-80 mm long, which were making their way up the Tarawera River. Whitebait, too, are taken in August by late-staying birds.

On 6 June 1981, I watched 32 Black-fronted Terns feeding in the early afternoon along a 500-metre stretch of coast on the west side of the Rangitaiki River mouth. They foraged about a large raft of loose *Ecklonia radiata* kelp floating within 200 metres of the shore. A moderate surf was running, light rain was falling, but only a light southerly breeze was blowing. The birds did not seem to be catching fish, but were delicately picking their prey from the surface. Perhaps they were feeding on the planktonic crustacea of which Lalas (1979) has written. I watched them for about 1½ hours, during which time each bird came inshore at least once for a drink of fresh water, which was taken on the wing, and a rest on the beach. From 2 p.m., single birds began to leave the beach roost and fly purposefully upriver. At 2.15 p.m., the main body of the flock, c. 20 birds, followed, leaving 9 still feeding at sea, including the two first-winter birds. By 3 p.m., they had all gone upriver. At about 4 p.m., the wind veered to the north and was soon blowing hard, accompanied by heavy rain.

A Black-fronted Tern feeding on pasture land tends to quarter the ground fairly methodically, as can best be seen when only a few are working an area. It flies into the wind, dipping down every so often to pick up something that catches its eye, then at the end of the run (determined by a fence or hedge, perhaps), it allows itself to be lifted by the wind and carried back to the start. Here it begins another run a little further from the first. If there is no wind Black-fronted Terns tend to fly in wide circles about the feeding ground.

Roosting

Although roosting Black-fronted Terns are normally found on the beach by day, they do at times roost in the fields. The preferred roosting place inland seems to be a fence post. Stead (1932) noted them perching on the fence wire as well as the posts. I once found all but two of a line of 30 posts of a fence without battens occupied by Black-fronted Terns, the other two being taken by Red-billed Gulls.

The birds were squabbling over these perches, dislodging one another by flying in from behind and below and giving a sitting bird a lift under the tail or settling on its back. At least ten of this flock were content (or resigned) to roosting together on the ground.

I have not found where the flock spends the night, but I suspect that they roost inland in the fields during bad weather and on the Rurima Islets in fine. They do not spend the night at either the Tarawera or Rangitaiki River mouths. Indeed, I have found the Tarawera mouth quite devoid of shorebird life after dark. The Rangitaiki mouth, on the other hand, has hundreds of roosting gulls and sometimes a few Caspian Terns *(Hydroprogne caspia)* and White-fronted Terns but no Black-fronted Terns. In 1972 most of the Black-fronted Tern flock roosted by day at the Rangitaiki mouth, but since then the Tarawera has become favoured owing to heavy human disturbance, much worse at the Rangitaiki mouth than at the Tarawera mouth. This despite the badly polluted condition of the Tarawera River caused by effluent from the Kawerau pulp and paper mill. Until 1981, when I saw two on 30 May and 32 on 6 June, I had not seen a Black-fronted Tern at the Rangitaiki mouth since 28 May 1978. On this occasion a single bird was present while the main flock of over 30 birds was roosting at the Tarawera mouth. K. V. Todd (pers. comm.) has found that, in the Napier district also, they change their preferred estuary in different years.

The rivermouth roost presumably provides the Black-fronted Tern with a number of facilities, especially an open area in which it can feel secure, the company of related species and a good bathing place; first-winter birds, in particular, seem to be very fond of bathing. In addition, they often feed over the lower reaches of the river, and usually when returning from a foraging trip, whether at sea or inland, they dip down to snatch a drink or two before settling on the beach to preen and rest. The roost also seems to be ideally situated midway between their two main feeding grounds.

Roosting Black-fronted Terns are very quiet and placid, in contrast to their behaviour on their breeding grounds, as described by Guthrie-Smith (1936) and Soper (1976). Indeed, at the Tarawera beach roost, they are usually so quiet and still and their grey colouring blends so well with the dark sand there that they are easily overlooked. The only calls that I have heard are a soft *tseek tseek,* usually given on the wing and not audible for any distance, and the occasional grating scolding when one is annoyed with another. Among the Red-billed Gulls and White-fronted Terns, the main species with which the Black-fronted Tern shares the roost, it is " bottom of the pecking order."

PLUMAGE

On arrival in the Bay of Plenty, in late March/early April, the Black-fronted Tern flock is a " motley group." Plumages range from

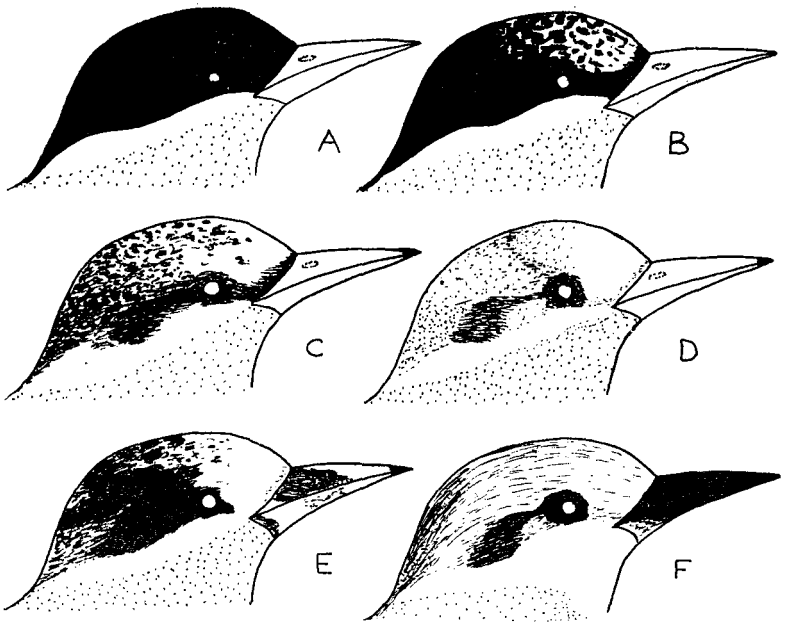


FIGURE 2 — Black-fronted Tern head patterns and bill colourings seen in the Bay of Plenty in autumn and winter. The unshaded areas of the bills are orange; the stippled neck and throat areas are dove grey.

A — Adult in full breeding dress with complete black cap and no dark bill tip; usually seen from May onwards but occasionally in April.

B — Adult within 10 days or so of completing the moult into breeding dress; usually seen in May and June, less often in April.

C — Adult beginning to regain black cap of breeding dress, still has dark bill tip. Based on a bird seen 29 March but birds in this plumage are usually seen in April and May, occasionally early June.

D — Adult in non-breeding dress with no black crown feathers and with dark bill tip. Even the nape is grey, not black as in most terns. Not common in Bay of Plenty as, on arrival, they are usually showing some black crown feathers; seen in March and April only.

E — Second-winter bird with blotchy black-and-white cap and dark-brown and dull-orange bill, in moult midway between F and A. Based on a bird seen on 15 May, but I have seen birds in this plumage in April, May and June.

F — First-winter bird with pale throat, streaky crown and dark bill; ear-covert patches and eye patches tend to be darker than those of non-breeding adult. These birds retain this dress throughout their stay, i.e. April-August, occasionally September.

adult non-breeding and adult breeding to second-winter and first-winter subadult.

Since May 1977, when I took a series of colour slides of birds with various head patterns and bill colours, I have tried to relate these differing plumages to the birds' ages. I believe that there are three detectable age groups in the Bay of Plenty flock between March and the end of June; adult, second-winter and first-winter.

Lalas & Heather (1980) reached similar conclusions with Black-fronted Terns in the South Island though, as well as the adult, they describe the following three distinguishable immature age groups, the third of which, although a transitory stage, they described somewhat vaguely.

1. This is the *juvenile* speckled plumage, which I have not seen in the Bay of Plenty. As the juvenile plumage is moulted in March (Lalas & Heather 1980), first-winter birds would all have lost this plumage before their arrival in the Bay of Plenty.
2. These I have called *first-winter* birds, i.e. birds of the year that have lost the speckled juvenile plumage yet remain distinct from adults during their stay in the Bay of Plenty. See Fig. 8.
3. These I have termed *second-winter* birds as I believe they are recognisable from April to the end of June, their second winter, by the patchy black and orange of their bills and their patchy crown pattern. See Fig. 2E. B. D. Heather (pers. comm.) thought this third age group still recognisable at Farewell Spit in late May 1980.

The plumage of the second-winter bird is in a midway state between first-winter and adult breeding; in my experience its head moult is later than that of the majority of adults. From the end of June they become identical with adults in breeding dress. Lalas & Heather (1980) said that the change of bill colour, from first-winter dark brown to adult orange, seems to be highly variable in its timing. If this is so, it would be difficult to distinguish a second-winter bird that had an early change of bill colour, i.e. before its arrival in the Bay of Plenty in April, from adults midway between non-breeding and breeding plumages. Without the mottled black and orange bill to separate the second-winter bird from the adult in mid-moult, the only distinguishing feature is the mottled crown, patchy in the second-winter bird (Fig. 2E), speckled in the moulting adult (Fig. 2C, 4A & 4B), as they are otherwise identical in plumage. However, work would need to be done with ringed immature birds before one could be sure that this patchy crown pattern is a constant distinctive feature. It may be that only a percentage of second-winter birds are readily recognisable in May/June. P. M. Sagar (pers. comm.) has suggested that second-winter birds that have an early change of bill colour may be birds that fledged early as chicks.

Basically I agree with Lalas & Heather (1980) regarding adult

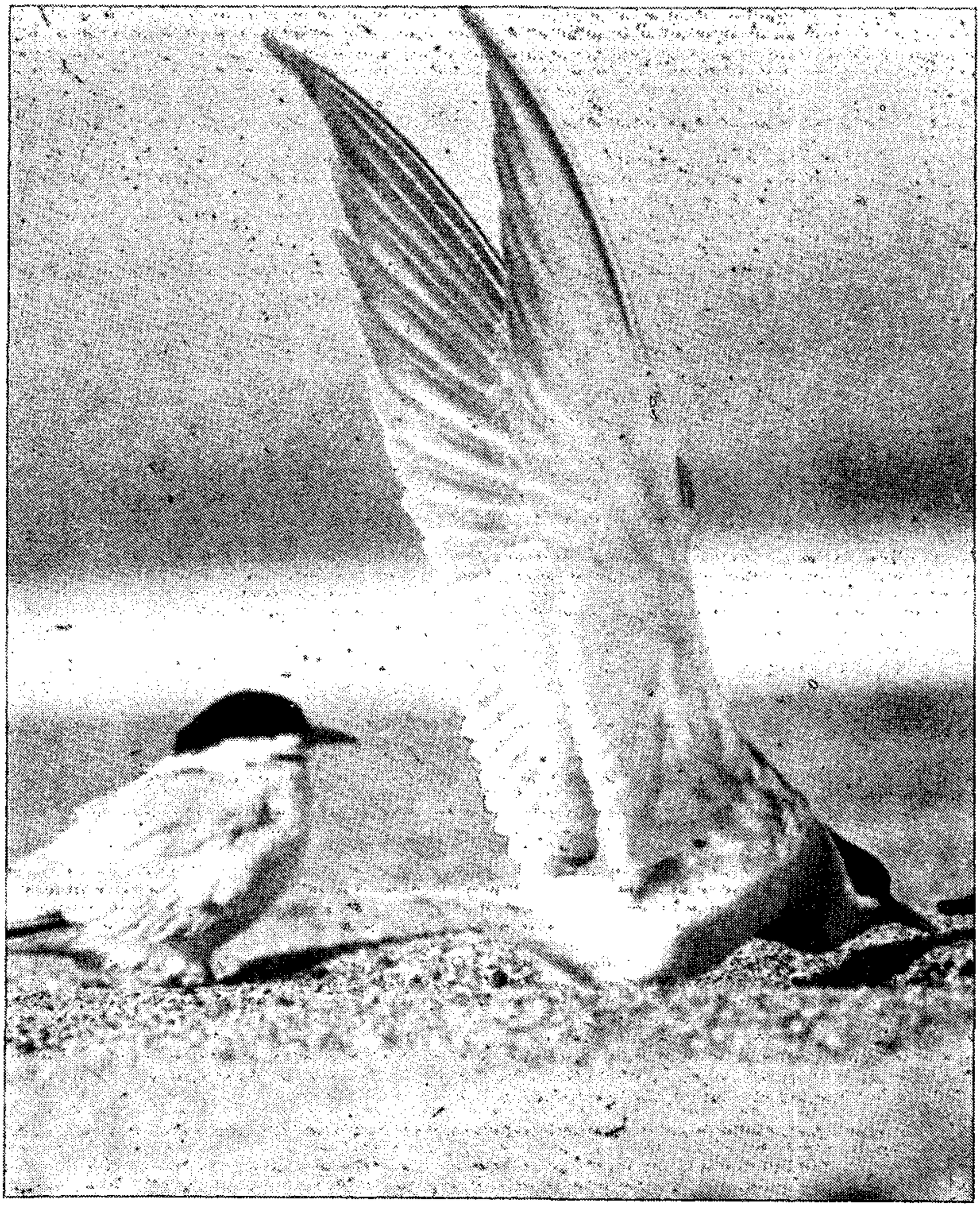


FIGURE 3 — Adults in full breeding dress with complete black cap and orange bill. Note fresh condition of secondaries and primaries, darker tips to primaries and white-shafted dark first primary. Note also white rump and upper and lower tail-coverts, a prominent feature in flight. Tarawera mouth, 15 June 1980.

plumages. The only disagreement is in the extent of time over which the autumn-winter moult takes place. Most Black-fronted Terns, on arrival in the Bay of Plenty in late March/early April, have begun their moult into breeding dress; for example, the first bird to arrive in 1981, on 29 March, resembled Fig. 2C. Both Lalas and Heather (pers. comm.) have suggested that this stage could equally well be moulting out of breeding plumage. That is so, but with so few birds present in the early autumn in the Bay of Plenty, it is relatively easy to keep individual birds under observation and to determine whether they are moulting into, or out of, breeding dress. Occasionally birds have arrived in early April in full breeding plumage, for example, four in April 1977. P. M. Sagar (pers. comm.) has seen Black-fronted Terns in full breeding dress in April in the South Island.

These examples are at variance with Lalas & Heather's generalisation that, "They are in full non-breeding plumage from February to late April." They also say that all adults are in full breeding plumage from the beginning of June. In my experience, at least 10% of the adults in the Bay of Plenty flock still have considerable grey to lose from crown and forehead at the beginning of June, and one cannot safely say all are in full breeding plumage until the end of June. Of 32 adults seen on 6 June 1981, four still had very grey crowns and foreheads, i.e. at a stage midway between Fig. 2B and 2C, at least two weeks from completing the moult. A number of other birds were at a stage a little more advanced than Fig. 2B. Even if allowance is made for the possible confusion with some second-winter birds at this time of year (only one bird was recognisable as such on 6 June 1981), there would still be many adults left with the moult uncompleted. B. D. Heather (pers. comm.) found a similar percentage of birds with the moult uncompleted in the Black-fronted Tern flock at Farewell Spit in late May 1980.

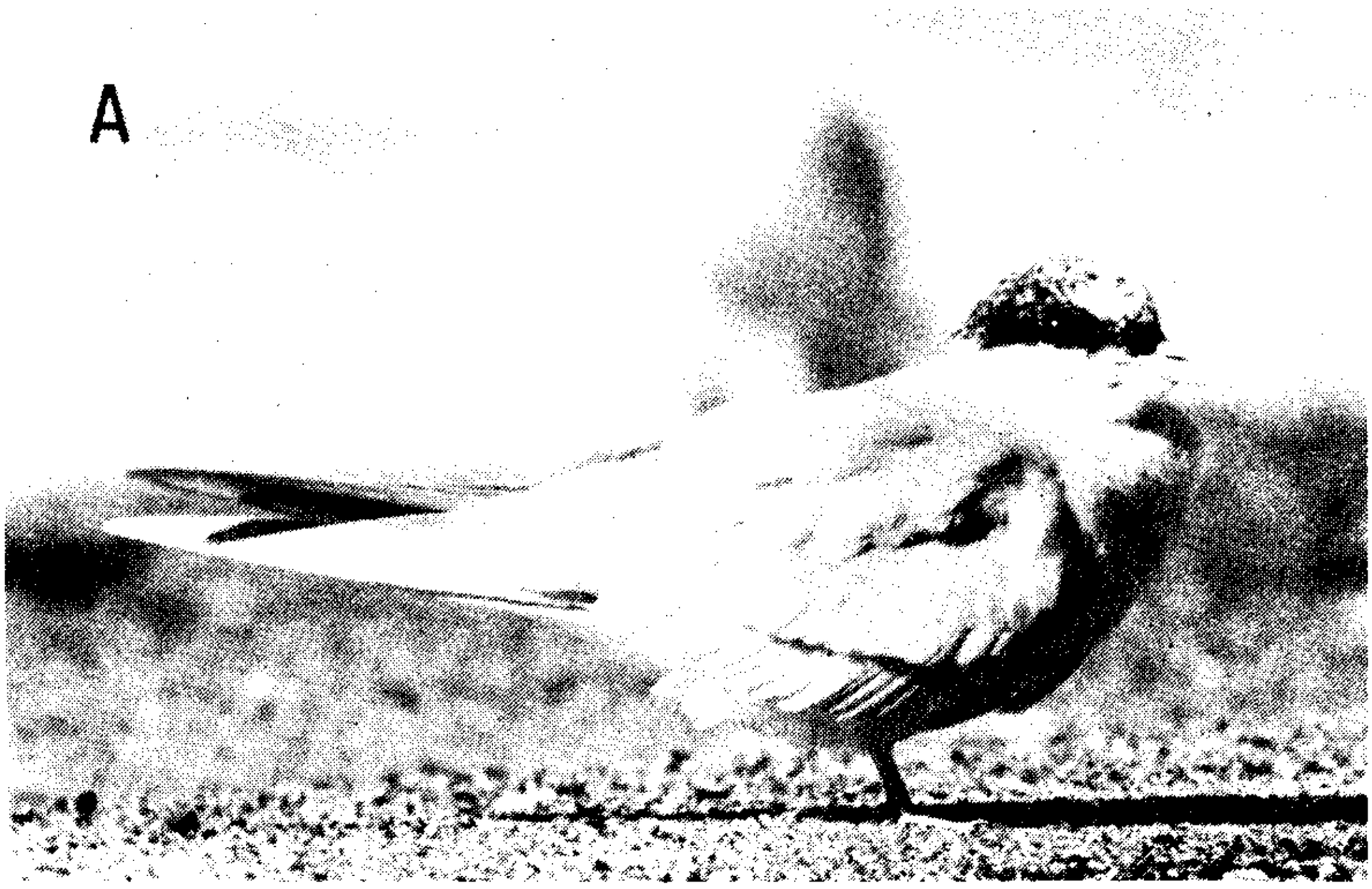
The following are my descriptions of the three apparent age groups that I have seen in the Bay of Plenty.

Adult breeding: The breeding dress of the adult is very smart. The whole body is dove grey, except for the rump and upper and lower tail-coverts, which are white. The crown, from the gape through the lores and below the eyes to the nape, is jet black. The black crown is separated from the grey neck by a white cheek stripe. See Fig. 2A. The tail is as grey as the body, the upperwing is a little darker, and the underwing is a little paler. See Fig. 3. The legs, feet and bill are bright orange.

Adult non-breeding: This plumage differs from that of the breeding bird in two respects:

1. The crown is pale. At the nape it is as grey as the body but it becomes paler towards the forehead, which is white or very pale grey. There is a dark patch about each eye and another dark patch on each set of ear coverts. See Fig. 2D and Fig. 6.
2. The bill is a slightly duller orange with a dark brown tip.

A



B

FIGURE 4 (A) & (B) — Adult regaining the black cap of breeding dress. This bird has all but lost the dark bill tip. Note the speckled appearance of the cap at this stage and that the dark feathers appear early at the base of the upper mandible. Tarawera mouth, 3 May 1981.

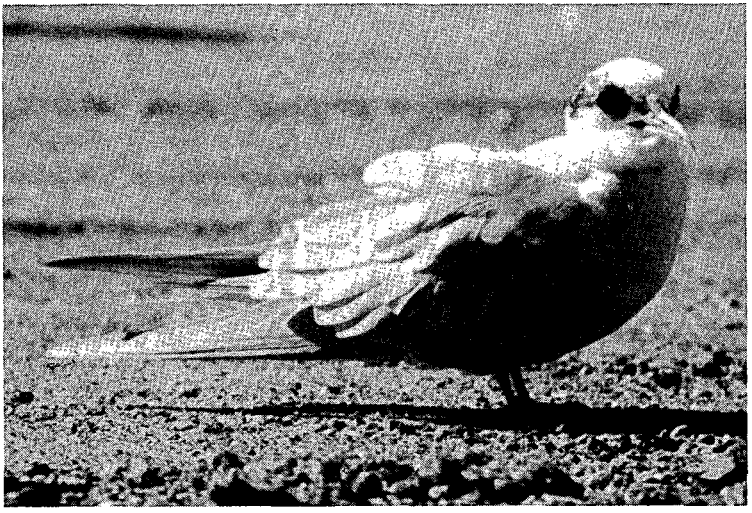


FIGURE 5 — Adult in early stages of moult from non-breeding to breeding dress. Note prominent dark eye patches; new black cap feathers are appearing about the eye patches, at the base of the bill and on the hind-part of the crown. Tarawera mouth, 3 May 1981.

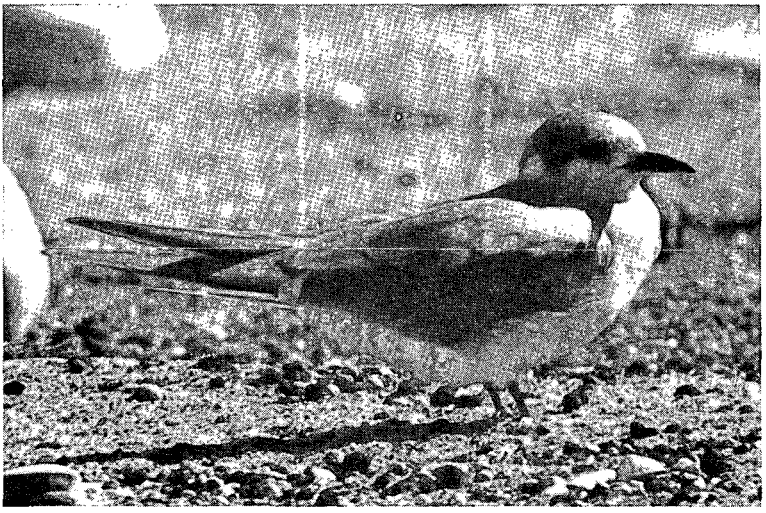


FIGURE 6 — Adult in complete non-breeding dress except for the few dark crown feathers beginning to appear. The bill tip is dark. Note pale grey forehead shading to dark grey at nape. Tarawera mouth, 20 April 1980.

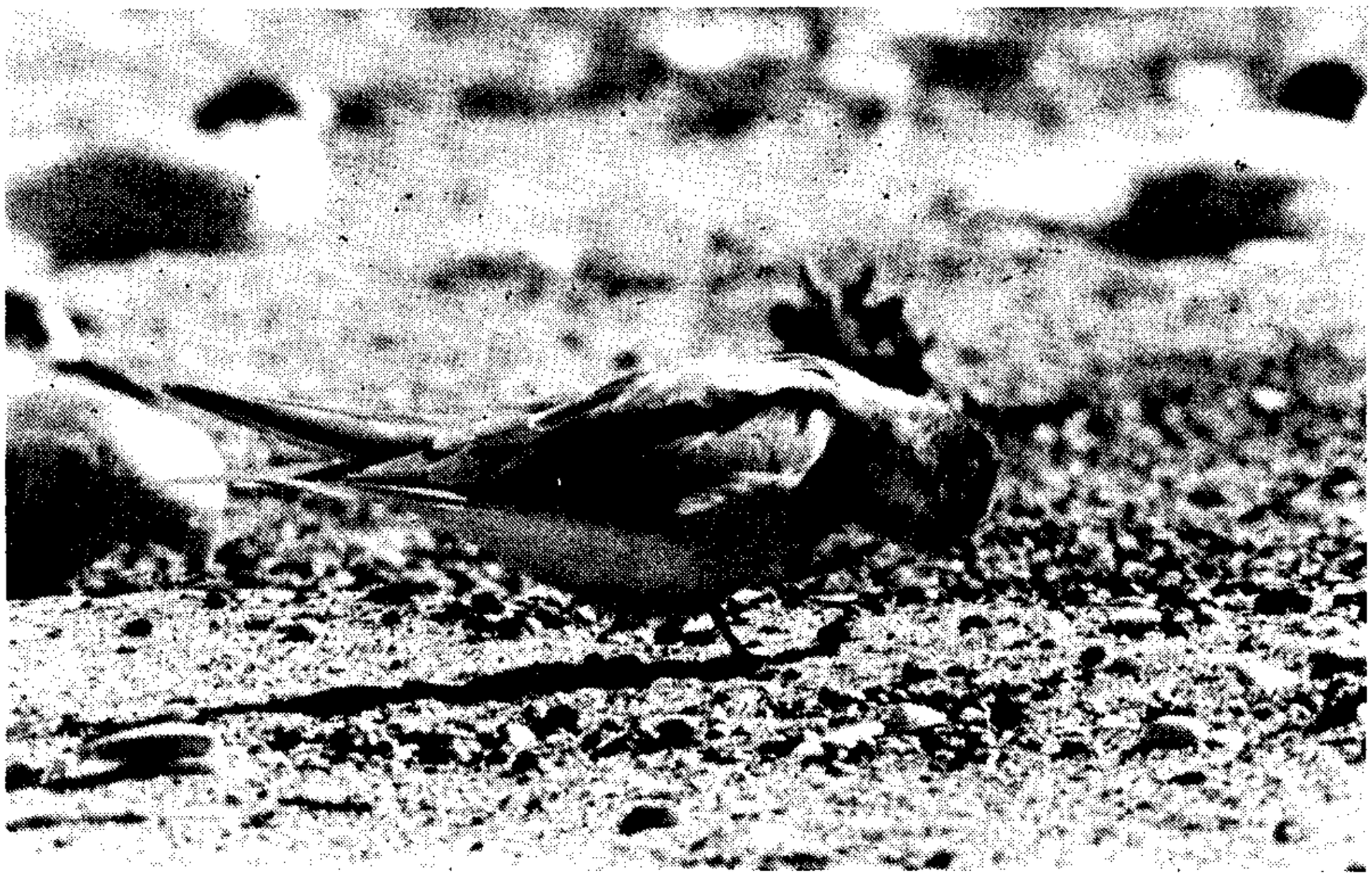


FIGURE 7 — Adult in complete non-breeding dress, showing the dark grey, not black, nape.

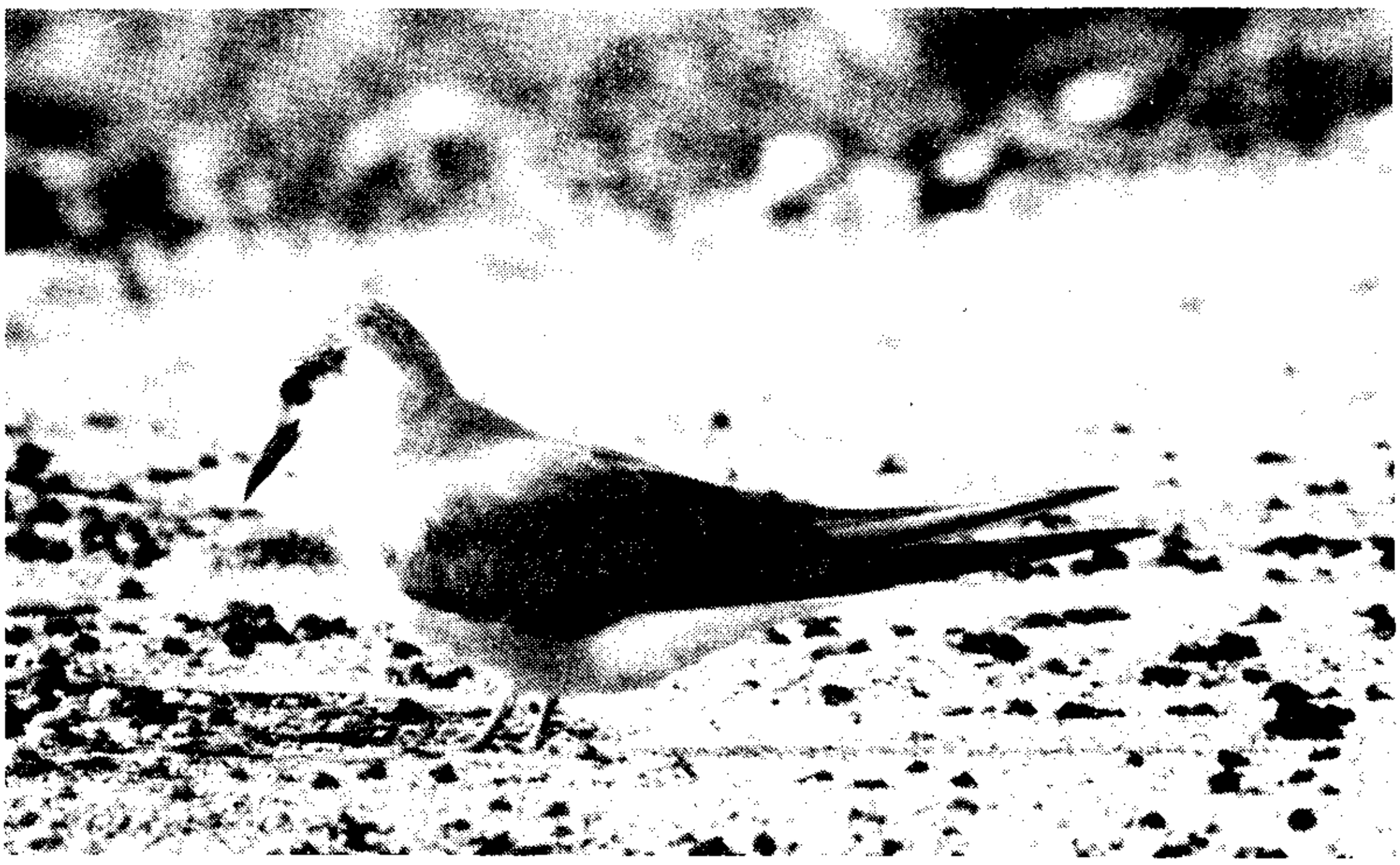


FIGURE 8 — First-winter bird with streaky crown, dark-brown bill and white throat. Tarawera mouth, 25 June 1978.

First-winter: These birds are very distinctive, being white on the throat and much paler grey on the breast than adults. The crown is like that of non-breeding adults but streakier. See Fig. 2F. The dark patches about the eyes and on the ear-coverts are similarly placed to those of non-breeding adults but tend to be darker. The body grey has a greenish tinge, as opposed to the bluish tinge of the adult, and the upperwing is a shade darker than that of the adult with an olive-brown tinge to the primaries and about the carpal joint. The bill is dark brown or black, often with a little dull orange showing at the base of the lower mandible. The legs and feet are as orange as those of adults. See Fig. 8.

Second-winter: Although in body plumage these are identical with adults, they can, I believe, be recognised by the patchy dark brown and dull orange of the bill and the patchy crown pattern. The adult, when midway between non-breeding and breeding plumages, assumes a more speckled crown pattern and has, except for a dark tip, a bright orange bill. Fig. 2E depicts the blotchy bill and crown pattern typical of the most recognisable stage of a second-winter bird's moult, whereas Fig. 2C is typical of the adult beginning to assume the black cap of its breeding dress. In my experience, second-winter birds are very slow to complete this March-June moult and can, therefore, be distinguished from adults from the time they arrive in the Bay of Plenty in April/early May until at least mid-June. By the end of June, with the moult completed, they become identical with adults. Birds displaying these patchy markings are by far the minority. I have not seen more than two in any one winter. For example, of 29 Black-fronted Terns seen at the Tarawera mouth on 15 May 1977, 22 were adults, 5 first-winter and only 2 were second-winter; of 35 birds on 6 June 1981, only 1 was second-winter.

To summarise, then: three apparent age groups are present, and recognisable, in the Bay of Plenty between the end of March and the end of June — adult, first-winter and second-winter. Adults may arrive in full non-breeding or full breeding plumage, or at any stage between. Not until the end of June have all adults and second-winter birds assumed full breeding dress. The presumed second-winter birds are among the latest to complete the moult, both their bill and crown colours often still being mottled in mid-June. If some second-winter birds do assume the orange bill of the adult earlier than April, they would be difficult to distinguish during their stay in the Bay of Plenty. Most adults have attained full breeding dress by mid-June, some even arriving thus attired in April. First-winter birds leave in the same garb as that in which they arrived. Because of this and their late departure from their winter quarters, and sometimes their over-summering there, I conclude that Black-fronted Terns do not breed before they are 2 years old.

ACKNOWLEDGEMENTS

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SHORT NOTE

WRECK OF KERGUELEN AND BLUE PETRELS

In September 1981 occurred the heaviest recorded wreck of Kerguelen Petrels *(Pterodroma brevirostris)* and Blue Petrels *(Halobaena caerulea)*. Several hundreds of dead birds were found on many North Island west coast beaches. Some were blown into the harbours of Wellington and Auckland, a few were blown inland, and one Kerguelen finished up at Tapu in the Firth of Thames. More Blues than Kerguelens were found. Several Kerguelens came in alive, and various people and especially the Auckland Zoo tried to nurture them back to health. But as with most small petrels picked up starving and exhausted, all died after a few days. Larger seabirds such as mollymawks and giant petrels stand more chance of recovery, but members should beware of lightly taking on caring for them as it requires much time, patience and understanding.

Watching seabirds from the shore can be frustrating and eye-straining; but what excitement on 8 September at Muriwai, in a strong south-westerly and frequent heavy rain was the close view (10-15 m) of Kerguelen and Blue Petrels in flight over the surf and the shoreline.

No problem of trying to hold binoculars steady on a heaving boat's deck when watching from a land rover, keeping pace with the birds. The flight of the Kerguelen Petrel was steeply undulating with quick twists and turns; features most noticeable were the very high 'dished' forehead, the long wings in proportion to the stocky body, and the narrow sideways-compressed bill. The flight of the Blue Petrels was dainty, and the white tip of the tail showed distinctly.

Extra beach patrols in the Auckland region produced many reasonably fresh specimens. From those collected, 26 Kerguelen and 27 Blue Petrels were examined and partly dissected. Except for one Kerguelen, all were classed as adult, based on the ends of the tibias, which were entirely fused. This does not nesessarily mean that the birds were fully mature. Only one male of each species had gonads approaching breeding condition, and equal female condition was found in only three female Blue Petrels.

One Kerguelen Petrel, known to have been force fed, had its gut full of undigested fish but nothing in its gizzard. This would support the theory that birds reach a point of exhaustion beyond which they cannot absorb food.

Of the 26 Auckland specimens of Kerguelen Petrel, 17 were males and 9 were females (one male with gonads 8.8 x 4.2 mm). Of the 27 Blue Petrels, 17 were males and 10 were females (one male with gonads 9.6 x 6.8 mm). The sample was probably too small for the sex proportions to be significant.

More interesting were the gizzard contents. Except for two Blue Petrels, all contained squid beaks. Every Blue Petrel also had plastic pellets of varying size and number; most also had pieces of pumice, and a few had unidentifiable vegetable remains, probably algae. Oddities were a kowhai seed, a piece of flat green plastic, and a rubber ring of the kind used for castrating lambs. Only one Kerguelen Petrel contained a plastic pellet. This must surely indicate that Blue Petrels are mainly surface feeders, but not the Kerguelens.

In October, these two species were still being found by beach patrollers, but no more fresh specimens came to hand. In this wreck, the weather was certainly a contributing factor, but this is not always so. With other large seabird wrecks, for example, that of Fulmars *(Fulmarus glacialoides)* in 1975, weather conditions were not unusual.

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THE DIET OF THE AUSTRALASIAN HARRIER (Circus approximans) IN THE MANAWATU-RANGITIKEI SAND COUNTRY, NEW ZEALAND

By D. J. BAKER-GABB

ABSTRACT

Of the 477 food items identified in the diet of the Australasian Harrier, mammals (46%) were the main food. Birds and their eggs (41%) were the next most numerous food, and insects (8%) and fish and frogs (5%) were in about equal numbers. Live prey was numerically more important than carrion in all seasons and especially during summer. However, the biomass of carrion eaten annually was greater than that of live prey. Food items were taken according to their availability, and not according to preferences of the predator. The legal protection of the Australasian Harrier in New Zealand is recommended.

INTRODUCTION

Only two diurnal birds of prey are resident in New Zealand: the Australasian Harrier *(Circus approximans)* and the rarer New Zealand Falcon *(Falco novaeseelandiae)*. For a medium-sized hawk the Harrier is common in open country, having been recorded in favoured swamp and sand dune habitat at densities of one bird per 50 ha and one breeding pair per 120 ha (Baker-Gabb 1981). This breeding density is high and falls within the upper limits of the graphed relationship between female body weight and breeding density of 22 species of diurnal raptor (Newton 1979). These observations suggest that in New Zealand the Harrier occupies an unusually important position as a predator and as a consumer of carrion.

Turbott (1967) suggested that before the number of rabbits *(Oryctolagus cuniculus)* was brought under control in the 1950s, Harriers were more numerous in New Zealand than they are today, and Gurr's (1968) data on population declines on the Otago Peninsula clearly support this notion. It may have been this high population density that prompted Stead (1932) to state that the presence of great numbers of Harriers was one of the chief difficulties in establishing game birds in open country. For this reason, and perhaps also because they are said to attack weak lambs and cast sheep occasionally, Harriers remain one of three species of native bird not protected by law in New Zealand. Harriers are still often shot, trapped and poisoned, though not on the scale of former years when bounties were paid for their legs by acclimatisation societies. For example, in the 1930s

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and 1940s the Otago Acclimatisation Society paid bounties for 26 184 Harriers killed in 7 years (L. Gurr *in litt.*) and the Auckland Acclimatisation Society paid for the killing of 200 000 Harriers in 15 years (Oliver 1938). With this in mind I shall describe the diet of Harriers from a 1200 ha area of the North Island. I shall also discuss whether the seasonal changes in diet I observed were due to changes in food availability or to changes in favour of more palatable prey, as concluded by Redhead (1969).

This research on the diet of the Harrier was undertaken as part of a wider study of the influence of predators on the fauna at Pukepuke Lagoon Game Management Reserve (40°10°S, 175°15°E). The diet of Australasian Harriers has been recorded in five other qualitative studies, but these differed from the present study in that data were not collected from a discrete area where prey populations were also studied. Furthermore, little use was made of field observations or of prey remains at nest sites, fewer food items were recorded, and no attempt was made to separate live prey and carrion in the diet. Carroll (1968) studied the stomach contents of 124 Harriers collected over 3 years from a wide range of North and South Island localities. Redhead (1968, 1969) made a similar study when he analysed the stomach contents of 129 birds and 20 pellets collected from the south-east of the South Island. Douglas (1970) analysed 99 pellets and Fox (1977) 18 pellets cast by Harriers from eastern South Island hill country.

Pukepuke Lagoon is situated 3 km from the coast near the centre of the Manawatu-Rangitikei sand country, an area of approximately 4200 km^2 on the south-west coast of the North Island. Detailed descriptions of the region can be found in the NZ Ecological Society Proceedings (1957), Cowie & Smith (1958), and Cowie *et al* (1967). The study area was dominated by rows of low dunes covered with marram *(Ammophila arenaria)*, spinifex *(Spinifex hirsutus)* and tree lupins *(Lupinus arboreus)*. Between the dunes there were extensive sand plains and peaty swamps where red rush *(Leptocarpus simplex)*, toetoe *(Cortaderia toetoe)*, flax *(Phormium tenax)*, raupo *(Typha orientalis)* and cabbage trees *(Cordyline australis)* were the common plants. Intensively grazed and well-drained pastures of introduced grasses covered about 50% of the study area. About 12% of the area had been planted with pines *(Pinus radiata)*.

METHODS

Data collection and analysis

Between March 1976 and August 1977 a total of 344 pellets (75 from the communal roost, 87 from nest sites, 182 from birds in cage traps), 120 prey remains (from five nest sites), and the stomach contents of five Harriers were collected for analysis. Also recorded were 36 successful attacks on prey and 28 instances of Harriers feeding from carrion.

Stomach contents: The crop and stomach contents of five Harriers found dead in the study area were analysed using the techniques described by Day (1966) and Redhead (1969).

Field observations: Regular field observations are important for recording food items such as frogs, fish and bird nestlings that leave few indigestible remains in pellets (Schipper 1973, Brown 1976). Casual observations are often biased towards large and unusual prey and may be coloured by observer bias and sometimes by misidentified prey.

Prey remains: I gathered most of the prey remains from five nest sites and their associated plucking stations, after the young had fledged. Thus a bias in favour of prey taken during the second half of the breeding season exists. I also collected prey remains from two of five nests when I visited them once to weigh and band the nestlings 2 weeks before fledging. Ten collections were made from plucking stations near three other nest sites during the incubation period.

The numbers of large prey items found at nest sites such as rabbits, hedgehogs *(Erinaceus europaeus)*, ducks and Pukekos *(Porphyrio porphyrio)* were calculated from the number of skulls, legs and wings recovered. Adult and fledgling Passeriforme feathers were identified by comparing them with specimens from a reference collection. I did not try to distinguish Skylarks *(Alauda arvensis)* from New Zealand Pipits *(Anthus novaeseelandiae)* in prey remains.

Pellets: Harrier pellets consist of the undigested residue of food from the stomach. Bone is readily dissolved by Harrier digestive juices, and so the pellets consist largely of hair, feathers or chitinous insect parts, and often vegetable matter. Misidentified pellets were most unlikely because pellets were collected from trapped birds, nest sites and communal roosts only.

I soaked pellets in water overnight and then teased them apart on a shallow white tray. After macroscopic examination a representative sample of hairs and feathers were mounted in 70% alcohol and examined microscopically. By not examining microscopically every hair and feather from every pellet I probably overlooked a few prey items. Mounted hairs and feathers were identified using the key developed by Day (1966), which identifies mammalian hair to genus or species but feathers to order only. Those feathers I could not classify to species level on macroscopic characteristics were from Passeriformes and Anseriformes. Because Day did not separate hare *(Lepus europaeus)* and rabbit hair on microscopic structure, I examined 182 pellets known to contain hair from either hares or rabbits used as trap bait. I found that pellets containing the hair of hares were markedly paler and so I used this character to distinguish it in pellets. To reduce the bias from contamination of pellets by rabbits and hares used as baits, the frequency of lagomorphs in the diet from this source (pellets from traps) was assumed to be the same as their frequency from all other uncontaminated sources.

Small insects such as ladybirds (*Coccinella* sp.) were found only in pellets that also contained the remains of insectivorous birds, and so these insects were not regarded as occurring in the diet of the Harrier in their own right.

The data of Glading *et al.* (1943) on food presented to captive hawks, including harriers (*Circus* sp.), confirmed that the occurrence of each species in a pellet corresponded roughly with one prey item. I have followed this guideline in estimating numbers of prey in pellets. unless numbers of identifiable parts indicated otherwise. A range of one to four prey species was found in pellets. The results are presented as the percent frequency of each food compared with the total number of items identfied. The prey remains and field observations were combined with the results from the pellet analyses. Schipper (1973) has demonstrated that when data from several sources are combined the results are more comprehensive.

Biomass of food eaten

Prey and carrion of vastly different biomass are considered equal when evaluated only in terms of their frequency in the diet. It is also biased to consider, for example, that all of the weight of an animal such as a 3 kg hare contributes to the diet when only a small fraction of the animal may be eaten. To reduce these biases an estimate of the biomasses of the foods eaten was calculated. The assumptions made below are subject to considerable variation and so only general conclusions have been made concerning the relative importance of classes of animals in the diet.

When fed regularly in captivity, both adult and nestling Harriers consumed about 120 g of meat per day (Redhead 1969). However, hungry Harriers may consume up to 240 g of tissue in one meal, but rarely more than this (Robertson 1978), and so animals larger than 300 g (see below) were considered to be wasted food. Harriers have not been seen to cache prey and so left-over food would be likely to be eaten by another Harrier or another predator. During the breeding season, however, an upper limit of 500 g of useable food was chosen, based on what I have seen a male Harrier carry and what a family of two adults and one or two nestlings might reasonably consume.

In addition to not being able to eat some of the available tissue of large (> 300 g) animals, Harriers did not eat, or regurgitated as pellets, some parts of all animals such as large bones, hair, feathers and gut contents. From feeding trials with captive birds wastage factors were calculated to be: 33% for large (> 300 g) mammals, 20% for large birds, 17% for medium-sized (75-300 g) mammals, 12% for medium-sized birds, 9% for small (< 75 g) mammals and 5% for small birds, fish, frogs and insects (Fox 1977, Baker-Gabb unpublished data). Weights of animals were taken from Fox (1977), Baker-Gabb (1978), Robertson (1978) and specimens in the National Museum of Victoria.

Bird prey counts

Five times per season I recorded the number of passerines observed as I walked a 2.5 km transect through equal areas of open farmland, duneland, pines and raupo. Counts were made early in the morning on fine calm days.

The data from the four vegetation types were weighted to match the proportion of the vegetation types in the study area. They were then combined to give a measure of relative seasonal abundance rather than absolute density of passerines (Emlen 1971).

Live prey and carrion in the diet

Medium-sized (75-300 g) and small (< 75 g) land birds, golden bell frogs *(Littoria aurea)*, large insects, house mice *(Mus musculus)*, brown rats *(Rattus norvegicus)* and juvenile rabbits were classed as live prey, while all sheep *(Ovis aries)*, brush-tailed possums *(Trichosurus vulpecula)* and prions (*Pachyptila* sp.) were classed as carrion. I found ten prions dead in the study area after a summer storm, and so the four prions in the Harriers' summer diet had probably been found dead. Brush-tailed possums are nocturnal and so are available only as carrion.

I could not be sure whether the following species that occurred in the diet were live prey or carrion because I did not see them being taken. Thus, most rabbits, hares, hedgehogs, ducks, Pheasants *(Phasianus colchicus)*, Pukekos and Australian Magpies *(Gymnorhina tibicen)* were placed in a category termed " unknown."

Harriers kill both adult and juvenile rabbits and hares (Buller 1888, Sharland 1932, Stead 1932, Douglas 1970). I have seen them kill juvenile rabbits and eat rabbit and hare carrion.

Although hedgehogs are mainly nocturnal (Brockie 1957), I sometimes saw hedgehogs foraging during the day in all seasons except winter. It is not certain that Harriers can kill hedgehogs, but the occurrence of juvenile hedgehogs in prey remains at nest sites suggests that they may be taken as live prey at this stage. Robertson (1978) saw a juvenile Harrier capture a medium-sized hedgehog during the day, but when the bird was flushed 20 minutes later the hedgehog was curled up and alive. Hedgehogs are frequently recorded as roadside carrion (Brockie 1963, Baker-Gabb 1978, Robertson 1978), and they are often taken by Harriers. Hedgehogs recorded in this study at nest sites were probably not road-killed because the recorded home ranges of the nesting Harriers did not include any public roads. Douglas (1970) found hedgehog remains at nest sites 10 km from the nearest country road.

I have found no evidence in the literature of Harriers killing adult game birds. I have seen them flush ducks, Pheasants and Pukekos more than 100 times, but the birds either successfully defended themselves or evaded the Harrier. However, Harriers do occasionally take

young game birds (W. Pengelly, A. Garrick, *in litt.*) and I have seen them kill 4-month-old Domestic Fowls *(Gallus domesticus)* that had no cover into which to escape. Game birds in pellets and prey remains were therefore placed in the same *unknown* category as hedgehogs and most rabbits and hares.

RESULTS

The results of all four analyses of data are given in Table 1 and summarised in Figures 1 and 2. Of the 477 food items, mammals (46%) were the main food, birds and their eggs (41%) were the next most numerous food, and insects (8%) and fish and frogs (5%) were about equal. In terms of biomass eaten, mammals (71%) were much more important than birds and their eggs (25%) and fish and frogs (4%). Insects contributed less than 0.1%.

Rabbits (17%), hedgehogs (9%), sheep (8%) and house mice (8%) were the most frequently taken mammalian foods; being eaten in all seasons. Brown rats (2%), brush-tailed possums (2%) and hares (0.5%) were recorded infrequently.

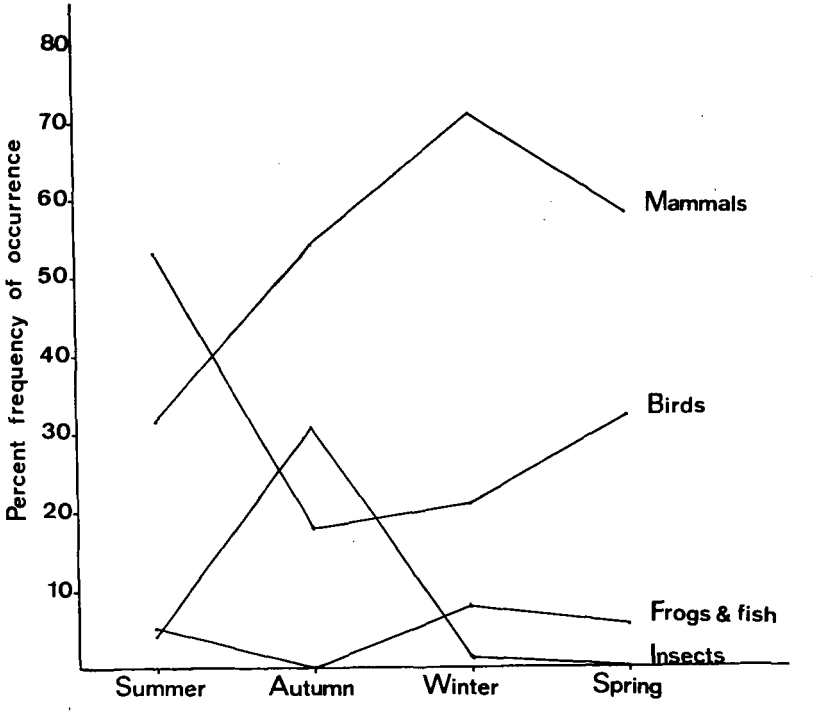

FIGURE 1 — Seasonal occurrence of classes of food in the diet of the Australasian Harrier.

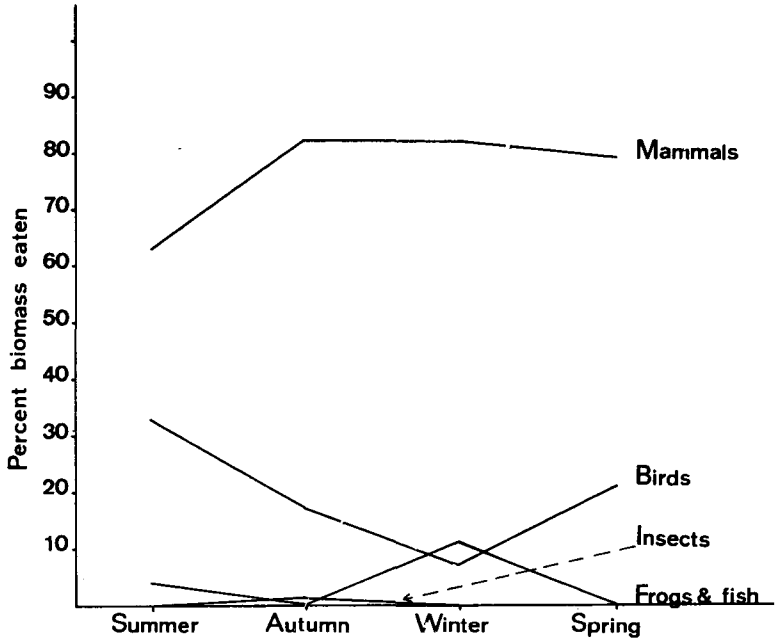

FIGURE 2 — Biomass of classes of food eaten by the Australasian Harrier.

The highest percentage of rabbits was eaten in autumn and winter, when they were probably taken as carrion. I saw rabbit carrion used 11 times in these seasons (compared with only twice in spring and summer), and I also found shotgun pellets and rabbit hair together in two pellets collected in winter. A source of rabbit carrion in the study area was provided by the Manawatu Pest Destruction Council (MPDC) which shot and poisoned rabbits, particularly in winter when control operations are most successful because grass growth is least (N. Bowick *pers. comm.*). During autumn and winter most rabbits were of adult size, whereas in summer 65% (20) of the rabbits collected as prey remains at nest sites and plucking stations were classed as immature from their skull measurements. These immature rabbits were probably taken mainly as prey because both of two fresh carcases examined at nests had haemorrhage marks where the Harrier's claws had punctured the skin.

Hedgehogs occurred fairly regularly in the diet throughout the year, although fewer were taken in spring. The winter records were probably carrion because many die at this time of year from diseases such as pneumonia, or drown while hibernating (Brockie 1957). Some of the remains of 20 hedgehogs found at nest sites may have been live

prey, for skull measurements showed that 40% were juveniles, an age group more easily taken alive.

Most (79%) sheep in the diet were eaten in winter and spring. The high frequency of occurrence of wool in spring (33%) indicates how important sheep carrion is when it is available during the lambing

TABLE 1 — Seasonal diet of the Australasian Harrier

	Summer Dec-Feb		Autumn March-May		Winter June-Aug		Spring Sept-Nov		Totals	
	n[1]	%[2]	n	%	n	%	n	%	n	%
Rabbit	31	12.7	22	25.9	22	23.9	7	12.3	82	17.2
Hare	2	0.8	-	-	-	-	-	-	2	0.4
Hedgehog	20	8.2	10	11.8	12	13.0	3	5.3	45	9.4
Possum	4	1.7	1	1.2	2	2.2	2	3.5	9	1.9
Sheep	5	2.0	3	3.5	11	12.0	19	33.3	38	8.0
Brown rat	-	-	4	4.7	4	4.3	-	-	8	1.7
House mouse	15	6.2	6	7.0	14	15.2	2	3.5	37	7.8
Total mammals	77	31.6	46	54.1	65	70.6	33	57.9	221	46.4
Duck	5	2.0	5	5.9	2	2.2	3	5.3	15	3.1
Pheasant	5	2.0	2	2.4	-	-	3	5.3	10	2.1
Pukeko	6	2.5	-	-	-	-	1	1.7	7	1.5
Prion	4	1.7	-	-	-	-	-	-	4	0.9
Aust. magpie	1	0.4	-	-	-	-	-	-	1	0.2
Blackbird	6	2.5	1	1.2	2	2.2	1	1.7	10	2.1
Starling	2	0.8	-	-	-	-	-	-	2	0.4
Hedge sparrow	19	7.8	-	-	1	1.1	2	3.6	22	4.6
House sparrow	5	2.0	1	1.2	1	1.1	-	-	7	1.5
Skylark/Pipit	5	2.0	-	-	-	-	1	1.7	6	1.3
Yellowhammer	14	5.8	-	-	3	3.3	2	3.6	19	4.0
Greenfinch	6	2.5	-	-	-	-	1	1.7	7	1.5
Chaffinch	4	1.7	-	-	-	-	-	-	4	0.8
Goldfinch	2	0.8	-	-	2	2.2	-	-	4	0.8
Silvereye	1	0.4	-	-	1	1.1	-	-	2	0.4
Grey warbler	1	0.4	-	-	-	-	-	-	1	0.2
Unidentified passerines	43	17.8	4	7.0	5	5.3	1	1.7	53	11.2
Total birds	129	53.1	13	17.7	17	18.5	15	26.3	174	36.6
Eggs	15	6.2	-	-	2	2.2	6	10.5	23	4.8
Frog	6	2.5	-	-	-	-	3	5.3	9	1.9
Carp	2	0.8	-	-	1	1.1	-	-	3	0.6
Eel	4	1.7	-	-	6	6.5	-	-	10	2.1
Total	12	5.0	-	-	7	7.6	3	5.3	22	4.6
Coleoptera	1	0.4	-	-	-	-	-	-	1	0.2
Hemiptera	3	1.2	1	1.2	1	1.1	-	-	5	1.0
Orthoptera	6	2.5	25	29.4	-	-	-	-	31	6.4
Total insects	10	4.1	26	30.6	1	1.1	-	-	37	7.6
TOTALS	243	100.0	85	100.0	92	100.0	57	100.0	477	100.0

[1] n = Estimated number of individuals

[2] % = Per cent of total individuals

season in late winter and spring when stock losses are greatest. In contrast, sheep made up only 2% of the summer diet.

Mice were taken in all seasons, but the highest percentage occurred in winter, and the lowest in spring. Brown rats were recorded only in the autumn and winter diets. The capture rates of these rodents paralleled the pattern of population changes in rodents, whose numbers increase from late summer through to winter, when they decline (Daniel 1978, Fitzgerald 1978).

Of the 138 (29%) passerines in the diet, one was a large (> 300 g) bird, 12 were medium sized (75-300 g) and 125 were small (< 75 g). The summer peak of passerines in the diet (109) corresponds with the peak in relative abundance (Table 2). There was a positive, but non-significant, correlation (Spearman's $r = 0.4$, $p > 0.05$) between the number of passerines counted and the number in the diet.

Of the 36 passerines identified in prey remains from Harrier nest sites, 20 (56%) were nestlings or fledglings, showing that Harriers took advantage of this abundant and vulnerable food source when it became available. Most passerine species which were commonly seen in the study area were represented in the diet; however, six species occurred infrequently. Magpies were available only as carrion. Starlings *(Sturnus vulgaris)* usually foraged in open farmland, which Harriers did not hunt at Pukepuke Lagoon (Baker-Gabb 1978). When they foraged in swampland and duneland in autumn and winter, Starlings moved in flocks, which provide protection from predators (Tinbergen 1951). Silvereyes *(Zosterops lateralis)* and Grey Warblers *(Gerygone igata)* are agile restless birds which remain within or close to cover while foraging in shrubs (Soper 1963). Fantails *(Rhipidura fuliginosa)* and Welcome Swallows *(Hirundo tahitica neoxena)* are unlikely prey because they forage on the wing and Harriers take most of their prey on the ground (Oliver 1955, Baker-Gabb 1978).

Thirty-two game birds, including ducks, Pheasants and Pukekos, comprised 7% of the annual diet. They were identified most frequently in the spring, summer and autumn diets. All 16 game birds in the

TABLE 2 — Average number of passerines counted seasonally along 2.5 km transect

Bird size	Summer Dec-Feb	Autumn March-May	Winter June-Aug	Spring Sept-Nov
Large (> 300 g)	19.0	16.1	12.5	25.0
Medium (75-300 g)	19.0	9.9	11.0	8.5
Small (< 75 g)	163.0	60.5	50.0	102.5

summer diet were identified from prey remains, 15 being adults and one a duckling. The number of game birds in the study area was high. NZ Wildlife Service personnel have recorded the breeding success of ducks in 80 ha of wetlands at Pukepuke Lagoon. During the 9 years from 1970 to 1978 a minimum of 706 duckling broods have been produced, with approximately 700 ducklings hatched each year (A. Garrick *in litt.*). Large numbers of Pukekos bred in the area. Some Pheasants bred, and others were regularly released in the surrounding farmland for sportsmen to shoot.

The 23 eggs in the spring and summer diets included three duck, two Pheasant, two Blackbird *(Turdus merula)*, four Hedge-sparrow *(Prunella modularis)*, five Skylark and seven unidentified eggs.

All 22 frogs, eels (*Anguilla* spp.) and carp were found as prey remains, rather than in pellets. Nine frogs were caught during spring and summer, while three carp and ten eels were recorded in the summer and winter diets.

I did not see many large insects until late summer and they did not occur in nest site pellets or prey remains. Most insects occurred in pellets collected from the communal roost and trapped birds during autumn. The insects in the diet were predominantly orthopterans (6%) and hemipterans (1%).

Live prey and carrion in the diet

Table 3 shows that, excluding the *unknown* category, live prey (77%) was the most numerous food in the annual diet. There was a significant difference between the numbers of live prey and carrion items

TABLE 3 — Live prey and carrion in the diet of the Australasian Harrier

Food	Summer Dec-Feb			Autumn March-May			Winter June-Aug			Spring Sept-Nov		
	n[1]	%[2]	%[3]	n	%	%	n	%	%	n	%	%
Live prey	171	71	33	42	49	8	37	40	11	25	44	8
Carrion	18	7	19	17	20	36	27	29	31	21	37	54
Unknown	54	22	48	26	31	54	28	31	58	11	19	38
Total	243	100	100	85	100	100	92	100	100	57	100	100

[1] n = estimated number of individuals

[2] % = per cent of total individuals

[3] % = per cent of biomass eaten

eaten seasonally ($X^2 = 46.7$, $p < 0.001$), mainly due to the disproportionate numbers eaten during summer. During winter and spring there were approximately equal numbers of live prey and carrion in the diet.

Excluding the *unknown* category, the biomass of carrion eaten in all seasons was more than twice that of live prey, except in summer, when live prey predominated. The *unknown* category accounted for half of the biomass eaten, and it is my opinion that most of this would have been made up of carrion, although this cannot be proved.

DISCUSSION

In summary, large insects, rabbits, hedgehogs and rodents occurred frequently in the autumn diet. These mammals remained important during winter and spring, but large insects were no longer available then. At this time the diet changed to include considerable sheep carrion. In summer, it changed back to live prey, particularly passerines and their eggs and young, and to a lesser extent juvenile rabbits.

Live prey and carrion in the diet

The Harriers at Pukepuke Lagoon drew their food from a wide range of live prey and carrion and they ate greater numbers of live prey than carrion annually. However, in the annual diet the biomass of carrion eaten was greater than that of live prey. In summary, both live prey and carrion were important, with live prey being more so in summer and carrion more so in the other three seasons.

Food availability versus palatability

Redhead (1969) recorded similar trends in species composition in the diet of the Australasian Harrier to those outlined above. He stated, without supporting evidence, that the summer changes were a move from a staple mammalian diet to a preferred one, and that birds, particularly passerines, and their eggs were taken in preference to all other foods available at the time.

In this study the seasonal changes in the diet closely matched seasonal changes in prey densities and vulnerability and in carrion availability. Therefore, I believe that birds took the foods that were available, not what they are supposed to prefer. It has been shown that Harriers made good use of sources of rabbit and sheep carrion, killed inexperienced young mammals and birds in spring and summer, and included birds' eggs and insects in their diet when they were available.

Douglas (1970) provided further support for the availability hypothesis. In his Harper-Avoca study area, hare carrion was unusually abundant in summer. In this season 76% (34 items) of the Harriers' diet was mammalian (56% hare), and only 15% (7) was insect and 9% (4) was avian.

From a series of experiments with carrion baits, Robertson (1980) found that rats and domestic fowl pullets were consistently favoured by Harriers ahead of eels, rabbits and possums. He concluded that, rather than selecting particular species, Harriers chose the smaller (< 300 g) carrion items because they were able to carry them to nearby cover where other Harriers were less likely to disturb them. When rabbit carcases were provided, some with exposed flesh and some with their skin intact, the birds chose to feed from those with flesh readily available.

It is possible that Harriers find hare and rabbit carrion more palatable than possum because, when a choice between these species has been offered, Harriers have nearly always eaten the lagomorphs first (Baker-Gabb 1978; Robertson 1978, 1980; Fennell 1980). These choices may also be influenced by the ease of handling because the thicker skins of possums may be more difficult for Harriers to penetrate.

A considerable body of evidence shows that population density of raptors is limited primarily by food availability in all seasons (Newton 1979) and that raptors hunt where they find a particular prey species at its highest density (Craighead & Craighead 1956, Rusch *et al.* 1972, Schipper 1973). If this was not the case and there was sufficient food for raptors to follow consistently their palatability preferences, population densities of raptors would increase until food availability was once again limiting.

Sampling techniques

From the data of Carroll (1968), Redhead (1968, 1969), Douglas (1970) and Fox (1977), Australasian Harriers in widely separate New Zealand localities have a similar diet to that found in this study. Differences between the studies in the use of particular foods are mainly due to variations in the prey and carrion available in the habitats sampled and to differences in sampling techniques. A lower frequency of frogs, fish and bird nestlings was recorded in these other diet studies, probably because field observations and prey remains were not included. In his study of the diets of three species of harrier, Schipper (1973) also noted that frogs, fish and bird nestlings were recorded at much lower frequencies when field observations and prey remains were not included.

Legal protection

The study area I used was centred on a game management reserve where the number of game birds was high. It follows from my predictions concerning prey and carrion availability that the frequency of game birds in the diet of Harriers would be higher at Pukepuke Lagoon than in most parts of New Zealand. It was in fact higher than the frequency of game birds in the diet (3%) combined from five other studies (Carroll 1968, Redhead 1968, 1969, Douglas 1970, Fox 1977), but it was still low at 7% of the annual diet.

All game birds I recorded in the diet were adults, except for one duckling taken as live prey. Probably most adult game birds were carrion or moribund birds because I saw six (20%) eaten as carrion but no successful attacks. Carrion was available in the form of birds that had died from natural causes, ducks that had died following ingestion of lead shot (Caithness 1974) and game birds that were shot and not retrieved during the shooting season. In the years 1970-1978 an annual average of 616 ducks shot and recovered and 54 shot but not recovered has been recorded at Pukepuke Lagoon (A. Garrick, *in litt.*). Thus, quite apart from the point that Harriers may help to control predators of game birds and their eggs, Stead's (1932) assertion that the presence of large numbers of Harriers is one of the chief difficulties in establishing game birds in open country now seems to be unfounded.

Like Carroll (1968), I can find no first-hand evidence of Harriers attacking and killing lambs or sheep, let alone their causing significant economic losses to sheep farmers. Because six studies from throughout New Zealand have now shown that a minimum of 96% of 1122 food items in the Harriers' diet were either of no economic value or harmful to man's interests, there seems no reason why the Australasian Harrier should not be given the same legal protection in New Zealand as other native brids.

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This paper is based on a section of a MSc degree completed at the Botany and Zoology Department, Massey University, Palmerston North. I would like to thank my two supervisors, L. Gurr (Massey University) and P. Moors (NZ Wildlife Service), for their interest and encouragement throughout the study. I received a travelling expenses grant of $300 from the NZ Wildlife Service. A. Garrick and T. Caithness kindly provided unpublished data on waterfowl numbers at Pukepuke Lagoon. I am grateful to L. Gurr for the unpublished data on bounties paid for Harriers in Otago. I would like to thank Prof. J. M. Cullen, P. Dann and H. A. Robertson for their helpful comments on a draft of this paper.

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SHORT NOTE

ANOTHER NANKEEN NIGHT HERON

The photograph of the juvenile Nankeen Night Heron at Owaka (*Notornis* 28: 218) was responsible for the identification of a previous specimen, observed some years ago but not recognised at the time. The notes of this sighting have been languishing in my files since August 1973 when it was reported by Mr J. A. McCluggage of Pohokura, Taranaki.

Mr McCluggage's description of the bird, seen on his farm, and which remained in the area for some months, tallies with all features of a juvenile Night Heron. Mr McCluggage, who now lives in Thames, has confirmed the identification from the *Notornis* photograph.

It also seems appropriate at this time to document a further apparently unrecorded adult specimen of the Night Heron, which is now in the Taranaki Museum. Unfortunately the only data recorded is that the bird was " shot near Cape Egmont " by Newton King. As a permanent pakeha settlement did not begin in the area until 1881 the specimen is likely to have been taken some time between then and 1927 when King died.

RON LAMBERT, *Taranaki Museum, P.O. Box 315, New Plymouth*

SHORT NOTE

SIGHTING OF SOUTH ISLAND KOKAKO *(Callaeas cinerea cinerea)* IN MOUNT ASPIRING NATIONAL PARK

For several years from about 1957, I went down to Mt Albert Station, then owned by Mr John Quaife, to help with the autumn cattle muster, usually in late March and early April. The calves duly weaned and the sale lot on their way to Cromwell, I would go up into the Teal Creek valley for a few days of deer shooting. The track, a seldom-used blazed trail, led steeply up the north side of the valley through thick silver beech forest with little understorey and a scattering of totara.

As I climbed and returned I would always come upon areas of the mossy forest floor that had been recently disturbed, and rotting tree trunks and branches that had been picked at and underdug. I suspected kaka but saw no other sign.

On my visit to Teal Creek in 1964, I heard what I described to my hosts as a rather exalted Tui, followed by the harsh and prolonged cry of a falcon, then silence. Mrs Quaife, who had heard of their possible previous existence in the area, suggested Kokako, but I didn't give much credence to it.

The following year, still intrigued by the "ploughing," I took more care to travel quietly and, on my way down, spent an hour or so just listening. I was rewarded by hearing the same Tui-like sounds from two different directions, and did see movement of what appeared to be a largish bird in the tree tops from whence one song came. Again a falcon came screaming down the valley and all sounds ceased.

The next year (1966), I missed the muster and paid my visit in early May. I was coming quietly down the trail and stopped to ease my shoulders by resting my pack, which was loaded with venison, on a convenient rock. Presently, I realised I was looking straight at a strange bird perching on a branch 15-20 metres away. It was just below the canopy of a beech downslope from me, about 15 metres above the ground but horizontally only about 3 metres above me. It seemed to be quietly singing to itself as its head and beak were constantly moving and I heard an occasional note, but with a gusty wind rustling the leaves and the river roaring below, it was hard to tell if the song was continuous. The light was not good, but I could see detail quite well. It was facing directly towards me, the tip of its tail visible below the 10-cm-thick branch. It was dark grey with jet black head and beak. One could imagine it was wearing a mask! Its wattles, which were quite prominent, were putty coloured, just a light fawn, but it was undoubtedly a Kokako.

I tried to ease out of my pack straps to get at my camera, but the bird immediately hopped into the upper branches and disappeared.

I was fairly sure I heard a snatch of song from another direction, but just then a falcon screamed down near the river and, apart from an occasional call from that, I heard nothing more. The position was NZMS 1 Map S107 Grid 968687.

The following year (April 1967), I was within 400 metres of the previous sighting, and close to a patch of "ploughed" ground which I had seen on my way up the valley about six days before. It was a fine afternoon, no wind, the only sound being the roar of the river just below. I had stopped to listen, propped against a tree for only a few minutes, when a Kokako appeared walking along a log which protruded from a thick patch of fern beside a patch of "ploughed" ground. I think it saw me immediately because it quickened its pace, flew from the end of the log to a sloping tree trunk a short distance below, and began to climb the trunk in a most peculiar way. With each rather ungainly step upwards, it appeared to hold on to the bark with its beak, look in my direction, take another step, hold, look, and so on until it reached the branches, when it hopped rapidly out of sight. I was fairly certain I saw two largish birds moving in the canopy nearby, but as a small flock of parakeets was moving through just then, I could not be sure. I had to hurry on then, as it is not a place one would care to be benighted in.

The following day I took Mrs Quaife up to the spot, but in 3-4 hours we saw and heard nothing except the inevitable falcon.

I had informed the resident park ranger at Wanaka of my sighting the previous year, and again jogged his memory. The Park Board eventually flew in a hut to a nearby clearing, and spent some time in an unsuccessful search.

My next and last trip (1968) was also without sighting except of the falcon.

K. McBRIDE, *Kawarau Downs, RD4, Kaikoura*

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SOUTH ISLAND KOKAKO (Callaeas cinerea cinerea) IN Nothofagus FOREST

By M. N. CLOUT and J. R. HAY

The location of a 1967 sighting of South Island Kokako *Callaeas cinerea cinerea)* in beech *(Nothofagus)* forest at Mount Aspiring National Park was searched, without success, in May 1981. Early literature on South Island Kokako shows that they commonly inhabited beech forest and had ground-feeding and low-nesting habits which made them vulnerable to introduced mammalian predators. It is suggested that the dramatic irruptions of rodents and stoats *(Mustela erminea)* that occur after beech 'mast' years in the South Island may have contributed to the rapid decline of *C. c. cinerea.*

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The sightings of South Island Kokako *(Callaeas cinerea cinerea)* by K. McBride at Teal Creek (44°14'S, 169°11'E) near Makarora came to our attention recently (McBride 1981), confirming the existence of this subspecies as late as 1967.* The Teal Creek area was further investigated between 16 and 18 May 1981.

The party consisted of R. P. Buckingham, NZ Forest Service, Southland, M. N. Clout, Ecology Division, DSIR, Nelson, J. R. Hay, Royal Forest & Bird Protection Society, Rotorua, E. Kennedy, NZ Wildlife Service, Invercargill, K. McBride, Kaikoura, and R. J. Pierce, University of Otago.

Two days were spent at Teal Creek searching for Kokako in the 2 km stretch of forested valley where K. McBride had observed the birds over 14 years ago. Dawn listening watches were made, tape-recordings of North Island Kokako *(Callaeas cinerea wilsoni)* 'mew' calls were played and the area where the birds had been seen was thoroughly traversed by members of the party. Unfortunately no Kokako were heard or seen and there was no sign of the patches of torn-up moss and litter on the forest floor, which McBride (1981) noted on his previous visits.

Bird numbers at Teal Creek were low in May 1981, with the exception of Rifleman *(Acanthisitta chloris)*. Other species encountered were Kea *(Nestor notabilis)*, Hedge Sparrow *(Prunella modularis)*, Brown Creeper *(Finschia novaeseelandiae)*, Grey Warbler *(Gerygone igata)*, Fantail *(Rhipidura fuliginosa)*, Yellow-breasted Tit *(Petroica macrocephala)*, Song Thrush *(Turdus philomelos)*, Blackbird *(Turdus merula)*, Silvereye *(Zosterops lateralis)*, Bellbird *(Anthornis melanura)*, Chaffinch *(Fringilla coelebs)* and Redpoll *(Carduelis flammea)*. Apart from Kokako, the only notable absences from our list are the New Zealand Falcon *(Falco novaeseelandiae)*, which McBride (1981) observed several times near Kokako, and parakeets (*Cyanoramphus* spp.), which K. McBride (pers. comm.) recalls having seen in flocks of over 100 birds in the area during the 1960s. Other changes since the 1960s have included colonisation of the valley by possums *(Trichosurus vulpecula)* and a marked decline in the abundance of red deer *(Cervus elaphus)*.

The valley of Teal Creek is steep-sided, cold, and over 600 m in altitude. Below the subalpine scrub zone (c. 1000 m), it is clad in almost pure silver beech *(Nothofagus menziesii)* forest. The forest is structurally very simple, with a mossy, bouldery forest floor and an open understorey containing *Blechnum discolor*, small-leaved *Coprosma* species, *Carmichaelia* sp., *Griselinia littoralis*, *Hoheria glabrata*, *Pseudopanax crassifolium*, and *Coprosma foetidissima*.

* A search of the Teal Creek valley for Kokako was made without success in November 1970 by Peter Child (1981, **Birdlife of Mount Aspiring National Park**, Dept of Lands and Survey, Wellington), who also found none during surveys of the Park up to 1976 — Ed.

For those familiar with typical habitat of Kokako in the North Island, this sort of forest appears at first to be unsuitable for the species. Experience with the North Island subspecies has shown that a high diversity of plant species and structurally complex vegetation are indicators of good Kokako habitat (Hay, pers. obs.). Pure beech *(Nothofagus)* forest has a relatively low plant species diversity and is simple in structure, with few lianes or epiphytes. There is, however, ample evidence of the previous occurrence of South Island Kokako in this general forest type. Potts (1873) described Kokako prying in moss on branches in " some of the gloomy alpine valleys " and later (Potts 1882) referred to their occurrence on the upper flats of the Rakaia River, in areas fringed by beech forest. A partial albino shot at the foot of Mt Franklin (Kirk 1881) was probably in this habitat, and Reischek (1885) referred to Kokako at Arthur's Pass. Travers (1871) put the case beyond doubt, stating: " The *Glaucopis cinerea,* or crow, of the Middle Island, is rarely found below an altitude of two or three thousand feet, and indeed, is found in greatest numbers at and above the higher of these altitudes, in the glens of the *Fagus* forest."

The rapid decline of the South Island Kokako seems strange when compared with the persistence of the North Island bird, which has lost so much more of its lowland forest habitat. A likely explanation is that South Island Kokako were more vulnerable to introduced mammalian predators. The fact that Kokako in the South Island commonly inhabited beech forest (unlike those in the North Island) may have heightened the vulnerability of the South Island subspecies to predation.

An important feature of beech forest is the occurrence at irregular intervals of ' mast ' years, during which unusually large quantities of beech seed are produced, with subsequent effects on the abundance of small mammals, as was shown by events following the mast year of 1971. In the autumn of that year very heavy seeding of all beech species occurred in both the North Island (Fitzgerald 1978) and South Island (Franklin 1974, Manson 1974, Wardle 1974). House mice *(Mus musculus)* are known to increase greatly in numbers after heavy seeding (Fitzgerald 1978), and in South Island beech forests (where beech seeds lie dormant over winter) the numbers of both house mice and ship rats *(Rattus rattus)* reached plague proportions in late 1971 and early 1972, following the 1971 mast year (R. H. Taylor, pers. comm.). Stoats *(Mustela erminea)* are known to respond in turn to such rodent irruptions with a marked increase in their numbers (King 1978). The effect of this whole sequence of events on vulnerable birdlife is likely to be heavy losses from increased predation following a beech mast year (Riney *et al.* 1959). There is some evidence for such an effect in the Nelson Lakes area, where there were marked reductions in the numbers of robins *(Petroica australis)* and parakeets after the 1971/72 irruption of rodents and their predators (R. H. Taylor, pers. comm.).

South Island Kokako, with their tendency to nest in the understorey or subcanopy (Potts 1873, Smith 1888, Fulton 1907), their limited powers of flight and their habit of foraging on or near the ground (Travers 1871, Potts 1873, Smith 1888, Fulton 1907), are likely to have been particularly vulnerable to mammalian predators. After the penetration of New Zealand forests by ship rats (Atkinson 1973) and stoats (Thomson 1927) late last century, the birdlife of South Island beech forests would have been exposed to episodes, in the wake of beech mast years, when these predators were very abundant. Although South Island Kokako inhabited some regions without any beech (e.g. Stewart Island, South Westland), beech forest seems to have been a major habitat throughout most of their range. This predisposed them to occasional very intense predation pressure from ship rats and stoats, which they were ill-adapted to withstand, and was probably an important factor in the rapid decline of the subspecies.

ACKNOWLEDGEMENTS

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SEASONAL FISHING BY GANNETS IN MANUKAU HARBOUR

By R. B. SIBSON

On the west coast the nearest long-established gannetries to Manukau Harbour are Oaia, about 15 miles north from the Heads and Gannet Island off Kawhia, about 60 miles to the south. More recently in the 1970s surplus Gannets *(Sula bassana serrator)*, presumably from Oaia, began prospecting the Sugarloaf, also known as The Stack or Pillar Rock, which at low tide is linked to the mainland at the southern end of Muriwai beach (Reed 1979). By 1980 the Sugarloaf population had reached saturation point and every year now young adults are hopefully investigating nearby ledges on the mainland itself.

Gannets are not truly pelagic. They take most of their food in the comparatively shallow waters of the coastal shelf. When they enter Manukau Harbour and have passed Puponga Point they may take one of three main channels where the water flows strongly four times a day as tides rise and fall. The northern channel, Purakau, leads eastwards past Puketutu Island to Onehunga and so to the extensive shallows above Mangere Bridge. The central channel bears south-east to the Narrows between Karaka Pt and Weymouth and then broadens with many branching creeks. A third important channel heads south past Mako and Kauri Points, along the inner coast of Awhitu Peninsula to Waiuku.

This note is based on jottings from the personal observations of Ross McKenzie and myself made over 40 years and from census returns going back to the 1950s. To the sheltered waters of Manukau, Gannets seem to be seasonal visitors, being scarce between mid-September and May and most numerous from mid-winter to early spring, with a peak in August. On 15 out of 20 summer censuses (1961-1980) none was recorded at all; and the average for the other five counts was only two. It may be significant that in January 1942 when I spent some days on the Awhitu Peninsula, White-fronted Terns *(Sterna striata)*, but no Gannets, were seen daily fishing the Waiuku Channel. Yet in September, as I travelled by launch from Onehunga to Orua Bay seven Gannets were seen; and between 6 and 10 September, a few Gannets but no White-fronted Terns, fished the Waiuku Channel every day.

On 20/8/54 I watched at least 20 Gannets fishing close to Mangere Bridge. At one time, as seven were circling and plunging into a smaller bay, some Pied Shags *(Phalacrocorax varius)*, which had been resting on a basalt reef, flew across to join in the hunt. All the

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Gannets were adults with richly golden napes. A few gulls were attracted by the commotion. On 28/8/67, about full tide, ten or more Gannets were soaring high near Onehunga and above Mangere bridge. On 17/8/68, when the NZ Ecological Society was meeting in Auckland and there was an excursion to AMDB ponds, a dozen or more Gannets near Puketutu Island were watched with some interest as they flew in low circles and made shallow dives. Other significant sightings for August are c.200 off Seagrove on 13/8/61, 40 on 1/8/65, and 40+ on 19/8/66 along the Karaka coast.

Observations such as these prompted me to collate such material as I could find. Doubtless a regular watcher at Huia would log a few Gannets at almost any season over the deep narrow channel inside the Heads, as is shown, for example, by three at Huia on 15/10/67, eight at Weymouth on 10/5/66 (HRMcK), and four in mid-harbour off the end of Mangere airport on 8/4/74. But few seem to penetrate far up the channels till June, when hungry gatherings suddenly become conspicuous, especially along the Waiuku Channel, e.g. 40 off Glenbrook on 14/6/53, when the count for the whole harbour was only 47. Similarly, on 14/6/64, out of a census total of 112, 80 were along the Waiuku Channel or off Pollok Spit and 30 reached Weymouth. On 5/6/66, when 102 Gannets were logged, there was a lively swirl of 58 over the Weymouth 'Narrows,' where on 17/6/61 HRMcK had recorded an impressive 170+. A rather interesting record is of four on 2/6/58 riding out a westerly gale in the lee of Puketutu on the calm surface of AMDB pond No. 4 before it had become unsavoury. For 11 censuses taken in June, the average is 28.

Since August seems to be the peak month, it is a little surprising that for July the average number logged on 12 censuses is only 13. A note by Ross McKenzie reads, "Weymouth 27/7/57. A few about most days." On 8/7/66, at least 18 were enjoying good fishing between Puketutu and Hillsborough. On 11/7/79, Ross noted 30+ near Weymouth; and on 5/7/81, 52 followed the tide past Karaka to the Narrows. July is certainly a month when Gannets may be plentiful on the Manukau.

The obvious decline in September is not unexpected. By then some adults are already incubating eggs, and most are busy at their colonies, building nests and defending sites. September Gannets in Manukau may well be young adults which will either nest later in the season or not at all. On 20/9/63, a few were noted at Weymouth (HRMcK) and on 2/9/66 eight were off Puketutu.

Since most young Gannets in mottled brown plumage quickly leave local waters and head westwards towards Australia, they are rarely seen within the Heads and the small number of sightings is not surprising. The only record I have been able to find is of one near Weymouth on 15/3/58 (HRMcK). However, on the outer coast the corpses of fledglings that have failed to survive their first flights are washed ashore every autumn.

When Gannets are most numerous 'over the Manukau,' the Tasman Sea is at its most inhospitable and they are free from territorial cares. The major wrecks of the truly oceanic Tubinares usually occur towards the end of the winter, and the broad expanse of Manukau Harbour offers comparative shelter. Are June to August also the peak months for Gannets within Kaipara, Raglan and Kawhia Harbours?

Such numbers as I have quoted must be lured by good fishing. What species of fish are shoaling in such numbers that swirls of apparently ravenous Gannets engage in a frenzy of diving? Without being specific, Oliver (1955) mentions "garfish, herrings and young mullet." The new *Birds of the Western Palaearctic* enumerates at least 15 species of fish taken by British Gannets *(S. b. bassana)*. The fish range in length from 2.5 to 30.5 cm. Evidently hungry Gannets don't despise tiddlers. Have we among our members some budding ichthyologist who will tell us precisely what species of fish our Gannets are hunting when they follow the tides in the main channels of Manukau Harbour?

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SHORT NOTE

A CRESTED TERN IN HAWKES BAY

On 23 April 1981, during a beach patrol, after an easterly gale, between Westshore and Bay View, north of Napier, Rosalie Giblin, Cara Saxby and I came on a small group of White-fronted Terns *(Sterna striata)* with a larger tern in their midst.

The larger tern was similar in build to a White-fronted but smaller and less plump than a Caspian Tern *(Hydroprogne caspia)*. The plumage of back and wings was a darker grey than the pearl-grey of the White-fronted Terns; breast, abdomen, face, and back of neck were white; and a white patch showed on the wing near the carpal joint. The forehead was white, merging through speckled grey into a blackish-brown crown, which was rather pointed at the back and protruded slightly whenever the wind ruffled the crown feathers. The bill was greenish yellow, about 6 cm long, and powerful looking. The legs were blackish.

We studied the bird for about 20 minutes, but missed it in flight when passing gulls put the tern flock to flight.

This bird was later identified as a Crested Tern *(Sterna bergii)*, the fifth record for New Zealand.

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REISCHEK'S 1890 PAPER ON 'THE KAKAPO (Strigops habroptilus) IN THE WILD AND IN CAPTIVITY'

By K. E. WESTERSKOV

ABSTRACT

During his stay in New Zealand, 1877-1889, the Austrian naturalist Andreas Reischek studied, collected and kept in captivity Kakapo *(Strigops habroptilus)*. In addition to mention of Kakapo in papers in English, Reischek after his return to Austria in 1890 published a paper on the species in German, consolidating his experience and presenting new facts. A close and full translation of the paper is presented, together with notes and comments. The main sections discuss: unsociability, irregular breeding years, nesting, feeding behaviour, an alpine variety, winter ecology, parasites, plumage, trapping, offer of trapping Kakapo for Little Barrier, Kakapo in captivity.

INTRODUCTION

The Austrian naturalist and taxidermist Andreas Reischek was in New Zealand from 1877 to 1889. During this time he collected almost 1000 birds in addition to eggs, nests and skeletons, now in the *Naturhistorisches Museum Wien* (as well as an unknown number of other specimens sold or given to other museums, institutions and individuals); in the collection are 20 skins of adult Kakapo, 5 mounted specimens in a special Kakapo display case, 2 downy chicks and 2 eggs. In the *Oberosterreichische Landesmuseum Linz,* where Reischek was curator 1896-1902, there are 9 Kakapo specimens from a diorama made by him but not on display at present.

In addition to the 36 Kakapo specimens in Austrian museums, Reischek also kept live specimens for study, his first description of a pair thus held being published as early as 1878 (for translation see Westerskov 1980: 281-283).

While still in New Zealand, Reischek published 16 papers on birds in *The Transactions of the New Zealand Institute,* one of which (1884) contains a fairly detailed account of his observations of Kakapos until then. In subsequent papers there are brief mentions of Kakapo (Reischek, 1885: 98; 1887: 441) and two longer sections in *Yesterdays in Maoriland,* compiled by his son (Reischek 1930: 220-224 and 243-246).

In 1978, during a two-month stay in Vienna I found a series of ornithological papers by Reischek written and published in German in a somewhat obscure ornithological journal, *Mittheilungen des ornithologischen Vereines in Wien;* during a subsequent two-month

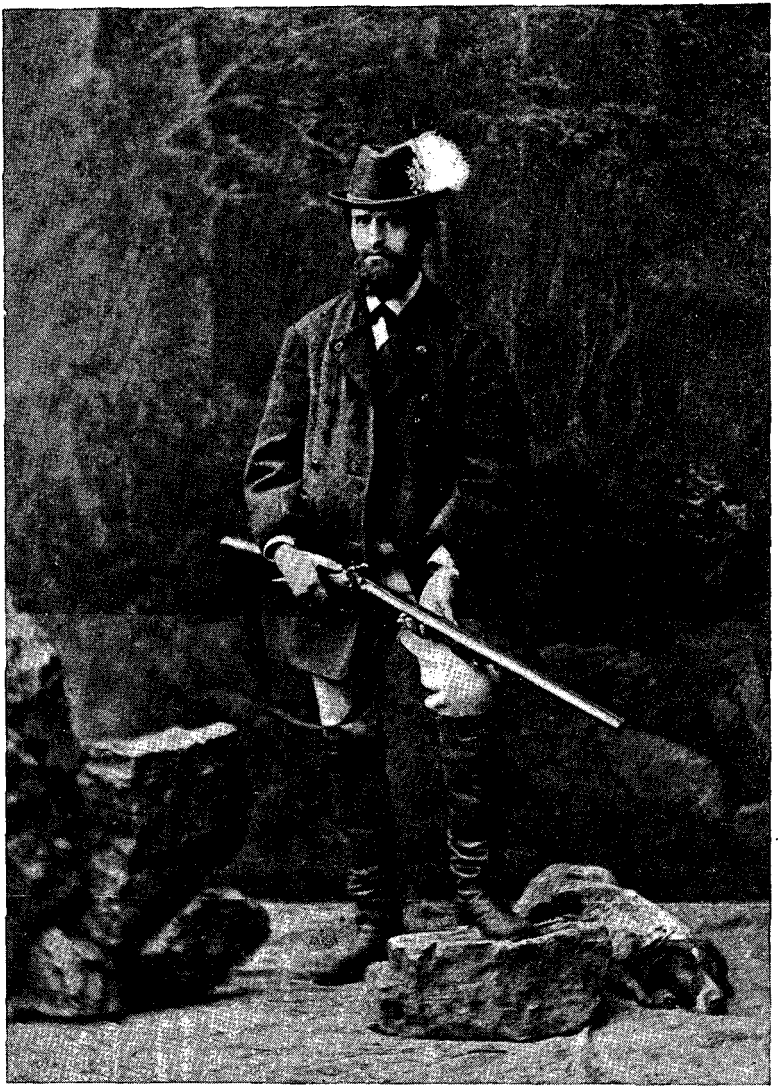

FIGURE 1 — Andreas Reischek, naturalist, taxidermist, hunter, would-be explorer, photographed in an atelier, probably in Vienna c. 1876 when he was 31 years of age. He is wearing traditional Austrian sportsman's attire of the day: loden coat with antler buttons and hat with **Gamsbart** (a clump of chamois back hairs). The gun is a double-barrelled, muzzle-loading, percussion hammer-gun. Photo courtesy Alexander Turnbull Library.

visit in 1980 to complete an examination of the Reischek material, I found another five notes and papers by Reischek. For the first two notes on New Zealand birds (Reischek, 1877; 1878) on Little Spotted Kiwi *(Apteryx oweni)* and Kakapo respectively, see translations in Westerskov 1980: 280-283. While some of these publications overlap in content Reischek's papers in the *Transactions of the New Zealand Institute,* others do not and contain valuable information, especially on the occurrence of rare forms, and biological observations.

One of these series, on the Kokako *(Callaeas cinerea),* has been translated and published (Westerskov 1979); this is the second such translation and more will follow.

Reischek returned to Vienna on 15 April 1889 but experienced difficulties both in gaining suitable employment and in obtaining satisfactory compensation for his large bird collection, which was not presented to the Museum in Vienna until 1891. He prepared his collections and did free-lance taxidermy, including work for the newly completed *Museum Francisco Carolinum* in his home town of Linz (now the *Oberosterreichische Landesmuseum*), where he was appointed *Kustos* in 1896. During the several years of uncertainty Reischek must have derived some satisfaction and stimulus from his writing and lecturing in Vienna and Linz on New Zealand bird life.

The local journal in which he chose to publish his series of New Zealand ornithological papers was an unfortunate choice from an international point of view. The *Mittheilungen,* printed in large *(quarto demy)* size, was local, in the German language, and was a mixture of ornithology, poultry management, cage bird and carrier pigeon keeping. It was little known in foreign countries and Reischek's papers on New Zealand ornithology appear to have remained unknown in New Zealand. None of them are listed in the *Aves* section of the *Zoological Record* for the period 1890-1893.

The following translation of Reischek's paper on the Kakapo is as close to the original German text as clarity allows, with minor alterations and interpretations as discussed in the notes and comments following the translation. For easier reading, I have added section headings: Reischek's original paper consists of only 11 paragraphs.

A copy of the original German text has been deposited in the Hocken Library, University of Otago, where it can be consulted by those interested.

THE KAKAPO *(Strigops habroptilus)* IN THE WILD AND IN CAPTIVITY

By Andreas Reischek

When the sun sets over the forests of New Zealand and when at dusk the first shadows fall and the lively multitude of birds of the day is silenced, then is the time when the Kakapos wake up in

their tree- and ground-holes where they have spent the day hidden by mighty roots.

They announce the start of their activities by hoarse screeches and soon set out to wander on their self-made tracks which are kept extremely clean; every Night Parrot, when using a track, bites off and consumes or at least tears off grasses and roots growing on the track.

These tracks are very like deer trails, and so it used to be thought they had been made by Maoris trekking from west to east. I had always doubted this explanation as for long there had been no Maoris in the west; if such a crossing had taken place a long time ago, the tracks would have been overgrown with the fast and luxuriantly growing vegetation as found throughout New Zealand. These communication lanes were, however, kept utmost clean and in good condition, and I soon found by watching the Kakapos that they were the caretakers.

Unsociability

When two Kakapos meet on these tracks, a bitter fight follows; the two opponents attack each other with beak and feet while their excitement is made known by their ardent screaming. When one of the combatants tires, he throws himself on his back and defends himself in this position against the attacks of his opponent. Such a fight ends either with the hurried escape of the defeated bird, which then is pursued by the victor for a short time, or with the death of the weaker combatant, which is killed by a bite in the throat.

The Kakapo is probably the most unsocial of all birds. Males of other species are usually antagonistic to one another, but they are never hostile to a female of their own kind. The Night Parrot, however, knows no gallantry. He knows only the right of the stronger, and the female as well as the weaker male is felled by his bite. Even during the mating period he restricts his tenderness towards his mate to *not* biting her to death or chasing her away. He does not perform a courtship display in order to win the favour of the female — in attack he gains the reward of love. The two partners separate immediately after completing mating and continue their lonely existence, every feeling of belonging together apparently extinguished: not once did I find two adult birds together in a hollow, even during the mating period.

Irregular breeding years

The Maoris maintain that the Kakapo breeds only once every five years, when the fruits of *Taphra Trycinetta** are ripe. However incredible this sounds — and at first I myself doubted the truth of

* Reischek's original form, should undoubtedly read: the fruits (tawhara) of the kiekie (**Freycinetia banksii**); see notes for details.

this claim — it appears to be not without foundation: only during the year 1884 did I find eggs and young in different stages of development, but in 1885, 86 and 87 neither I nor various collectors and hunters known to me as fully reliable could find any signs of breeding Kakapo in the same region.

Nesting

The female chooses as nest site a hole in the ground that has several entrances and sections so that the bird can mislead an enemy if pursued. One of these nest burrows with two entrance holes and two sections which I measured had the following proportions: the entrance tunnel was a foot [30 cm] long and led into the larger chamber which was 24 in. [60 cm] long, 18 in. [46 cm] wide and 12 in. [30 cm] high; connected with this chamber via a one-foot [30 cm] long tunnel was a smaller hole, measuring 14 in. [36 cm] in length, 12 in. [30 cm] in breadth and 6 in. [15 cm] in height.

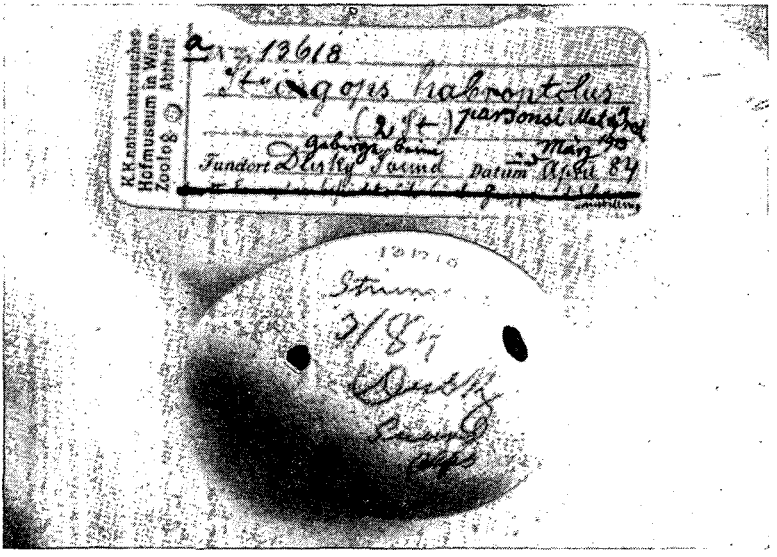

FIGURE 2 — Kakapo egg in the Reischek collection, Vienna, collected by Reischek in Dusky Sound, April 1884. The **3/84** written with pencil on the shell must be a Reischek (or later) museum error as Reischek (1884:188) did not arrive in Dusky Sound until 10 April; in the museum's egg catalogue under accession No. 13 618 is also listed one egg (not two) of '**Stringops habroptilus,** Dusky Sound, April 1884.' There were two eggs in box under this entry, both well preserved; the egg shown measures 51.5 x 37.2 mm. Photo: K. E. Westerskov.

FIGURE 3 — Downy Kakapo chick (a few days old) in the Reischek collection, Vienna, collected by Reischek, probably in Dusky Sound, April 1884 (cf. Reischek, 1884, p. 195). Reischek's original label is missing and no catalogue entry is available. Photo: K. E. Westerskov.

The nest was found in a hollow in the first chamber and consisted of gnawn-off chips of wood and breast-feathers of the Kakapo. The female herself pulls these feathers to provide a soft warm layer for her offspring; an incubating female is thus easily recognised by her bare underside.

The clutch consists of two to three dirty yellowish-white eggs. I have always found only two eggs in a nest, but reliable people have assured me that three eggs are often found in a clutch. The newly hatched chicks are covered in white down, which soon gives way to the feathered plumage. The feathers show dirty white down at the tips until the young bird is a little over six months old.

When the young Kakapos leave the nest their short tail- and flight-feathers are as completely developed as in their parents. They differ from their parents only in their smaller body size and darker colours. As soon as the young have had their first outing away from the nest, they are abandoned by the mother and from then on go

through life alone. The father appears to show no interest at all in his progeny. The female at the nest makes as little noise as possible, and in the nest surroundings she moves about with the greatest wariness in order not to give the nest location away.

Food and feeding behaviour

The food of the Night Parrots consists exclusively of vegetable matter: grasses and their seeds, lichens, moss and roots, eaten in large quantities. The Kakapo eats as much as he possibly can, and in satiated specimens, the crop is still bulging full. The plants are bitten off with the beak and held with a foot, and so food is consumed in the same way as by other parrots. The birds are fattest in the New Zealand late autumn (May-June) because at this time they find everywhere a surplus of food and need not set out on long wanderings in order to find it, as they have to in winter when the vegetation is covered in snow.

At winter time the Kakapo grows thin because, even when it finds enough lichens in the shelter of the shrubs to avoid starvation, it must search for its food and for this purpose often covers vast areas. The Kakapo runs when carrying out these food-gathering wanderings; when snow covers the ground it paves its way on the same track, which sinks 1-2 inches [2.5 - 5.0 cm] into the snow cover.

During the feeding excursions the Kakapo develops high speed and endurance. One bird of which I had made drawings had a peculiar pace; it ran several steps and then made a few jumps, whereas all other Kakapos didn't make these jumps; the tracks of this bird were thus distinguishable and I observed that it covered three English miles [4.8 km] during a night.

The Kakapo is also capable of moving, skilfully climbing in tree branches, although it is comparatively rarely seen in trees. Its flying ability is little developed, and when fleeing it seeks to escape from an enemy usually by running, in which the wings are used only to help keep balance.

An alpine variety of Kakapo

A variety of *S. habroptilus* which I found only in the mountains and which I accordingly have given the name var. *alpinus* is extremely adept at climbing over rock. This variety differs from the Kakapo living in the lowlands in its considerably bigger body size as well as by its more shining plumage coloration and splendid pattern: the feathers on the back are adorned with bluish-green, iridescent mirror-like reflections; the skeleton is also more robust than in the common variety and the bird is much rarer than the latter.

I found this Kakapo, as already mentioned, only in the mountains and only in altitudes between 2500 and 5000 feet [820-1640 m]. As I first saw this bird during the summer, I thought that it would wander to the lower-lying bush in winter. But when I visited the mountain

FIGURE 4 — An example of Reischek's fine taxidermy: a Kakapo obviously feeding and holding some food material (now lost) in its left claw. From an original Kakapo diorama presented to the **Museum Francisco-Carolinum** Linz. Photo: K. E. Westerskov.

region in winter, with snow covering the ground, I found its tracks on the white cover.

Kakapo in winter

During the summer I had found Kakapos especially numerous in an area where one side of the valley consisted of a deep and steep rock wall down which one could get only by letting oneself down on a rope. I wished to visit this area to study the winter life of these Kakapos, but when I arrived at the gorge I lost heart when I saw the snow and ice masses covering the area. I hesitated a long time until I finally decided in the interest of science to set out on the dangerous journey into the depths of the mountains.

First, I roped my dog Caesar down into the abyss — the faithful companion of my lonely travels, often during long months my only company — and then I followed, recovering the rope. Here I found the tracks of the Night Parrot in fair number. To learn about its nightly activity, I dug a hole in the snow which admitted me and my dog, and then covered us both with a white sheet in order not to attract the attention of the bird.

Here I sat for hours, above me the clear star-studded sky and all around as far as the eye could see nothing but the white expanse of snow, brilliant in the moonshine. Nowhere a tree or shrub; at most a tuft of snow grass, a top of a stunted silver beech projecting above the white mass, all a picture of splendid emptiness. To this must be added a biting cold which stiffened my limbs as I did not

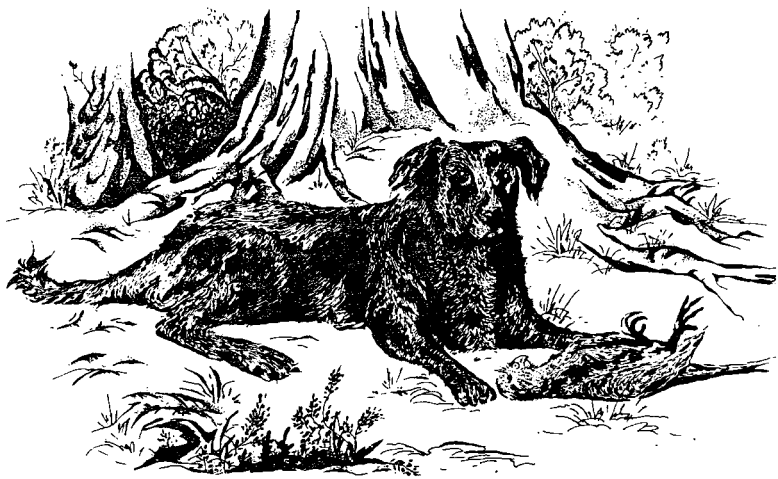

FIGURE 5 — Caesar, Reischek's efficient dog and faithful companion throughout his travels in New Zealand; here with a captured Kakapo. Redrawn by J. Clough from frontispiece to Reischek's **The Story of a Wonderful Dog**, Auckland 1889.

dare to make any movements which might betray my presence to the exceedingly fine hearing of the Night Parrots.

Sitting here I saw Kakapos hurriedly running by. They stood out sharply against the dazzling white snow wherever it was bathed in moonlight. Now they would disappear into the darkness of the shadows around a rocky outcrop; after a while they would reappear to examine thoroughly every tuft of snow grass for seeds or gnaw the soft twigs of akeake *(Dodonaea spatholata)*.*

When the cold had become too much for me and I had to move to warm myself by exercising — in order to avoid exposure and freezing stiff — the parrots disappeared at my first movement; they fled fast, running to seek shelter in their holes in the ground to which they had scratched passage ways through the snow.

It is one of the characteristics of the Alpine Kakapo that it digs its own sleeping chamber and always returns to it, whereas the Kakapo living in the lowland bush at day-break slips into the first and best hollow it finds.

The departure from this valley was laborious and dangerous and I now think back on the event with horror. As already mentioned, one side of the valley was bounded by a steep, insurmountable rock face while the terraced formation on the other side, seen from above, appeared to allow an easy climb; during the summer I had climbed this slope with ease.

As I came closer I noticed to my horror that the distance had deceived me: the terraces extended almost endlessly and furthermore were covered with ice and frozen snow in a way that imperilled every step. It was possible to cross the sloping walls separating the terraces only by chopping steps in the ice cover, using my ice-axe, a terrible job for my exhausted strength in the icy winds. If the ice cover had been only a few inches thicker a crossing would have been impossible. As I climbed up a terrace, I pulled my dog after me with the rope.

Sleep and fatigue often nearly overpowered me, but by exerting all my will and strength I resisted the temptation to take a short rest because I knew that a sleep, under these conditions, would have been my last. If my strength had given out then, if I had yielded to my need for rest, my bones would today have been bleaching under the New Zealand sun.

Finally I scaled the last rock wall; exhausted, I sank to the ground and after a while for the first time I was able to warm my stiffened limbs somewhat by rubbing them with snow. Then I tramped for an hour downwards to the bush where I lit a fire right around me, which dried out my soaked clothes. Only then was I able to search for my camp.

* Reischek's original form, which is a mistake and should probably be **Olearia colensoi**; for details see notes.

The fatigue experienced during this expedition confined me to my sick-bed in camp for a week, shaking with fever; but I consoled myself with the thought that I had obtained several beautiful specimens of the Mountain Kakapo.

Parasites

It is a strange fact that the Mountain Kakapo, which is always much fatter than the bird living in the plains, is infected with parasites quite absent from the plains bird. These parasites are tapeworms of a milky-white colour, about ¼ inch [6 mm] thick and 6 in. [15 cm] to 2 feet [60 cm] long; two or three worms are often tied together in a knot, and a single one of these parasites is often twisted into a knot.

The presence of such spongers, however, does not indicate presence of a disease because the bird is almost invariably fat and well nourished.

Abnormal plumage coloration

In September of the year 1884 I found in Dusky Sound a Mountain Kakapo that was striking by its abnormally coloured plumage. The head of this bird was pale green; back, wings and tail were yellowish green adorned with dull yellow spots; neck and breast yellow, also paler spotted; beak yellowish, feet silvery grey, and eyes dark brown.

Sunning themselves

In spite of being nocturnal the Kakapo loves the rays of the sun, and I often saw birds sunning themselves stretched out on a rock or sitting on the dwarf shrubs with obvious pleasure. Some of them let me come so close without fleeing that it was possible for me to catch them.

Kakapo becoming rare

Kakapos have already begun to become rare and will soon be as localised as the kiwis. According to Chief Wahanui of the Ngati Maniapoto tribe in Mokau, the Kakapo was formerly so widely distributed in the North (Island) that his grandfather ate Night Parrots. Today no more are to be found, as they yield to the onslaught of European civilisation as it continues to spread and are incessantly pursued by the half-wild dogs.

This dying-out of Kakapos and species of kiwis was discussed at a meeting of the Auckland Institute by Chief Judge Fenton in a lecture on the dying-out of the Maoris, their art, and the New Zealand fauna. He proposed to introduce these birds to an island where their requirements are met and where there are none of their enemies in order to save them from complete extermination.

Little Barrier Island as a bird sanctuary

The lecturer described Hauturu Island* as such a suitable place; it lies to the north, is quite large, 2000 feet in height, and covered with a vegetation which satisfies the demands of the birds.

I also knew this island well and agreed with this proposal. I offered at my own expense to provide Kakapos and kiwis for release on the island. Accordingly, I took with me from Dunedin, the capital of Otago, cages and suitable foodstuffs and proceeded on a journey to trap the Night Parrots and kiwis.

Trapping the Kakapo

When, with much trouble, I had caught several of these birds, I placed them in the cages in such a way that females and males were together as I assumed they were more likely to tolerate one another than if the sexes were kept separately. Next morning to my great horror I found, however, all the females killed by the male birds, the dead birds lying on the floors of the cages with severed throats.

From then on I kept only birds of the same sex together in one container, and while these also fought one another to begin with, none became the master of another and in the end they became accustomed to one another.

After the birds had adapted well and were eating satisfactorily, I put them aboard the government ship with the instruction that from the first port of arrival they be sent immediately to the Director of the Auckland Museum (to whom I wrote at the same time) so that he could liberate the birds right away and send me new cages so that I could deliver more Kakapos and kiwis. These birds unfortunately never reached their destination — but more about that later.

Hoping to receive new transport cages I continued my trapping and brought the caught birds together in a pit in the ground where steep walls should prevent their escape. There was no danger of escape by flight as the Kakapo only leaps down from higher objects and never flies upwards.

During the first night the Kakapos spent in this pit they managed nonetheless to escape by digging through, and it was only after much trouble that I recovered the escapers. I now secured the pit against further digging attempts of my captives, but in the end I found I had to guard them all night. There was sufficient space in this pit for the birds to get away from one another and the Kakapos tolerated one another; they also lived in harmony with the kiwis with which they shared the pit.

After I had kept the birds in this way for several weeks and all the time waited in vain for transport cages, I came to the conclusion that no cages had been sent to me. Annoyed over this, I gave the birds away or let them loose in their native habitat. Immediately after this I received a letter from the Secretary of the Acclimatisation

*Now called Little Barrier Island, covering 2817 ha, highest point 722 metres.

Society in which he acknowledged receipt of my letter but also informed me that the advised shipment had not arrived at his address.

Subsequent investigation of this matter showed that, as a result of violent storms, the ship had not reached port till after a six-week voyage, and during this time all the birds had died.

Kakapo in captivity

The newly trapped Kakapo behaves to start with in an extremely violent fashion, bites wildly everything in sight, and runs incessantly backwards and forwards in the cage. It also does not accept food till after several days have elapsed. When the first wildness has gone, it soon accepts the turnips, potatoes and vegetables which make up its food in captivity and consumes appreciable quantities; but it drinks only a little water.

After some time Kakapos caught as adults usually become so tame that they will take food out of your hand and will let themselves be touched without biting. Artificially reared birds of this species become even more trusting; an acquaintance of mine owned such a bird which at night-time ran to the bush but always returned to the house at daybreak.

Although the Kakapos, as already mentioned, eat a lot as soon as they have adapted to captivity, they do not thrive in confined spaces but grow thin and finally die. I believe that the reason for this is the inadequate exercise which the captive birds can obtain.

The cage to accommodate Kakapos must be very strong and made entirely from metal or at least be safely lined with metal as wood would very quickly be destroyed by the parrots' beaks.

Kakapos for Europe

I wanted to take with me to Europe several Night Parrots kept in a roomy cage in which there was also a darkened sleeping box. Unfortunately the birds escaped through a cage door left open by the uncalled-for curiosity of a passenger. When I returned to the ship before the departure from the country I was advised that my Kakapos had escaped and fled to the yardarms.

The captain was kind enough to let his crew help me try to recapture the birds, and now began a hunt during which I had to laugh again and again in spite of my annoyance over the probable loss of the Kakapos. However skilfully the jack-tars negotiated the rigging the Kakapos understood it even better and soon had reached the outermost tops. Harassed here too, the birds glided through the air into the sea and found their deaths in the waves. Only a few Kakapos again reached my hands and I also lost these soon through a seasickness so all the costs and trouble I had spent had been in vain.

NOTES AND COMMENTS

A few comments are necessary to explain various obscure points and verify parts of the translation.

Reischek called the Kakapo *Stryngops habroptilus* — although in his 1878 note he correctly called it *Strigops habroptilus* following most writers of his day adding an *n* but in this paper also altering the *i* to *y: Strynġops.* G. R. Gray (1847), curator of birds in the British Museum (Natural History) from 1831 to 1872, described this species as *Strigops habroptilus,* well named from *strix* = owl and *ops* = face, *habrops* = soft and *ptilon* = feather, meaning the soft-feathered owl-face. Buller (1868: 11) correctly called it *Strigops* but as early as 1870 T. H. Potts listed it as *Stringops (Strigops) habroptilus* and from then on *Stringops* was in common use, for instance by Buller, Finsch, Haast, Hutton, and Sharpe. Reischek followed common practice at the time by using *Stringops* in his description (1884), but the 1890 use of *Stryngops* was apparently a lapse by him.

Discussing the irregular breeding years, Reischek wrote that breeding takes place only every five years when the fruits of ' Taphra Trycinetta is an erroneous rendering of *Freycinetia.* This fits in well the Maori and generic names of an important food plant. The Maori name for the fruit of kiekie is tawhara (= Reischek's Taphra) and Trycineeta is an erroneous rendering of *Freycinetia.* This fits in well with the following quotation from Reischek's *Yesterdays in Maoriland:* 222: " The Maoris maintain that the kakapo breeds only once every five years, when the berries of the tafra *(Freycinetta)* ripen." The species name is kiekie *Freycinetia banksii;* its fruit is called tawhara.

There are two obscure references to trees from when Reischek studied Kakapo in the alpine snow country.

(1) " a top of a stunted *Silberfichte* projecting above the white mass." This German name refers to the silver fir, the commonest species of fir to a European being *Abies alba,* but it is used generally in both languages for species of the genus *Abies;* none of these were found then or are found now in Fiordland alpine valleys, and Reischek was using a familiar and common tree name for the small stunted trees he saw sticking up through the snow. In his 1884 paper (p. 197) Reischek says: " I found three birds in different places, sitting upon low silver-pine scrub." I have translated it as silver beech, but it could have been totara, which has sharp-pointed, narrow, *Abies*-like leaves.

(2) Kakapos were examining tussock for seeds and were gnawing the soft twigs of " Ake-Ake *(Dodonaea spatholata)."* Here Reischek has made a mistake as akeake *Dodonaea viscosa (= spatholata)* is a lowland-coastal shrub, not found in the alpine scrub zone and occurring only north of a line running approximately from Greymouth to Banks Peninsula (Poole & Adams 1963). In his *Yesterdays in Maoriland,* Reischek (1930: 244) has an almost identical description but corrects the species' name: " . . . and pecking at the soft branches of the ake-ake

(Dodonaea viscosa)." After a visit to certain southern islands of New Zealand, Reischek (1888) mentions " the akeake (*Olearia* sp.)." Williams (1957) records that akeake is used in reference to: " *Dodonaea viscosa, Olearia traversii* and other species, trees " and Salmon (1963) uses akeake for both *Dodonaea* and *Olearia avicenniaefolia.*

The Maori name *akeake* is used for *Dodonaea viscosa (= D. spatholata)* and for some of the shrubs of the genus *Olearia.* Reischek obviously knew an alpine *Olearia* as akeake but in the 1890 paper used the Maori name and *Dodonaea spatholata* in error. D. V. Merton has suggested that the most likely food plant Reischek referred to was *Olearia colensoi* (known to be a common and favoured food of the Kakapo occurring both in Fiordland and on southern islands), and in the translation this name has been substituted for the obviously incorrect *D. spatholata.*

Reischek's reference to Chief Judge F. D. Fenton's proposal to make Little Barrier Island a bird sanctuary for Kakapos, kiwis and other threatened native birds has the following background. At the meeting of the Auckland Instiute held on 18 October 1886, four papers were read. One of these was Reischek's (1886a) paper on the Pied Tit, Robin and Bellbird. According to the *New Zealand Herald,* 19 October 1886 (p. 3) reporting the meeting: " Professor Thomas read a paper on ' Ornithological Notes ' by Mr Reischek. He added that it appeared that the birds of New Zealand seemed to have less power of resisting their various enemies than those which had had to go through keener competition in their struggle for life. Judge Fenton suggested that the members of the society should make an effort to get the Little Barrier Island (Hauturu), where the birds alluded to were abundant, into their own possession. Mr Reischek and Dr Murray Moore also spoke."

At the following meeting of the Auckland Institute, held on 14 November 1886, Reischek (1886b) made the following proposal: " If the members of this Institute are in favour of obtaining Hauturu Island for preserving and protecting the Native birds, from my knowledge, and after many years studying the habits of New Zealand birds, I could not recommend a more favourable place . . . . and if my aid in the project is of any use, I will be most happy to procure (gratis) live specimens of both sexes of *Apteryx* (kiwi) and *Stringops* (kakapo), if the Committee will provide me with cages and arrange for the transport, before or when I am again on the West Coast, about December next." It is about the fate of this proposal that we have read in his Kakapo paper translated above.

The claims of Little Barrier Island as an ideal bird sanctuary were set before the Government in 1891 by Judge Fenton. In 1892 Hugh Boscawan camped on the island and reported to Parliament on its suitability. The island was bought by the Crown under the provision of the Little Barrier Island Purchase Act 1894 as a preserve for flora and fauna (Hamilton 1961).

Some of the comments made on this manuscript by D. V. Merton, Wildlife Service, who has probably had more experience with Kakapos in the field than anyone else, will be of interest; Merton found many of Reischek's observations " of very real significance to current research on Kakapo." Different points will be discussed in the order in which they occur in Reischek's text.

Merton has found that most of the Kakapos located in recent years have been roosting in low trees, on the ground in dense cover, under tussock bushes, or in shallow natural cavities; rarely in holes as described by Reischek. He further found that Kakapos maintain tracks only during the booming periods: such long well-defined tracks along ridges, as rescribed by Reischek, are now known to be the contiguous " track and bowl systems " of neighbouring males on an arena. They are thus not for migration or commuting, but for courtship purposes only; they belong to several birds and are maintained almost exclusively during the irregular booming seasons. 'Tracks ' used at other times of the year are not deliberately maintained by the birds; this is supported by H. A. Best (pers. comm.) from recent observations on Stewart Island.

Reischek comments about intraspecific hostility of Kakapos to the point of killing one another and even males killing females. Merton wonders if Reischek had *seen* this in the wild; he suggests that Reischek's observation of captive birds may have been extrapolated as the basis of the dramatic statement of Kakapo antagonism and of males killing females in the wild. Merton has found that in the wild they live singly and are intolerant of one another, and that in general each bird has a large home-range (at least 1 km^2), except during the courtship period. If Reischek's observation is correct, such fighting behaviour would occur only during the courtship season; in mid-summer when little if any snow was about. Without night vision equipment — as used now — the recorded observations would seem impossible in the wild, and Merton suggests that Reischek probably inferred such encounters after hearing pre-booming social interactions, during which (Merton says) "you would swear the birds were killing one another."

Merton agrees with Reischek's observation that the " Kakapo is the most unsocial of all birds " and says it is fully supported by recent observations; they are intolerant of one another, male and female of their own species; he doubts, however, that males would, under normal circumstances, ever kill one another or females in the wild: " Such behaviour is counter-productive and suicidal to the species."

Reischek apparently never saw the Kakapo's elaborate cortship display as he had no night vision equipment. Although he did study Kakapos by moonlight, he is not likely to have seen them closely enough to see the display. Kakapos do have an elaborate and spectacular courtship display during the night, booming and displaying from established bowls or courts on arenas (Merton 1977).

Observations at two nests on Stewart Island in the 1980-81 summer have confirmed that the female alone tends the nest.

Reischek's comment (based on what he had learned from the Maoris and supported by his own observations) that Kakapos breed only every 5 years when the fruits of kiekie are ripe was considered by Merton to be of considerable interest and is supported in principle by recent findings: "We have found that booming (= breeding) occurs at intervals of 1-4 years, usually every 2 years, always in summer (in the South Island and on Stewart Island). It is almost certainly regulated by food availability and/or quality." Further, "in some years *all* birds in a region boom, in others *none* boom, and yet in others *some do* and others in neighbouring valleys *do not*. We have yet to confirm that no nesting is attempted by females in non-booming years, but I am sure Reischek and his contemporaries are correct in this assumption."

Of the two Kakapo nests found in the 1980-81 summer, one was under a tussock clump and the other in a shallow natural cavity. Merton has not seen Kakapo burrows as described by Reischek and suggests that they may in fact have been petrel burrows taken over by Kakapos because, even in an earth-floored enclosure, Kakapos seem unable to tunnel under a side wall to freedom.

Reischek's observation that young birds show dirty white down at the feather tips until 6 months old, Merton finds of interest and perhaps of practical application in identifying birds of the year and thus proof of recent breeding.

Reischek's conclusions on the food of the Kakapo are by Merton considered correct after examination of many hundreds of droppings. Merton has found that Kakapos have a most unusual if not unique method of feeding, all grinding of food items being done in the bill. Except for some seeds, only very fine material is taken in; the gizzard is small and degenerate and its function of grinding food seems largely to have been taken over by the bill.

Regarding flying ability Merton agrees with Reischek; Merton finds the Kakapo's powers of 'flight' "approximate those of a fat Black Orpington hen"; its 'flight' is a wing-assisted leaping or parachuting of steep descent for short (4-5 m) distances only. Merton has often seen Kakapos climbing in trees up to c. 15 m, and about 40% of birds captured have been in trees, at heights of 1-6 m.

Merton comments that: "In mountainous country (Fiordland), adult males in breeding condition often migrate to higher levels to tend arenas. Females presumably inhabit lower areas. This would account for larger (male) birds, weighing 2.0-3.5 kg, in fine plumage at higher levels, and females weighing 0.75-1.5 kg elsewhere. Most sexually active male Kakapo we have found in Fiordland in recent years have been at 2500-3500 ft [760-1065 m] above sea level. They lived nearby or at slightly lower elevations at other times." He concludes that Reischek's suggested bigger alpine race may in fact have been mature males encountered at higher levels, and that the smaller birds found at lower levels are likely to have been females and young birds.

Reischek's long description of his visit to the Kakapo country in winter is a somewhat romantic account of an undoubtedly harrowing experience, in both length and emotion somewhat out of step with the remainder of the largely descriptive article. Merton has pointed out that the scene described is an unlikely landscape for Kakapo, and the proximity of the birds to one another is suggestive of activity on an arena. Such activity, however, is not known to occur in winter months. It is not possible to pinpoint the locality, but Merton suggests it is "most likely in Fiordland on account of Kakapo abundance at that time, the steep terrain and the extent of snow and ice. I suspect it may have been the Milford catchment, access to which at that time was by rope via the Homer Saddle."

In alpine areas Kakapos often boom from high vantage points. Merton comments that sexually active males may weigh 2.5-3.5 kg, while in non-booming seasons these same birds may weigh only 1.8-2.2 kg.

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SIZE DISCREPANCY BETWEEN EGGS OF WILD AND CAPTIVE BROWN KIWI
(Apteryx australis mantelli)

By BRIAN REID

ABSTRACT

Kiwi eggs laid in captivity are significantly smaller than eggs laid in the wild (mean weights, 360 g and 431 g respectively). The reason is not known but is believed to be related to diet.

INTRODUCTION

The 33 eggs used to confirm the reliability of the expression 0.565 ab^2 for calculating the weights of Brown Kiwi eggs (Reid, elsewhere in this issue) consisted of 26 'Zoo' eggs averaging 115.4 x 72.4 mm and 346.4 g (calculated mean, 344.5 g), and seven 'wild' eggs averaging 125.4 x 77.9 mm and 428.2 g (calculated mean, 430.5 g). In this limited sample the 'average' wild egg was about 80 g (23.5%) heavier than the 'average' Zoo egg.

These data suggest that eggs laid in captivity are much smaller than eggs laid by 'wild' (free-living) birds, and to investigate this anomaly I have applied the expression 0.565 ab^2 to all eggs for which measurements are available.

In addition to the 33 eggs mentioned above, measurements alone are available for a further 149 eggs and fresh weights alone for three eggs. The material includes 107 eggs laid in the wild by 86 females and 78 eggs laid in captivity by 19 females.

SIZE, SHAPE AND WEIGHT

Size: Measurements for 182 eggs are plotted in Figure 1. Wild eggs have a mean size of 125 x 78 mm, range 104-135 mm and 66-86 mm. The mean for Zoo eggs is 118 x 73 mm, range 95-132 mm and 64-82 mm.

Shape: Inconsistencies in shape occur in both wild and Zoo eggs. In both samples most eggs are elliptical or oval, but some are conical with pronounced blunt and pointed ends and others have little taper, both ends being similarly rounded. Some eggs are broad and others elongated. The length : diameter ratio varies from 1 : 0.52 to 1 : 0.71 (mean 1 : 0.625). Relative to their lengths, eggs laid in the wild generally have a greater diameter than eggs laid in captivity, and in both groups the L : D ratio tends to alter with size with smaller eggs being proportionately wider (Table 1).

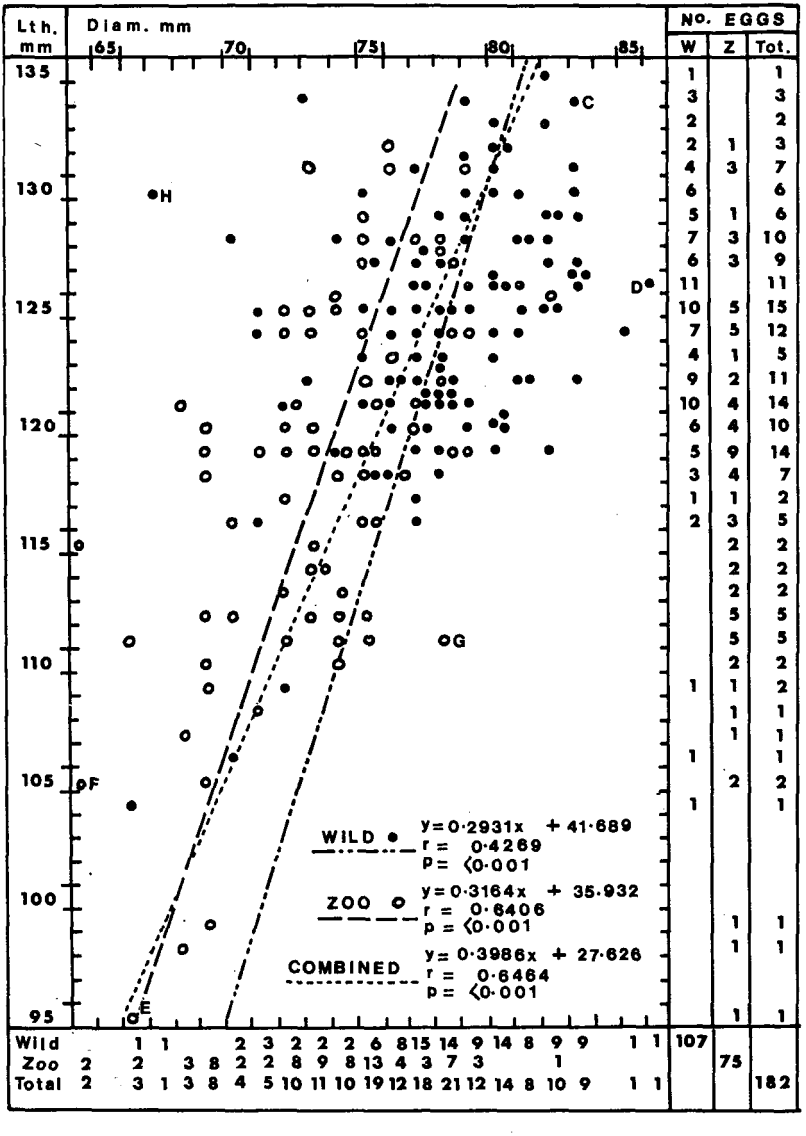

FIGURE 1 — Length and diameter of North Island Brown Kiwi eggs. Six eggs (with letters C-H) are illustrated in Fig. 2.

TABLE 1 — Length:diameter ratio of wild and Zoo kiwi eggs

Length Class	Wild Eggs		Zoo Eggs	
mm	N	L:D Ratio	N	L:D Ratio
131 - 135	12	1: 0.60	4	1: 0.58
126 - 130	35	1: 0.62	7	1: 0.60
121 - 125	40	1: 0.63	17	1: 0.61
116 - 120	17	1: 0.65	21	1: 0.62
111 - 115	-	-	16	1: 0.64
106 - 110	2	1: 0.66	5	1: 0.65
95 - 104	-		5	1: 0.67

Variations in size and shape are shown in Figure 2.

Weight: When the fresh weights for 152 eggs, most calculated from measurements, are included with the original 33, the difference between the means of wild and Zoo eggs is reduced (107 wild eggs, 431 g, SD 48.8; 78 Zoo eggs, 360 g, SD 53.0). The wild eggs are heavier by an average of 71 g (19.7%). An analysis of variance of the enlarged sample showed that the difference in weight between wild and Zoo eggs is statistically highly significant ($F1, 183 = 10.8$, $p < 0.001$).

Figure 3 shows the percentage of wild and Zoo eggs in each 20-g weight class.

DISCUSSION

There are no obvious explanations why kiwis in captivity lay smaller eggs than kiwis in the wild. In the domestic fowl a reduction in egg size can rseult from several causes or circumstances (Romanoff & Romanoff 1949). The bird's age, body size and condition, health and diet are those most likely to apply to captive kiwis.

Age: Domestic fowls produce their largest eggs when 2-4 years old. Thereafter, egg size decreases with increasing age, and eggs laid by a hen during her last year or two of production may be 8-16% (average 11-12%) lighter than those laid during her prime.

As all Zoo eggs in the sample were laid by kiwis that were adults of unknown age when taken from the wild, it is reasonable to assume that the captive group is biased in favour of older birds. Data from two birds at Otorohanga, however, appear to annul the

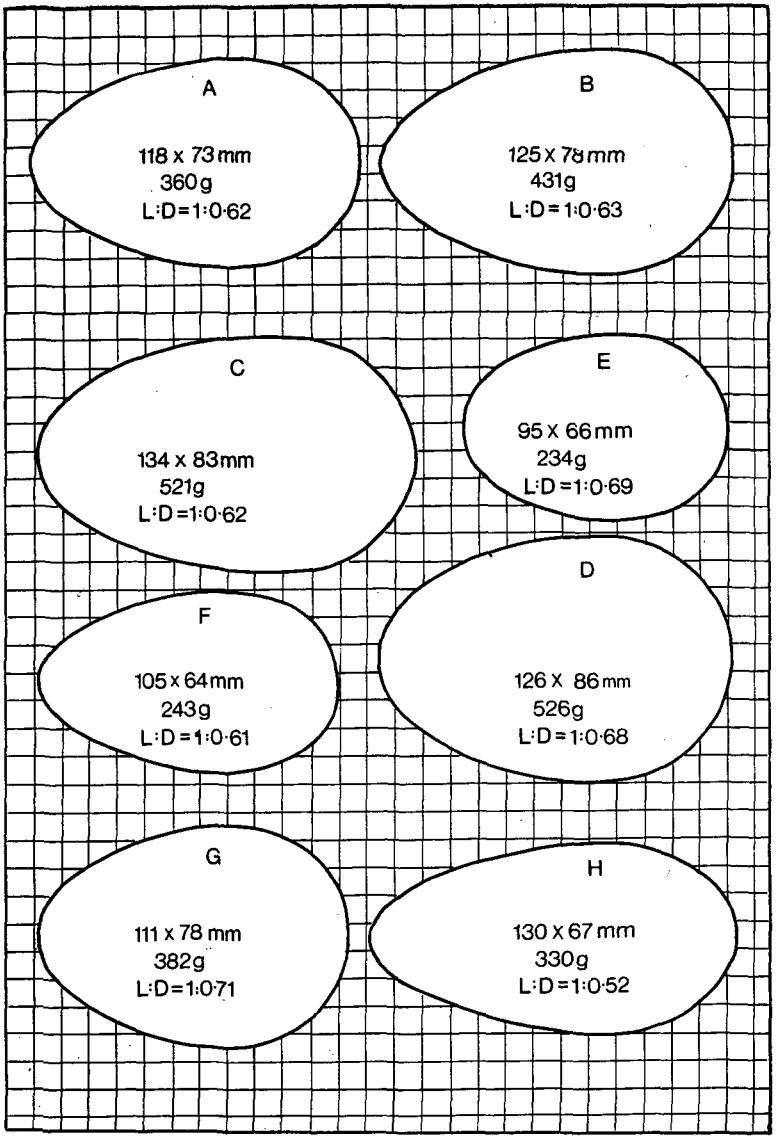

FIGURE 2 — Extremes in shape and size of North Island Brown Kiwi eggs (drawn to scale on 1 cm grid). Eggs A & B represent the 'average size' Zoo and wild egg. Eggs C & D are the heaviest and eggs E & F the smallest eggs in the sample. Eggs G & H are proportionately the broadest and the most elongated in the sample.

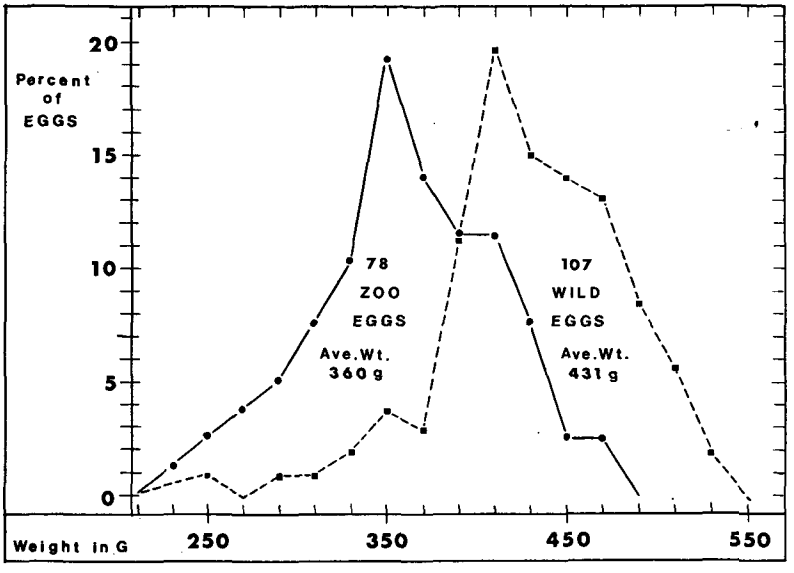

FIGURE 3 — Weight distribution of Zoo and wild North Island Brown Kiwi eggs plotted in 20-g weight classes.

supposition that the smaller size of these eggs is age-related. Both have laid regularly since coming into captivity — one producing 26 eggs in seven years, the other 32 eggs in six years, and the eggs have not decreased in size with increasing age of the hens.

Free-living kiwis lay one or two eggs a year, and so an annual production of four, five or sometimes six eggs by Zoo birds is incongruous. In domestic poultry the laying rate decreases with age; annual egg production by old birds drops to about 40% of their peak production. It would indeed be a unique biological adaptation if ageing kiwis increased egg production threefold in response to a benign habitat, while simultaneously decreasing egg size for other reasons. The effect of age on egg size in kiwis is not known but is assumed to be little or none.

Size: Egg size is broadly related to body size and, within a species, larger hens tend to lay larger eggs. Size is difficult to measure in living birds and precise data on the sizes of kiwis are lacking. Size can be obtained only from skeletal measurements and the usual method (weighing) gives a bird's weight without indicating the relative contributions of linear dimensions and condition (fat deposits, gut content) to a bird's weight.

As the range in weights (from emaciated to obese) obtained from Zoo birds duplicates that obtained from wild birds, there is no evidence that the smaller eggs indicate a disproportionately large number of small adults in captivity.

Health: Over the years some laying birds in captivity have been debilitated. However, although in one or two instances egg size may, perhaps, have been influenced by the health of the hen, there is no evidence that stress or any pathological condition has coincided with oogenesis and resulted in small eggs.

Diet: In the wild, kiwis eat earthworms, a wide variety of insects and other invertebrates, and some vegetable matter. In captivity an approximately uniform diet is fed at all institutions. The basic ration, which includes beef (ox-heart or skirt steak), rolled oats or equivalent cereals, wheat germ, soya or corn oil and a calcium-based mineral-vitamin additive, contains (dry weight) 54-55% protein, 16-17% fat and oil, 25% carbohydrate and 4% ash. This provides each bird with approximately 1380 kJ (330 Kcal) daily, and the premix ensures that essential micronutrients are available at levels matching the known requirements for breeding domestic poultry. A limited quantity of natural food is also available in the open-air enclosures.

For many years, there have been no nutrition-related deaths or diseases of Zoo birds fed this diet, and the long life, well-fleshed condition and high egg production in captivity all indicate a satisfactory ration. If dietary inadequacies are likely to influence breeding performance, limitations are typically manifested by either a reduction in the number of eggs or an increase in embryonic mortality, rather than by a decrease in egg size. In captivity most of the few embryonic deaths have resulted from artificial incubation experiments.

Although experiments have related a decrease in egg size in domestic poultry to either inadequate dietary linoleic acid (Calvert 1967, Menge 1968, Weatherup 1974) or insufficient protein (Romanoff & Romanoff 1949; Akayama *et al.* 1978), the resultant decreases were small; for example, in one study the average egg weight dropped by 1.7% when the protein content of the diet was reduced by 43%. Protein and linoleic acid are both well represented in the kiwi diet, and so some other nutrient imbalance (rather than age, size or health of Zoo birds) may be the primary cause of the smaller eggs.

It is questionable whether the total characteristics of a diet based on invertebrates can be duplicated in a mixture of mainly beef and oats and also whether a species that has evolved to utilise nutrients from one source can fully utilise the same (or substitute) nutrients from another source. Although the artificial diet seems adequate, it may differ in some way from the natural diet enough to inhibit the development of normal-sized eggs. Biochemists are still groping with 'unidentified factors' that stimulate growth or affect reproduction in domestic animals, and insects, which are lacking in the Zoo diet, may provide substances that enhance the full development of kiwi eggs.

ACKNOWLEDGEMENTS

I thank the many farmers and contractors who sent eggs from

damaged nests; museums and zoos for their co-operation; and my colleagues Brian Lloyd and Jim Mills for statistical guidance.

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SHORT NOTE

A NORTH ISLAND BROWN KIWI AND HER EGG

X-ray photograph of a captive North Island Brown Kiwi *(Apteryx australis mantelli)* taken 16-24 hours before she laid her 23rd egg in 50 months at Otorohanga. The egg (126 x 76 mm, 415 g) occupied a large portion of the body cavity, extending anteriorly to within 40-45 mm of the sternum and lying immediately dorsal to the gizzard. This egg was 19.3% of the hen's post-laying weight of 2.155 kg. Her other eggs have ranged in weight between 360 and 440 g.

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ESTIMATING THE FRESH WEIGHT OF THE EGGS OF BROWN KIWI
(Apteryx australis mantelli)

By BRIAN REID

INTRODUCTION

Land development schemes in recent years have 'unearthed' a surprising number of Brown Kiwi eggs. The artificial incubation of these eggs might have been more successful if the stage of development of the embryos had been known. Some information on weight loss during incubation is available from studies at Mt Bruce and Otorohanga, but this is of only limited value when the fresh weight of recovered wild eggs is not known.

An approximate measure of 'freshness' can be obtained from the buoyancy of an egg — if fresh it sinks rapidly but with continuing embryonic development it floats progressively higher in water. Barry Rowe of the Otorohanga Zoological Society was introduced to another technique of considerable value when delivering kiwis to Dr R. Faust of Frankfurt Zoo. This technique has long been used by German gamekeepers. It involves placing a light (dry) grass stalk or feather transversely across the top of the egg. Any slight, and otherwise undetectable, movements of the embryo are magnified in the readily visible vibrations of the stalk — even heart-beats may be seen as a series of slight but regular see-saw movements. This method also has the important advantage of showing whether the embryo is alive, but it shares the limitations of the immersion method in not showing the approximate age of the embryo, although the patterns and vigour of the stalk's movements may indicate that the embryo is an early one or at a more active late stage.

Estimations of age should be possible if patterns of weight loss during incubation are similar for all Brown Kiwi eggs and, also, if there is a fairly precise relationship between the linear dimensions and the weight of these eggs. Investigations on changes in weight during incubation are continuing at present. This paper is confined to aspects of the size/weight relationship of fresh eggs.

Reid (1971, *Notornis* 18 (4): 245-249) reported that in a sample of only two eggs the fresh weights agreed to within 1% of the weights obtained from the expression $W = 0.565\ ab^2$, where a is the length and b the maximum transverse diameter.

TABLE 1 — Actual and calculated fresh weights of Brown Kiwi eggs

Source of Eggs*	Dimensions Lth x Diam	L : D Ratio 100:	Weight (g) Actual Fresh	Weight (g) Calc .565ab^2	Difference g	Difference %
Wild	127.1 x 78.2	61.526	429.8	439.1	+9.3	+2.16
Wild	123.7 x 77.2	62.409	408.6	416.5	+7.9	+1.93
M.B.	98.5 x 68.6	69.645	258.5	262.1	+3.6	+1.39
W.Z.	113.2 x 74.6	65.901	347.3	352.0	+4.7	+1.35
M.B.	122.5 x 75.0	61.224	384.2	389.3	+5.1	+1.33
M.B.	116.7 x 72.4	62.039	341.7	345.5	+3.8	+1.11
W.Z.	118.3 x 75.7	63.990	379.0	383.0	+4.0	+1.06
O.Z.	125.0 x 74.0	59.200	383.0	386.7	+3.7	+0.97
M.B.	125.4 x 81.6	65.071	467.2	471.7	+4.5	+0.96
M.B.	118.1 x 75.3	63.760	374.9	378.3	+3.4	+0.91
Wild	129.0 x 75.0	58.140	406.5	410.0	+3.5	+0.86
M.B.	105.3 x 69.0	65.527	281.0	283.2	+2.2	+0.78
Wild	125.4 x 78.6	62.679	434.6	437.7	+3.1	+0.71
Wild	126.4 x 83.0	65.665	488.8	492.0	+3.2	+0.65
M.B.	109.5 x 69.4	63.379	296.8	298.0	+1.2	+0.40
O.Z.	130.8 x 73.3	56.040	396.5	397.1	+0.6	+0.15
W.Z.	112.2 x 75.3	67.112	360.0	359.5	-0.5	-0.14
O.Z.	120.0 x 77.0	64.167	402.6	402.0	-0.6	-0.15
Wild	122.2 x 81.2	66.448	457.2	455.0	-2.2	-0.48
M.B.	118.0 x 71.0	60.169	340.0	338.1	-1.9	-0.56
O.Z.	124.1 x 75.2	60.596	400.0	397.1	-2.9	-0.72
W.Z.	121.0 x 71.7	59.256	354.6	351.5	-3.1	-0.87
M.B.	118.6 x 69.4	58.516	326.2	322.7	-3.5	-1.07
W.Z.	116.5 x 75.0	64.378	374.7	370.2	-4.5	-1.20
M.B.	115.3 x 64.1	55.594	271.1	267.7	-3.4	-1.25
O.Z.	114.2 x 73.5	64.361	353.0	348.4	-4.6	-1.30
O.Z.	112.3 x 73.3	65.271	346.0	340.9	-5.1	-1.47
M.A.C.	94.9 x 66.0	69.547	238.6	233.6	-5.0	-2.10
O.Z.	114.4 x 73.5	64.248	357.0	349.1	-7.9	-2.21
Wild	124.3 x 71.9	57.844	371.7	363.1	-8.6	-2.31
O.Z.	112.5 x 69.5	61.778	315.0	307.0	-8.0	-2.54
M.B.	105.1 x 66.2	62.988	268.5	259.9	-8.6	-3.20
W.Z.	119.0 x 73.5	61.760	389.0	363.0	-26.0	-6.68

M.B. = Mt Bruce Native Bird Reserve O.Z. = Otorohanga Zoo Soc.
M.A.C. = Maori Arts Centre, Rotorua W.Z. = Wellington Zoo

TABLE 2 — *Percentage error of calculated weights for eggs in different 'size' or 'shape' classes*

	Egg	Percentage Error						
		+			-			
	'Class'	3-2	2-1	1-0	0-1	1-2	2-3	3+
Weight (g)	450-500			2	1			
	400-450	1	1	2	2			
	350-400		2	3	2	2	2	1
	300-350		2		1	2	1	
	250-300		1	2		1	1	1
	No. eggs	1	6	9	6	5	4	2
L : D Ratio	1: 68-70		1				1	
	1: 65-67		1	3	2	1		
	1: 62-64	1	3	3	1	2	2	2
	1: 59-61		1	1	3	1		
	1: 56-58			2		1	1	
	No. eggs	1	6	9	6	5	4	2

As kiwi eggs are remarkably inconsistent in size and shape, and variations in dimensions may influence the size/weight relationship, a further 31 were measured to see whether this formula is useful for Brown Kiwi eggs in general.

MATERIALS AND METHODS

Of the 33 eggs tested; 7 were laid in the wild and 26 in captivity. The sample included 12 fresh eggs (less than 12 hours old) without air spaces and 21 clean empty shells. The specific gravity of the contents was determined for two fresh eggs (1.0288 and 1.0293), and the fresh egg weights for the 21 shells were obtained by filling each with water, multiplying their internal volumes by the specific gravity (1.029) and adding the shell weight.

RESULTS

Table 1 lists the measurements and shows that, notwithstanding a wide range in both shape (as defined by the length : diameter ratio) and size, most eggs had a true weight that closely approximated their calculated weight. In 15% of the sample the difference between true and calculated weight was less than 0.5%, in 45% it was less than 1.0%, in 75% the error was less than 1.5% and in 90% of the sample the calculated weight was within 2.5% of the true weight.

The density of Brown Kiwi egg shell (2.42) is nearly 2½ times that of the egg contents. Because smaller (or more elongated) eggs have a proportionately larger surface area than bigger (or wider) eggs, the shell : content ratio changes through the range of egg sizes. As a result, the expression $0.565\ ab^2$ may overestimate the fresh weight of larger eggs and understate that of smaller (or elongated) eggs.

Table 2 suggests such a tendency, but any skew effect is small. This method thus provides a useful, and at times precise, estimation of fresh egg weights.

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SHORT NOTE

KNOTS ATTENDED BY GODWIT

At the Heathcote-Avon estuary, Christchurch, the Knot *(Calidris canutus)* is a rather rare and brief visitor (a few days to a few weeks) compared with the Bar-tailed Godwit *(Limosa lapponica)*, which ranges from about 100 birds in winter to about 1000 in summer. Consequently, the Knot is of some interest locally.

We have noticed that, when a small party of Knot, say, fewer than five, is present with the godwit flock, they seem to hide deliberately in the centre of the godwit flock at the high tide roosts. Whenever the godwits have been displaced temporarily, the Knots carefully take up the same relative positions, often being almost completely out of sight.

Late one bitter afternoon, an unusually large (for this estuary) flock of 11 Knot came in, flying low, landed nearby, and huddled together in a tight group, standing in the shallow low-tide water close to a straggle of godwit that were feeding at the tide's edge. Immediately, the two nearest godwits stopped their probing and walked over to the Knots and seemed quietly but deliberately to break up the bunch. This behaviour was not aggressive, and the Knots were evidently not afraid; meanwhile, the godwits began to rake with their feet, and probe tentatively into, the muddy sand, apparently inducing the tired Knots to feed, which they did briefly.

Soon after the godwits had moved away to continue their own probing, the Knots stopped feeding and bunched up again. For a second time, one of the godwits returned, broke up the group again, apparently persuading the reluctant Knots to resume feeding. We could see this whole episode very clearly.

P. A. G. HOWELL; K. C. HARRISON

THE EXTERNAL MORPHOLOGY AND TAXONOMIC STATUS OF THE ORANGE-FRONTED PARAKEET

By A. J. NIXON

ABSTRACT

Size and shape differences between museum specimens of the Orange-fronted Parakeet *(Cyanoramphus malherbi)* and the Yellow-crowned Parakeet *(C. auriceps)* are investigated using discriminant function analysis. No significant differences were found between the two groups, and the plotted discriminant scores show very poor separation, whereas the technique distinguishes both groups from Red-crowned Parakeets. These results support the view that *C. malherbi* is a colour variant of *C. auriceps.*

INTRODUCTION

The Orange-fronted Parakeet *(Cyanoramphus malherbi),* was first described by De Souance in 1857, and little knowledge of it has been gained since it was redescribed by W. L. Buller in 1868. Many of the earlier notes on this parakeet (for example, Finsch 1870) refer to the possibility that it was the juvenile form of the very similar Yellow-crowned Parakeet, *C. auriceps* (Kuhl). Buller was at one time undecided on this matter but finally reinstated the species (Buller 1884). Since then the Orange-fronted Parakeet has been treated as a rare but distinct species, notably by Harrison (1970) in his re-evaluation of early literature and current knowledge. This view was challenged by Holyoak (1974) with a hypothesis that the Orange-fronted Parakeet is a colour-morph of the Yellow-crowned Parakeet. The questions raised about the biology of these parakeets deserve further consideration, especially now that live birds have been found by Wildlife Service expeditions in the Lake Sumner area (Cox 1981, unpubl.).

Three main features have been used to distinguish *C. malherbi* from *C. auriceps:*

1. Ecology and behaviour, aspects which have become confused (e.g. by Reischek's description of a montane habitat for *C. malherbi* as opposed to the forest-dwelling Yellow-crowned Parakeet, and also Buller's specific name *alpinus*);
2. Coloration, which seems complex but for which Holyoak suggests a simple genetic basis; and
3. Size and shape, quoted by most authorities as important distinguishing features (Buller 1882, Oliver 1955, Falla *et al.* 1970,

Forshaw 1973. Forshaw reconsidered specific status in his later edition).

The present discussion focuses on variations in size and shape. Such variations may reflect genetic differences between sexes and taxa, they may be important as reproductive isolating mechanisms, and they may be indicators of ecological divergence between species which superficially appear to share similar resources in the same habitat.

When distinguishing between *Platycercus alpinus (= Cyanoramphus malherbi)* and the other parakeet species, Buller (1870) suggested that " . . . comparing the bills of the two species the difference is very manifest, that of *P. alpinus* being fully one-third less than that of *P. auriceps.*" He later provided a set of comparative measurements (Buller 1875) which would seem to bear this size difference out. Later authors quote these and other accounts, or simply affirm that a small size difference does exist. On the other hand, Holyoak (1974) presents figures for bill length and wing length of specimens from European and North American museums which indicate no marked difference between species. Why is there such contradictory information? Assuming the measurements have been accurate, either there was a real difference in size, or the samples were biased in some way. Birds raised in captivity may be larger, and perhaps their presence has influenced comparisons.

To clarify some of these points, I have investigated specimens available in New Zealand museums, using multivariate statistical techniques.

METHODS

A series of morphometric measurements was taken from parakeet skins, mounts, and preserved birds from the National Museum, Canterbury Museum, and Auckland Museum. Five live Yellow-crowned Parakeets from an aviary colony were also measured to boost sample size. The inconsistency of measurement introduced by combining specimens of differing state was found to be insignificant compared with inter-group variation. Four groups were considered: Orange-fronted *(Cyanoramphus malherbi)*, wild-caught Yellow-crowned *(C. auriceps auriceps)*, captive-raised Yellow-crowned *(C. auriceps auriceps)*, and Red-crowned *(C. novaezelandiae novaezelandiae)*. The last group was included to give some comparison with a recognised species. The six variables were: wing length, tail length, tarsus (tarsometatarsus) length, bill length, bill width, and crown length.

The Hotelling T^2 test, the multivariate equivalent of the students t-test, was used to test the hypothesis of equality of the vectors formed by the means of the six variables for each group. The BMDP/3D computer program (Dixon 1975) was used to perform this task.

Discriminant function analysis is the multivariate statistical technique used here to describe differences in shape and size between species. When two groups are very similar, the distributions of

measured characters for each group may overlap so that, for any one variable, no clear cut-off point between groups is evident. However, the ability to discriminate between groups may be increased by forming a linear combination of the variables and associated weighting coefficients. Such a function has the form:

$$D_i = d_{i1} Z_1 + d_{i2} Z_2 + \ldots d_{ip} Z_p$$

where: D_i is the score on the ith discriminant function

Z is the standardised variable

d_i is the weighting coefficient

The weighting coefficients are estimated using matrix operations so that the between groups variation is maximised. When the data are projected from many variables on to fewer dimensions, the separation of groups is more easily appreciated. The discriminant function also gives information about the relative importance of each variable in determining this separation. Discriminant function analysis is often used to assign unclassified specimens to one or other of the groups, but in this case no new specimens were included; the derived functions being used simply as canonical variates upon which the distribution of grouped specimens could be plotted.

Two three-group comparisons were made. For both, two discriminant functions were calculated from the six variables using the SPSS computer package. The package offered the option of entering variables into the analysis phase (i.e. the calculation of weighting coefficients) by one of several stepwise methods so as to exclude redundant variables. The " Wilks lambda " stepwise method was used.

If a variable had not been recorded for any specimen, this specimen was excluded from the analysis phase but entered into the classification phase by substituting the overall mean for the missing value.

RESULTS

Nineteen Orange-fronted Parakeets were measured: 4 females, 7 males, and 8 unsexed. Table 1 compares the measurements of Orange-

TABLE 1 — Measurements of female Orange-fronted and Yellow-crowned Parakeets

	ORANGE-FRONTED ♀			YELLOW-CROWNED ♀		
Variable	Mean	SD	Number	Mean	SD	Number
Wing	103.5	3.70	4	103.7	5.09	13
Tail	106.5	10.21	4	110.6	7.29	12
Tarsus	18.67	0.643	3	18.35	0.841	13
Bill L	12.23	1.031	4	11.98	1.527	12
Bill W	7.38	0.562	4	7.65	0.650	13
Crown	17.5	3.87	4	18.4	2.90	13

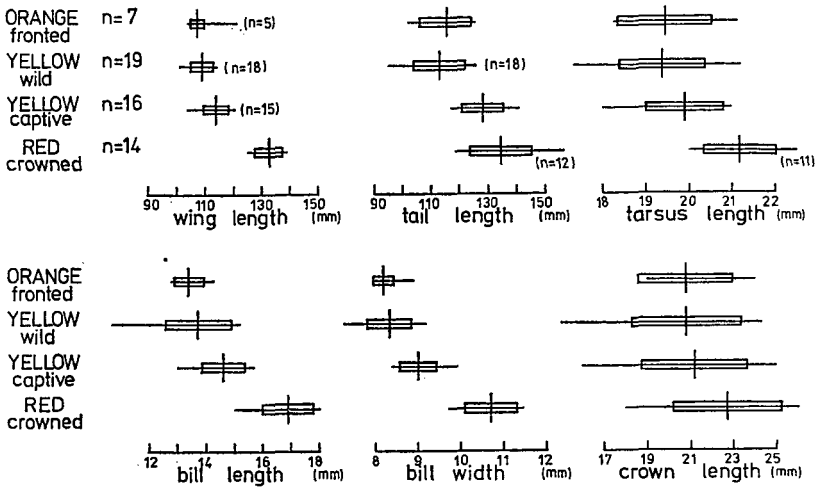

FIGURE 1 — Measurements of males of four species of parakeets.

fronted and wild Yellow-crowned female parakeets. Although the Orange-fronted sample means are slightly lower than the Yellow-crowned, students t-tests revealed no significant differences at the 1% level between the means of these two groups for all six variables. The small size of the sample of females makes further statistical treatment difficult.

Because of the sexual dimorphism in size of parakeets, and the larger sample of males, further analyses were restricted to male birds. Figure 1 shows the measurements of four groups of male parakeets. When the mean vectors were compared for Orange-fronted and wild Yellow-crowned, a Hotelling T^2 test gave a value for T^2 of 2.839 and a corresponding F value of 0.3380, indicating no significant differences between group mean vectors.

The first set of discriminant functions was calculated to describe the multivariate separation of the three supposed species: Orange-fronted, Yellow-crowned (wild), and Red-crowned. The standardised discriminant function coefficients were:

	Wing L.	Bill	Crown L.
FUNCTION 1	0.75030	0.65682	-0.69125
FUNCTION 2	-0.94874	1.24754	0.03513

Only three of the six variables were required to describe the variation that exists between groups. The remaining three variables contribute an insignificant amount of new information.

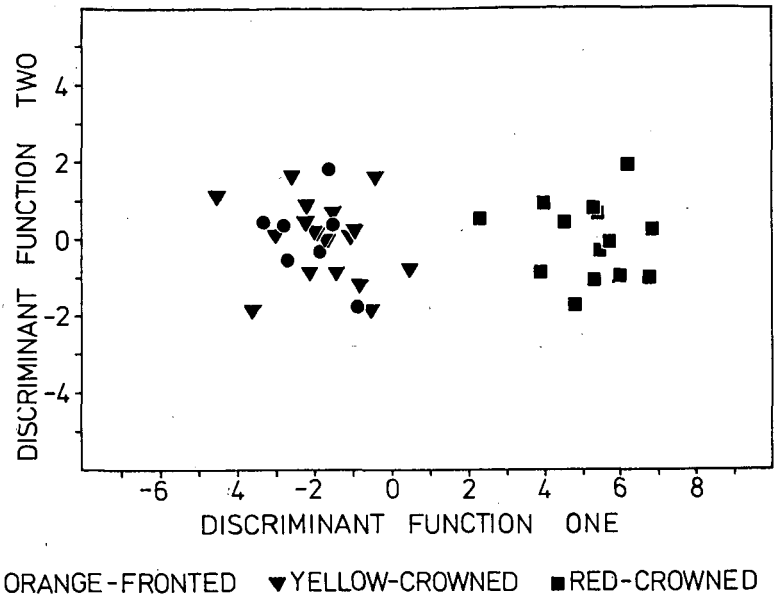

FIGURE 2 — Plotted discriminant scores of male Orange-fronted, Yellow-crowned, and Red-crowned Parakeets.

Figure 2 shows the plotted discriminant functions when the values for each case are inserted. Orange-fronted and Yellow-crowned Parakeets appear to separate very poorly. The Orange-fronted distribution is slightly narrower and lies within that of the Yellow-crowned.

Figure 2 shows that the technique differentiates between known species (Yellow-and Red-crowned) but cannot separate Yellow-crowned and Orange-fronted Parakeets. Therefore, I did a further analysis on these two groups, plus captive-bred Yellow-crowned. If the wild Yellow and the Orange-fronted Parakeets still failed to separate, but the captive birds showed some shift away from these groups, this could represent a possible explanation for the traditional view that a size difference exists.

Again using the method of entering variables into the analysis by a stepwise method, only two of the six variables were retained to give the following coefficients:

	Wing L.	Tail L.
FUNCTION 1	0.47163	0.76845
FUNCTION 2	0.92136	-0.69342

In the first function both coefficients are of similar magnitude. The separation of groups on this function indicates that they differ mainly in size, which might be expected with an intraspecific comparison if growth is not greatly allometric.

Figure 3 shows captive Yellow-crowned concentrated at one end of the multivariate distribution, whereas the Orange-fronted again fall within the wild Yellow-crowned range and are not clearly distinguishable. The assumption that measurements taken from live specimens did not significantly bias the results was substantiated by the even distribution of live specimens through the range of the captive Yellow-crowned sample on the first discriminant function.

Since only two variables contribute to the discriminate functions, Figure 3 is similar to a scattergram of wing length by tail length.

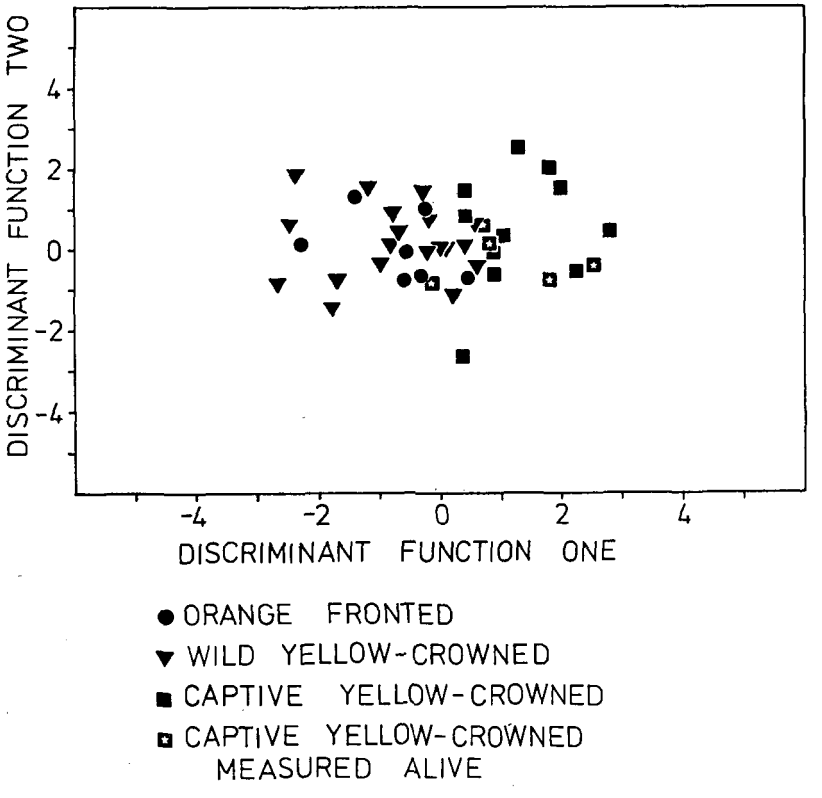

FIGURE 3 — Plotted discriminant scores of male Orange-fronted, wild Yellow-crowned, and captive Yellow-crowned Parakeets.

DISCUSSION

Contrary to what might be expected from the popular view, no marked size or shape differences have been found between the specimens of Orange-fronted and wild Yellow-crowned Parakeets examined. Captive-raised birds, on the other hand, are noticeably larger, and this may perhaps have led to the reported size differences that have been used to support specific status for the Orange-fronted Parakeet. Parakeets were popular cage birds at the time of Buller (Buller 1888) and Buller himself kept Yellow-crowned Parakeets (Buller 1870).

However, other factors are also likely to have confused this question. The size difference between sexes is perhaps the most obvious one; the species concept of the late 19th century is another. Buller and his contemporaries worked on the basis of the typological species concept, and although fascinated by spectacular variants, early ornithologists were not quick to recognise the range of continuous natural variation within a population. Many new 'species' were described from one or a few unusual specimens. *Platycercus aucklandicus, P. forsteri, P. novaezelandiae, P. pacificus* and *P. rowleyi* were all described on the basis of minor plumage and size variation but proved to be synonyms for the one species. Could the size variation within a species have added confusion to a failure to recognise polymorphism in the case of the Orange-fronted Parakeet ?

Holyoak (1974) suggested that the coloration of the Orange-fronted Parakeet can be explained as a partial lack of carotenoid pigment under the control of a single gene or several closely linked genes. But Fleming (1980) raised several other points relating to taxonomic status, which seem to favour specific status for the Orange-fronted Parakeet. In addition to the record he gave of flocking, Fleming cited " its constancy, its apparent restriction to the South Island . . . and its failure to turn up in a century's experience of aviary breeding of *C. auriceps* . . .", and he also alluded to a separate subalpine ecology.

C. malherbi specimens are not entirely constant in colour (Holyoak 1974, J. A. Bartle, pers. comm.), but even so, consistency is not necessarily evidence against colour polymorphism. More or less consistent colour varieties occur in many other platycercine parakeets. For example, pale forms of Scarlet-chested Parrot *(Neophema splendida)* and Bourke's Parakeet *(N. bourkii)* have been bred that appear to have a partial lack of carotenoid but normal melanin pigmentation (Musil 1970).

Although colour morphs showing variations comparable to the differences between *Cyanoramphus auriceps* and *C. malherbi* occur among other closely related species, the absence of the orange-fronted form from breeding aviaries is not surprising. If cage populations have originated from a small and geographically biased sample of birds (and thus genes), they could well lack rare alleles.

Musil (1970) also described apparently non-hereditary colour

variation among rosellas. Given that birds are unable to synthesise their own carotenoids (Fox & Vevers 1960), some environmental effect could be responsible for the coloration of the Orange-fronted Parakeet.

The restriction of Orange-fronted Parakeets to the South Island could be explained by the mutation being maintained in the south and not turning up in areas to which gene flow is cut off. However, there are references to Orange-fronted Parakeets in the North Island (Buller 1882), on Hen Island and Little Barrier Island (Buller 1884), Stewart Island (Harrison 1970), and the Auckland Islands (Gray 1859). These records were discounted by Harrison (1970), who proposed that the Orange-fronted was probably confined to the South Island. We should remember that this was a tentative conclusion drawn from very scant records and there remain uncertainties regarding the former distribution of this bird. For example, Harrison suggested that the specimen in the National Museum from the Wairarapa may be a caged bird referred to by Buller, but the Museum records state the specimen was shot. Buller's (1884) account of Reischek's meeting with Orange-fronted Parakeets on Hen Island and Little Barrier gives the particulars of birds observed and shot. The detail of this record, plus the existence of museum specimens allegedly from Hen Island, infer some reliability.

The question of alpine habitat was settled by Harrison (1970) and there remains no good reason to believe that the Orange-fronted Parakeet was found outside the natural range of the Yellow-crowned Parakeet. The species group may not therefore fit Fleming's model of Pleistocene speciation as well as do other bird groups with alpine members.

Finally, the record of flocking as evidence of specific status must be considered alongside Buller's (1870) quotation from Haast's letter that " these two kinds [Orange and Yellow] occur always together but in some localities the first, and in others the second is predominant." These observations really tell us very little about the behaviour of parakeets; they merely illustrate the poverty of our knowledge, with which we can only speculate.

Now that live Orange-fronted Parakeets have been found, we should be able to learn more by field observation and captive breeding. Should *C. malherbi* be confirmed as a good species, a detailed study of its ecology with regard to the competitive exclusion principle is warranted, given its close similarity in size and habits to *C. auriceps*. But if the colour morph hypothesis is correct, much effort in manpower and money could be better directed to " real " rare species, although breeding experiments in captivity may be of interest in understanding more about the genetics of bird coloration. The differences between Orange-fronted and Yellow-crowned Parakeets appear to be not as great as once thought, but further field and aviary studies are needed to resolve fully the question of taxonomic status.

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THE DISTRIBUTION AND NUMBERS OF CRESTED GREBE IN NEW ZEALAND 1980

By P. M. SAGAR

ABSTRACT

The first national survey of the Southern Crested Grebe *Podiceps cristatus australis* was carried out in the South Island, New Zealand, from 29 November to 14 December 1980. 170 adults were counted and 20+ more estimated on 28 of the 84 lakes covered during the survey. When other recent records are included, this survey indicates that the New Zealand population of adult Crested Grebes is about 240-250. The bulk (c. 55%) of the population was in Canterbury, where most birds were concentrated on two groups of lakes. Total numbers were probably greater than those recorded in 1970 but local declines have occurred. Some breeding data are also presented.

INTRODUCTION

The Crested Grebe *Podiceps cristatus* is a polytypic species with races found in the Palearctic *(cristatus)*, Africa *(infuscatus)* and Australia and New Zealand *(australis)* (Cramp & Simmons 1977).

In New Zealand, the Southern Crested Grebe was formerly distributed on a few large North Island lakes and was widespread throughout most of the South Island but seems to have disappeared as a breeding species from North Island lakes late last century (Westerskov 1972). Kinsky (1970) recorded it as breeding in the South Island only, on lowland lakes west of the main ranges and on alpine and subalpine lakes within and east of the main ranges, as absent from Nelson and Marlborough, and as a rare straggler to the North Island. The only recent North Island records are of a single bird seen on Lake Rotorua in December 1975 and June 1976 (Palliser 1977) and two birds seen on a farm dam at Te Awamutu (Goulding 1981).

Westerskov (1971) recorded the distribution and numbers of Crested Grebes in Canterbury during 1969-70 and provided a well-documented review of their previous status there. In recent years counts of Crested Grebes on the Ashburton Lakes (S. Moore, pers. comm.; C. O'Donnell, pers. comm.; and pers. obs.) and Lakes Alexandrina and McGregor (pers. obs.) showed that numbers there were much higher than those reported by Westerskov. Observations at other lakes in Canterbury were too few to show whether the Canterbury population had increased or had merely become concentrated in these two areas.

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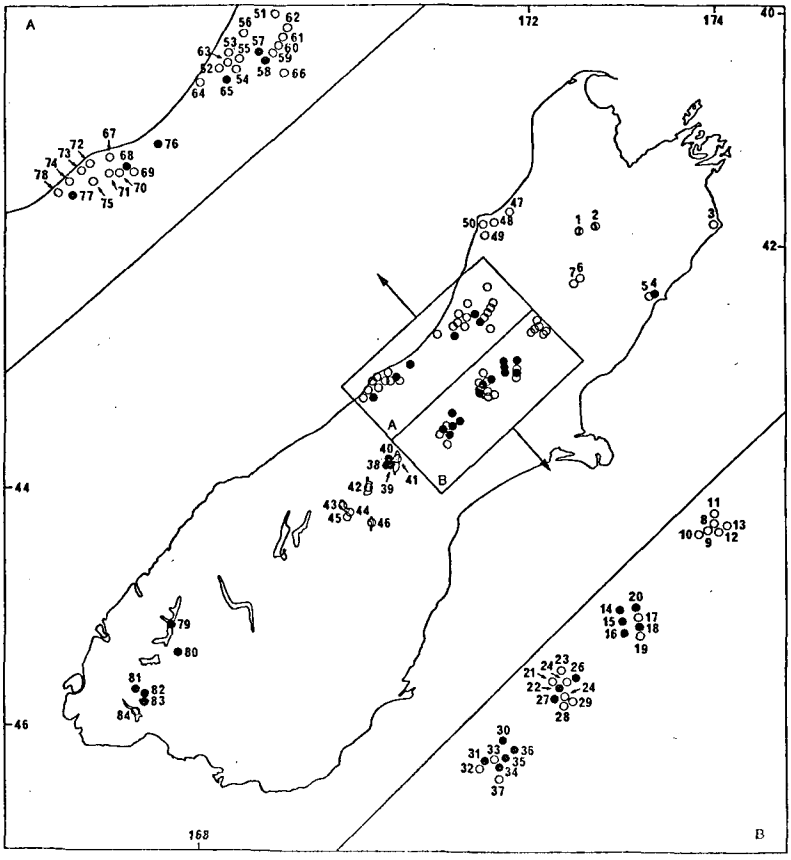

FIGURE 1 — Locations of South Island lakes survey 29 November - 14 December 1980. Closed circles — lakes where Crested Grebes were seen; open circles — lakes where Crested Grebes were not seen. Numbers correspond to lakes listed in Table 1.

Therefore, in 1980 OSNZ organised the first national survey to determine the distribution and numbers of adult Crested Grebes in New Zealand and to provide a basis of comparison for future surveys.

METHODS

Only the South Island was surveyed because any Crested Grebes seen in the North Island would be reported promptly. Effort put into the survey varied in light of local knowledge of Crested Grebe distribution. Thus, as many lakes as possible were surveyed in Canterbury, Westland and Fiordland, whereas only lakes where Crested

Grebes had been reported recently were surveyed in Nelson and Marlborough. No lakes were surveyed in Otago and Southland.

Studies overseas (e.g. Prestt & Mills, 1966; Hughes *et al.* 1979) have shown that Crested Grebes can be counted with reasonable accuracy, as long as large lakes and lakes with marginal vegetation are surveyed very carefully.

Crested Grebes are best counted during the breeding season, when most birds are defending breeding territories and only non-breeders may be moving from one lake to another. Surveys of Crested Grebes in Britain have shown that ideally all lakes should be visited on the same day to minimise the possibility of movement (Hughes *et al.* 1979). However, because of the large number and remoteness of lakes and the few observers in the South Island, three weekends and two weeks were allowed for the survey (29 November - 14 December 1980).

Observers were asked to complete a simple record form with the following details: Observer; date and time of count; lake; district; number of grebes counted during visit; number of grebes estimated to be present (to account for birds out of sight during the visit, for example, assumed to be on nests); breeding (yes/no/unknown); the number of grebes seen during any previous visit; and remarks (to include weather, suitability of lake for grebes, an assessment of the efficiency of the count).

Additional observations were obtained from the OSNZ Recording Scheme and the OSNZ Bird Mapping Scheme, 1969-76.

Lakes covered are listed in Table 1 and their locations are shown in Figure 1. See Irwin (1975) for the map number, full grid reference, area and altitude of lakes mentioned in the text.

RESULTS

Distribution and Numbers

No Crested Grebes were reported in the North Island during November-December 1980. A total of 170 adult Crested Grebes were counted and 20+ more were estimated in the South Island during the survey (Table 1), a total of 190+ adults. Grebes were found on 28 and estimated to be on 1 of the 84 lakes covered.

Nelson

No grebes were seen on Lakes Rotoroa and Rotoiti during the survey period. The only recent record known is of a single bird seen on Lake Rotoiti in June 1979 (J. Hawkins, pers. comm.).

Marlborough

A single grebe was seen on Lake Rotorua during the survey, but previous sightings show that up to four birds may have been present. Two adults were seen on Lake Rotorua on 19 September

1979 and four on 23 October 1980 (B. Elliott, pers. comm.). No grebes were seen on Lake Elterwater. A pair raised three young on Elterwater in 1976/77, and two birds seen courting in August 1977 apparently failed to breed successfully and had disappeared by January 1978 (Taylor 1979).

TABLE 1 — Counts and estimates of Crested Grebes made during the first national survey, 29 November-14 December 1980.

Lake	Number of Crested Grebes Counted	Number of Crested Grebes Estimated	Lakes	Number of Crested Grebes Counted	Number of Crested Grebes Estimated
Nelson			Canterbury (cont'd)		
1. Rotoroa	0	0	35. Maori Lakes	2	2
2. Rotoiti	0	0	36. Emily	2	2
Marlborough			37. Denny	0	0
3. Elterwater	0	0	38. Alexandrina	38	38
4. Rotorua	1	4	39. McGregor	8	8
5. Rotoiti	0	0	40. Glenmore Tarns	4	4
Canterbury			41. Tekapo	0	0
6. Tennyson	0	0	42. Pukaki	0	0
7. Guyon	0	0	43. Ohau	0	0
8. Sumner	0	0	44. Raupo Lagoon	0	0
9. Mason	0	0	45. Swan Lagoon	0	0
10. Katrine	0	0	46. Benmore	0	0
11. Marion	0	0	Westland		
12. Taylor	0	0	47. Denniston Dams	0	0
13. Sheppard/Mary	0	2	48. Gillows Dam	0	0
14. Sarah	2	2	49. Westport Reservoir	0	0
15. Grasmere	4	4	50. Addisons Road	0	0
16. Pearson	3	4	51. Hochstetter	0	0
17. Hawdon	0	0	52. Mudgie	0	0
18. Marymere	1	1	53. Kumara Reservoir	0	0
19. Vagabonds Inn	0	0	54. Okuku Reservoir	0	0
20. Letitia	3	4	55. Dillman's Dam	0	0
21. Henrietta	0	0	56. Arnold Dam	0	0
22. Selfe	3	3	57. Brunner	3	4
23. Lilian	0	0	58. Poerua	2	2+
24. Evelyn	0	0	59. Kangaroo Lake	0	0
25. Ida	0	0	60. Lady Lake	0	0
26. Catherine	5	6	61. Haupiri	0	0
27. Coleridge	7	7	62. Ahaura	0	0
28. Georgina	0	0	63. Bell Hill	0	0
29. Lyndon	0	0	64. Mahinapua	0	0
30. Heron	27	29	65. Kaniere	1	2
31. Clearwater	11	11	66. Kaurapataka	0	0
32. Camp	0	0	67. Saltwater Lagoon	0	0
33. Roundabout	0	0	68. Rotokino	2	4
34. Emma	8	10	69. White Heron Lagoon	0	0

TABLE 1 (Continued)

Lake	Number of Crested Grebes Counted	Number of Crested Grebes Estimated	Lake	Number of Crested Grebes Counted	Number of Crested Grebes Estimated
Westland (cont'd)			Fiordland		
70. Darby	0	0	79. Te Anau	4	4+
71. Joan	0	0	80. Thomas	3	3+
72. Windemere	0	0	81. Island Lake	7	7+
73. Okarito Lagoon	0	0	82. Green Lake	3	3+
74. Three Mile Lagoon	0	0	83. Monowai	2	2+
75. Wahapo	0	0	84. Hauroko	0	0
76. Ianthe	7	8			
77. Mapourika	7	10	TOTAL	170	190+
78. Five Mile Lagoon	0	0			

Canterbury

Grebes were seen on 16 and estimated to be present on 1 of the 41 lakes surveyed and 128 adults were counted and 9 estimated as being present.

No grebes were seen on lakes of the Lake Sumner group (lakes 8-13, Table 1), but two birds seen on Lake Sheppard in early November 1980 (R. Novis, pers. comm.) were included for this area. The remaining grebes were distributed as follows: Lake Pearson group (lakes 14-20) 13 counted and 2 estimated; Lake Coleridge group (lakes 21-29) 15 counted and 1 estimated; Ashburton Lakes (lakes 30-37) 50 counted and 4 estimated; Lake Alexandrina group (lakes 38-40) 50 counted. No grebes were seen on Lake Ohau, where two pairs were seen in October 1970 (Child 1972) and two birds were seen in January 1980 (M. Heine and J. Pearson, pers. comm.).

West Coast

Grebes were seen on six of the 32 lakes surveyed with 22 adults counted and 8+ estimated as being present, 30+ altogether.

None of the small coastal lakes and artificial reservoirs (lakes 47-50 and 53-56) supported grebe populations and the general impression of observers was that most were not suitable for Crested Grebes.

No Crested Grebes were seen on Kangaroo Lake, Lady Lake and Lakes Hochstetter, Mudgie, Haupiri, Ahaura, Mahinapua and Kaurapataka and there have been no reports to the OSNZ Recording Scheme.

Although three birds were seen on Lake Brunner, two pairs were estimated to be present and breeding. A maximum of four birds have been seen on this lake during many visits made over the past 2.5 years (R. Simpson, pers. comm.). Crested Grebes are known to

have bred at Lake Poerua, the latest being of a pair feeding young in 1979 (A. Brett, pers. comm.).

One Crested Grebe was seen on Lake Kaniere, but early 1980 sightings support the estimate of two (N. Ward, pers. comm.). A pair seen on the lake in November 1974 were the first seen there for several years (R. Simpson, pers. comm.) and none has been reported since, until now.

Although Saltwater Lagoon is a known Crested Grebe area, none was seen during this survey, despite a careful search (D. P. Murray, pers. comm.). None was seen in April 1980, when half the lagoon was surveyed by boat (N. Word, pers. comm.). The recent opening of the lagoon mouth has created tidal conditions unsuitable to grebes, probably explaining why none was recorded. This situation occurs every few years (D. P. Murray, pers. comm.).

Lake Rotokino is a known Crested Grebe lake and, although breeding has not been confirmed, it is probable (D. P. Murray, pers. comm.). The nearby White Heron Lagoon is visited by grebes probably from Lake Rotokino.

No grebes were seen on Lakes Darby and Joan during the survey and none has been reported previously.

No grebes were seen on the Okarito group (lakes 72-74) during the survey. One Crested Grebe was seen on Lake Windermere, which is attachd to Okarito Lagoon, in December 1978 (M. Heine, pers. comm.). Occasional sightings are reported on Okarito Lagoon, e.g. two in October 1974 (R. Simpson, pers. comm.) and one in January 1980 (D. P. Murray, pers. comm.). As the main part of the lagoon is tidal and may change rapidly during floods, it usually does not provide good breeding habitat, and may only be visited by occasional birds (D. P. Murray, pers. comm.). However, the northern end of Okarito Lagoon, which has the least tidal influence, may have a pair of grebes regularly; but few observers reach this end, and so records are few (R. Simpson, pers. comm.). Grebes are not known from either Three Mile or Five Mile Lagoons and they are unlikely to occur there during the breeding season as both lagoons are tidal and subject to drying out.

No grebes were seen on Lake Wahapo, which is probably too silty for grebes (W. J. Wood, pers. comm.).

Lakes Ianthe and Mapourika are known grebe lakes, birds having been reported there in most months and breeding has been reported in previous years.

Fiordland

Crested Grebes were seen on five of the six lakes surveyed. Nineteen adults were counted, but more are likely to have been present.

The large area of Lakes Te Anau and Monowai made them difficult to survey and the Middle and North Fiords of Te Anau were not visited during the survey. However, the results do indicate that

the large numbers of Crested Grebes reported on these lakes in the past for example, up to 70 on Lake Monowai in 1948 (Anon. 1948), do not now occur.

Only two Crested Grebes were counted on Lake Monowai during the survey and W. H. Mannix reports that their numbers have declined in recent years. However, this lake appears to be used more in winter as six separate grebes were seen at various locations on the lake on 31 May 1980 (E. J. Gibbs, pers. comm.).

There are few reports of Crested Grebes for Te Anau in the records of the Fiordland National Park Board for the period 1969-80 and most of these are either of single birds or of family groups (K. & J. V. Morrison, pers. comm.).

No grebes were seen on Lake Hauroko during the survey and both O. Linscott and K. Hamilton report consistent nil returns from there since at least 1975.

Birds were seen swimming in close pairs and exhibiting courtship display on Island Lake and Lake Thomas during the survey.

Breeding

Breeding was reported at some Canterbury lakes only. Single-egg clutches were found at Lakes Pearson (1), Catherine (1) and Clearwater (1) and a two-egg clutch at Lake Selfe. A brood of two striped chicks was seen on Lake Clearwater and a brood of three striped chicks on both Lake Coleridge and Glenmore Tarns.

A chick hatched from the Lake Clearwater nest and eventually fledged about Christmas 1980. Soon after this chick left the nest another pair of Crested Grebes built a nest under the same willow, laid four eggs and hatched two in March 1981 (D. H. Ackerley, pers. comm.). All three chicks on the Glenmore Tarns fledged (R. J. Pierce, pers. comm.).

DISCUSSION

The main source of error in the present survey is the lack of adequate coverage of lakes in South Westland and Fiordland, especially some known to be used by Crested Grebes. However, the results do provide a good basis for comparison with future surveys. The following are the known grebe lakes not covered during this survey, together with the maximum number of Crested Grebes reported since 1950: Christabel (2), Daniells (2), Gault, Matheson (1), Paringa (4), Rasselas, Moeraki (6), Tawherekiri, Pratt (1) and Ellery in Westland (OSNZ Recording Scheme and R. Simpson, pers. comm.) and Wilmot, Fergus (4), Gunn (4), Ronald, Manapouri (5), Thompson, Hankinson, lake in Mid Burn, lake in Poseidon Valley, Poteriteri and Hakapou (2) in Fiordland (OSNZ Recording Scheme, OSNZ Bird Mapping Scheme 1969-76, and K. Morrison, pers. comm.). Thus, at least 21 lakes where grebes have been reported were not covered during the survey. I estimate that the maximum possible number of Crested Grebes that these support is

50-60 birds. The addition of these to the 190+ on the lakes covered during this survey indicates that the New Zealand population of Southern Crested Grebes is 240-250.

Therefore the estimated distribution and numbers of Crested Grebes (based on information from this survey, OSNZ Recording Scheme and the OSNZ Bird Mapping Scheme, 1969-76) are: Nelson 0; Marlborough 4 birds on 1 lake; Canterbury 137 birds on 17 lakes; Westland 45-50+ birds on 16 lakes; Fiordland 50-55+ birds on 15 lakes, Otago 0; Southland 0.

Movement of birds from one lake to another at different times of the year may be essential in maintaining the population as a whole in any one area. That Crested Grebe distribution can vary in a group of lakes between and within years is well known (Hughes *et al.* 1979).

Because of this changing distribution, birds may recolonise lakes that have not been used for several years and abandon others. We cannot, therefore, compare in detail the results of this survey with those of Westerskov (1971, 1972), but the following general trends are apparent.

Westerskov (1972) reported that Lakes Rotoroa and Rotoiti were the only lakes in Nelson to have supported Crested Grebe populations. Breeding ceased in the 1950s and only stragglers were reported at Lake Rotoroa in 1952 and 1967. The record of a single bird on this lake in 1979, and the results of this survey indicate that Crested Grebes are still only stragglers in Nelson.

There are no records of Crested Grebes in Marlborough before 1972 (Westerskov 1972). Therefore the results of this survey show that Crested Grebes have either colonised Lake Rotorua for the first time or they have recolonised it after many years' absence. The breeding and disappearance of Crested Grebes from Lake Elterwater confirm the transitory and unpredictable movements of the species.

Westerskov (1971) collated sightings of Crested Grebes in Canterbury during the period 1964-1970 and he visited some of the lakes in January 1970. He concluded that about 50 pairs of Crested Grebes were nesting in 1969-70 and present as regular breeders on 23 lakes. This represented a decline of 35-40% from the 80+ pairs he estimated had been present in the 1940s. Much of this decline had occurred on the northernmost lakes. The results of the present survey (137 birds estimated to be present on 17 lakes) indicates a marked increase in numbers, but Westerskov did not visit all lakes during his survey and a large part of his information came from people who did not visit lakes primarily to count Crested Grebes. Therefore, he probably underestimated the number of Crested Grebes in Canterbury and so we cannot confirm an increase in the population between 1970 and 1980. However, Westerskov (1971) and the present survey confirm the continued population decline of Crested Grebes on lakes of the Sumner group from an estimated 16 pairs in 1940-1950, to 4 pairs in 1969-1970, and to 1 pair in 1980.

Soper (1972) and Falla *et al.* (1979) reported that Crested Grebes were most common in Fiordland and South Westland. However, the results of the present survey indicate that this is not the present situation. Canterbury lakes now support the bulk (c. 55%) of the New Zealand population, and most of these are on just two groups of lakes — the Ashburton Lakes and Lake Alexandrina group, which support c. 42% (104 of 240-250) of the New Zealand population between them. Lake Alexandrina supported the highest number of Crested Grebes (38) of any lake in the country, followed by Lake Heron (29) in the Ashburton Lakes.

This has been caused by a decline in the Fiordland population rather than an increase in the Canterbury population. Crested Grebes have been reported from 16 lakes in Fiordland (see above and Table 1) and the population decline was under way at least as early as the late 19th century, when Richard Henry (1903) noted that Crested Grebes were formerly numerous on Lakes Te Anau and Manapouri. Numbers have dropped drastically on Lake Monowai, where 11 pairs were counted in December 1947 (Anon. 1948), five pairs in 1975-1977 (K. Hamilton, pers. comm.) and two birds in 1980 (this survey). On 21 April 1948 two flocks of Crested Grebes on Lake Monowai contained 36 and 24 birds (Anon. 1948). Another report of a large concentration of Crested Grebes comes from Lake Thompson, where 54 were counted in March-April 1951 (Wood 1951). There are no known subsequent reports on large concentrations of Crested Grebes in Fiordland. Several pairs of Crested Grebes bred on Lakes Fergus and Gunn from 1950-1972 (OSNZ Recording Scheme and OSNZ Bird Mapping Scheme, 1969-1976) but none has been seen there, despite frequent visits, during 1976-1981 (K. Morrison, pers. comm.). Suggested reasons for the decline of Crested Grebes in New Zealand have been discussed previously (Westerskov 1971, Falla 1975).

The current estimate of 240-250 Crested Grebes and the concentration of c. 42% of this population on just two groups of lakes give cause for concern over the future of this species in New Zealand.

Little can be inferred from the breeding observations reported in this survey. The incubation period of the European race averages 28 days (Cramp & Simmons 1977). Assuming a similar time for the New Zealand race and back-calculating from sightings of chicks and hatching dates, the breeding season appears to be extended, with laying from at least October to February. The European race also has an extended breeding season which may cover up to 8 months (Cramp & Simmons 1977).

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OBITUARY

HECTOR ROSS McKENZIE, JP

1897 - 1981

HECTOR ROSS McKENZIE, JP

How dull it is to pause, to make an end,
To rust unburnish'd, not to shine in use.
— Tennyson.

Ross McKenzie, a familiar figure beloved by naturalists the length and breadth of New Zealand, died peacefully at Hamilton on 8 June 1981, when he was two days short of his 84th birthday.

In 1897 his mother travelled north from the King Country so that Ross could be born at Clevedon. Two years later the family settled there and Ross received his elementary education at the Wairoa South school. Then in 1910 the family moved north to Wayby. After another year's schooling, Ross was busy clearing logs, helping to enlarge the family dairy farm and to knock it into shape. Brown Teal were plentiful in the swamps. It never crossed his mind that within his lifetime they would become an endangered species.

From the Senior Cadets the farm boy passed naturally into the Territorials. In 1915 he enlisted in the Rifle Brigade and in February 1916 he sailed for the Middle East. When the Gallipoli campaign collapsed, his draft was redirected to France. On the eve of the battle of the Somme he was hit by a stray shell, lost a leg and suffered other wounds. By March 1918 he was back in New Zealand. He was still under 21. A fully active life in the physical sense being ruled out by his severe injuries, Ross took a Hemmingway course in accountancy. In 1921 he married Hetty Goertz (*v. Notornis* 22: 353-354). Then began a partnership that was rich and fruitful in every way. How many people, both local residents and visiting ornithologists, have reason to remember with affection and gratitude the hospitality so freely offered at their homes up the Ness Valley and in Clevedon!

With his burning energy and sense of duty Ross was soon throwing himself into the varied activities of village life — R.S.A., Boy Scouts, School Committee, Church, etc. He was, in fact, the obvious choice to be the unpaid treasurer or auditor for any local association. At the same time, love of the bush and the richness of the local flora led Ross to botany. Cheeseman's Manual became his Bible. His organising mind and a retentive memory stood him in good stead, so that Latin names presented few real difficulties and he collaborated with two notable lady botanists, Lucy Cranwell and Lucy Moore. He amassed a well-documented specimen collection which was housed in a huge cabinet. Such was his mastery that he could rattle off Maori and scientific names in one breath, but he drew the line at ferns! The successes of Clevedon School in the Cheeseman Memorial Native Flower Shows owe much to his guidance and inspiration.

Hungry for exercise in the open air, Ross turned to fishing and acquired a solid 12′ 6″ clinker-built dinghy. His growing family, three

girls and two boys, were enlisted as rowers. Needless to say, he knew exactly where and when to drop his lines out from Kawakawa Bay and many local people benefited from his piscatorial skill. To spend a day out with him in his dinghy when the snapper were being hauled on board with uncanny frequency was an event to be remembered.

But he was still prone to feelings of ineffectiveness. His mind and body needed new challenges, the stimulus of a subject with wide horizons. In the winter of 1941, Charles Fleming, who was the Auckland regional organiser — as they were then called — of the fledging OSNZ, received an enquiry from " someone at Clevedon named McKenzie," and since geology was about to take CAF elsewhere, he passed the letter to his successor who had already become interested in the ornithological possibilities of the Firth of Thames. Consequently Ross was enrolled and, with two witnesses, made his first bird-watching trip to the Miranda coast on 3 August 1941. For him the day was a turning point. In modern parlance, he was hooked. As surprise followed surprise, the Firth became his Brave New World. On that first trip two outstanding discoveries were a substantial flock of Black-billed Gulls far to the north of their known range; and the largest gathering of Wrybills recorded since the 19th century. In the next 40 years few months passed without Ross's patrolling the west coast of the Firth in one of a series of heroic cars, accompanied by Hetty or a team of devoted friends or a group of eager youngsters. His long brass telescope was always at the ready. Little that moved escaped the notice of " Old Hawkeye," as he came to be known.

Within a few years of joining the OSNZ he had made his mark and was established both as a character and as an authority. In September 1944 he appeared as co-author of a paper on Pied Stilts. His first solo contribution to NZBN was *A Blackbird Nesting Story,* published in July 1945.

Next year, at the invitation of the King's College Bird Club, he spent a bracing week on Little Barrier Island. Theoretically he was botanical advisor, and he certainly answered many questions on the identity of plants. But from dawn to dusk he was also watching birds and shrewdly filling notebooks with pertinent observations. So thrilled was he by the experience that he returned some months later just to find out what was happening on Little Barrier in winter. Following yet another stay on that magic island, one of his nest-record cards with the familiar writing was reproduced in Fisher and Peterson's *World of Birds* (1964).

At this time, with the aid of a walking-stick in one hand and a long lancewood pole in the other, he was amazingly mobile.

In 1947 one of America's most famous ornithologists, Dr R. C. Murphy, visited New Zealand and was accorded VIP treatment. Ross was asked to escort the visitor to the Firth of Thames and in due course a huge, black, chauffeur-driven car arrived at Clevedon. When RCM saw Ross's high-built Chev., which was expected to perform

all the functions of a jeep, he transferred with alacrity. The sleek Government car followed respectfully behind. Birds in abundance were well seen and a good time was had by all.

In 1949, a Pacific Science Congress brought several American ornithologists to New Zealand. Among them was Olaus J. Murie, who in 1923 was the first to find the nest and eggs of the Wandering Tattler. A quarter of a century later, led by Ross who now had one locally on tap, Murie was able to view *Tringa incana* at Kawakawa Bay, near the extreme south-west limit of its range. As the years passed, Ross's American connection became stronger and stronger, till in 1969 he was sponsored by Principia College, Elsah, Illinois, to visit the USA to lead field trips and to give talks on watching birds. His notebooks show how he revelled in bringing his telescope to bear on the migratory nearctic waders about which he had read so much and which he was always hoping, and indeed expecting, to find as stragglers to New Zealand.

Ross became a frequent contributor to *Notornis* and he always had something significant to say. Rare migrants and stragglers fell almost literally into his lap. His mastery of detail is shown right from his early reports on Wandering Tattlers (1949), Hudsonian Curlew (1950), and breeding of Kokako (1951). He was justly proud of having added the Terek Sandpiper, the Gull-billed Tern and other unusual visitors to the New Zealand list.

The OSNZ benefited richly from his enthusiasm. Elected president 1954-56, he made the theme of his address, as was to be expected, "Work and Service." During the expanding years 1957-1966, he was a wise and thrifty treasurer. When a South Auckland region was established, inevitably he became its first RR. Having two such important areas for the study of migratory waders within his zone, he played a leading role in establishing and planning winter and summer censuses of shore-birds in Manukau Harbour and the Firth of Thames. The experience gained has been invaluable elsewhere.

Wonderfully supported by Hetty, he travelled widely seeking birds and bird-watching enthusiasts. Ornithology had become his raison d'etre, or, as Hetty put it, his salvation, and their travels, whether to Spirits Bay or Stewart Island, became, as it were, missionary journeys. There can be few likely side-roads on the main islands which they did not follow hopefully to their ends, either at the sea's edge or high in the hills.

As if he was not involved enough already, he accepted from 1968 to 1972 under Graham Turbott the position of Associate Ornithologist at the Auckland Museum. Meanwhile for many years he had been collecting data and photographs because he had set his heart on writing a book. When it was published in 1972 it was a tour de force. The full title is *In search of Birds in New Zealand: How and Where to Find Them.* It is not without significance that the second part of the title was suggested by Hetty. Thousands have used it and found it

highly informative and thoroughly reliable. It remains in demand and those who are lucky enough to own a copy treasure it.

In May 1981, when a first recipient had to be named for the newly instituted Falla Memorial Award, the Council unanimously chose Ross McKenzie. What may have been the last letter he wrote acknowledges his delight at being so recognised. He was still contributing to *Notornis* in 1980, and he was still speculating on the problems of the mixed bag of moas which his uncle, H. S. Munro, had unearthed from a swamp near Clevedon in 1912.

Grateful for 40 years' dedicated work in the interests of New Zealand ornithology and for his inspiring example, the Society offers sincere sympathy to his daughters Mary, Ada and Catherine and their children and to the families of his sons, John and Roderick, who died before him.

— R. B. Sibson

I first saw Ross McKenzie in action soon after we moved to Clevedon. There, on the road by our mailbox stood a well-built man in ear-muffs and waistcoat. With a stout wooden stick he was directing a boy who was scrambling through the thick fern on top of the bank. They were searching out, successfully, of course, a Yellowhammer's nest. The cock bird had been seen singing on the telephone wires.

It was typical of Ross that, having heard of a new arrival interested in birds, he lost no time in calling, and soon we were joining in those famous expeditions to the Firth.

There was a special excitement in setting off early in an orderly and well-planned manner in the old Chev. The trip down the coast was enlivened with anecdotes. We scanned likely places such as the stony spit at Kawakawa Bay, which had once been occupied for several months by a Wandering Tattler — at least, those in the front did, as the view from the back was rather obscured by the side curtains in cold weather. Excitement mounted as we passed ' Bull Field ' keeping a sharp eye out for Redpoll in the short scrub just north of the ' Guy C. Goss.'

As we neared ' The Pools,' the car was more or less given its head while we searched the marshy edges for small waders. Out came the old brass telescope. We learnt the value of patience, meticulous attention to detail, and sheer persistence in getting results. It was always seen as a team effort, and the most junior member of the party was made to feel they had contributed something to the day.

With Ross everything had to be shared. His pleasure in giving pleasure was very real indeed. A new bird meant that everybody had an opportunity to see it. An interesting visitor meant an evening at Kiltarlity with Hetty's kindly welcome. People were her love. With their own family fledged, there were often visitors at Clevedon — overseas visitors, people convalescing, just people in need of friendship.

Often these were young, and in due course 'ornithological' grandchildren were added to the circle.

When Ross retired, he and Hetty embarked on lengthy tours of both islands, visiting members and encouraging new ones. In time they covered most of the roads in the country and these experiences were invaluable when he came to write *In search of birds in New Zealand*. While they were away their back door was never locked. "Someone might want to come in and make a cup of tea," Hetty used to say.

Theirs was a life of love and service to others, their influence going far beyond the sphere of birding.

In his latter years, after Hetty's death, and with his own increasing disability, Ross never lost his dry sense of humour. He could still joke over the fact that since his slight stroke he could not remember which way round to put his hat. His sharp eye could still put us to shame and his interest was as keen as ever.

— A. J. Goodwin

I knew him best in the 50s — long Miranda days, Karaka mornings, sorties around the sewage ponds, and some exhausting forays into Northland on waterfowl surveys or New Zealand Dotterel banding expeditions. All birds were grist to his mill of a mind, but in those years the waders took precedence. He was in their thrall. He could say with Huxley that they were the very breath of his nostrils, and others in his company either caught his disease or passed him off as eccentric — pleasant, harmless, but definitely eccentric. He certainly looked the part, with or without that old brass telescope.

Those were the days of the square-backed Chev with the hand-throttle that choked like a kookaburra. To climb up beside Ross at the wheel took some courage. His acute observation extended far beyond the road ahead of him. The sudden halt, the sharp turn without warning, or a cross-country diversion up a sloping bank were usually by choice, and always something to do with birds. Other drivers unfortunate enough to be caught in his wake used strong words. But "the road is mine, as it is theirs, and I shall use it as I choose. Do 'em good to have to slow down a bit, anyway. Look about them. See the country."

He taught me bird-watching; how to look and record, to listen and record, to count and record. Like Lord Halifax looking from a train at newly-shorn sheep ("Well, they're shorn on this side, anyway") he took nothing for granted. Mentor and loving friend, he shared bird-lore, Maori-lore, botanical information and apt biblical quotations.

In the bush or on a shellbank, while the lithe and mobile sauntered off or strode away, he established himself in one spot and

at the end of the day guess who had the best information? Old Hawk-eye himself.

I would look at herons, or a curlew. "Never mind those big things. Look for the small stuff. They're the puzzles. The little brown jobs." I say something about plumage colour. "Colour? Forget about it — a trick of the light — put there to confuse you. What about the bill? What's the thing *doing*? Does it bob? The rump's important. You must know the pattern of the rump. But for God's sake don't put the thing up till you're ready for it. Colour? Well, useful sometimes, I suppose. And the legs — well of course you've *got* to get the colour of the legs."

He had an endearing habit of describing a bird by reference to his own somewhat portly form. He "became" a wrybill, a greenfinch, a grey plover. Doubly earthbound by his humanity and his artificial leg, he could nevertheless draw himself up into an egret or a greenshank as one's imagination flew with his in specific forms, patterns, and stances.

To think of Ross is to think of Hetty. Theirs was almost a symbiotic relationship. Anyone fortunate enough to be their guests at Clevedon will remember the nightly bird-log: Ross stumping to his desk in that life-centre of a room, calling to Hetty in the kitchen, "What have you heard today, dear? — Yes — yes — got'm — got'm — what about the chaffinch? No yellowhammer on the wire?" Hetty is making pies, or preparing tomorrow's bread. "Just a simple little picnic." She stands at the doorway with floury hands, feet bare in the summer night, hydrangea-blue eyes far away while she wonders. "The yellowhammer. I didn't hear him, but I saw him. Was it today? The children from the school came up with a fish, and he shot past the window. I saw that rufous rump you say I have to look for. Was it today? Yes, there's the fish, still fresh." Her eyes sparkle at the proof. "It was this morning." When did she sleep? Last thing at night she was "just rinsing out the stump-socks"; first thing in the morning, there she was, glowing, with a tray, a flower, fresh fruit. She arranged their lives so that for him "the bird-work" took priority. "If I am to be content he must be happy. The bird-work keeps him happy. And look at the rich friendships it has brought us both."

For all Ross's rugged exterior — peg-leg, "luggies," and that indomitable nose — he was a softie at heart. He needed nurturing, and Hetty was a peerless nurturer. When he was testy she knew how to divert him with an anecdote, or apples to be peeled, or a strategic suggestion. When he tended to pontificate she could take just enough wind out of his sails to leave him afloat but not adrift: "And what will my Old Testament prophet *do* about it??"

All his life Ross maintained a wide correspondence. In the last 20 years it was he rather than I who kept our friendship alive

through letters, usually long, sometimes crisp, never boring. I was only one of his many correspondents.

He was a goldmine of a man, who shared his gold.

— Maida Barlow

It was on Manukau Census day, mid-winter 1963, that I met Ross McKenzie and the pattern for years of field trips was laid down for me. A splendid Black-tailed Godwit in breeding plumage marked that occasion. Thereafter, until the last outing shared 3 weeks before his death, his friendship, knowledge, kindness and encouragement were given unstintingly. This latter occasion brought two firsts for him, the only Grey Duck he ever saw on Hamilton Lake and the unexpected sight of a family trio of Coots grazing like sheep on the green shore. Between these days many events come to mind, but more than these, the simple sincerity and sheer worth of this man stand out. Knowing him changed the course of my life. I am sure that I am not alone in this.

Like many others, Ross " caught " his great interest in birds almost as one catches measles. Aided and abetted by R. B. Sibson, it developed into a consuming passion that lasted for the rest of his life. He recognised this condition in others and knew their overwhelming need to observe, to learn, to know and to write. His whole attention would be focused on filling the need of those who came to him to learn. He took infinite pains to supply full answers, making his correspondence an extensive task. His help was unfailing. Scouts came to be examined for their badges, students to glean from his long experience, overseas visitors to be advised on itineraries. All were made welcome, for the home of Hetty and Ross McKenzie was a place of hospitality and understanding.

Ross often joked about preaching the gospel of ornithology, but in fact he did just this. As a result he signed up new members for the Society everywhere he went. He reached out to people and they warmed to him. He was above all a teacher (though this was not his profession), with a good teacher's gift of triggering enthusiasm. Progress was always rewarded. A paper of particular interest, or a letter commending special effort, would go out to the deserving as a spur to further progress.

He intiated counts of waders which grew into regular censuses on both sides of the Auckland isthmus. These go back for many years, providing a store of uniquely valuable information. Such censuses and the surveys of the Pouto Peninsula and Kaipara Harbour and of the Hunuas for Kokako were planned with meticulous care and almost military precision. Teamwork and timing were stressed. With a task completed, sociable and usually very late lunches (work must come

first !) were memorable for good talk and the fellowship of shared interest. While Ross collected the day's records Hetty McKenzie, kindness personified, would quietly see to it that all had food and drink or would draw a shy newcomer into the circle.

A peerless field observer, Ross had an uncanny ability for nest finding. He would calculate to a nicety the chosen site of a dotterel's nest. Many found it almost magical but it was, like all his fieldwork, based on years of solid experience. When old war injuries brought increased infirmity he turned this into an asset. Unable to walk far, he would sit on his folding stool and, by using his telescope, find birds that his more mobile companions often missed. One learned the value of staying put and combing through a resting flock several times over, for persistence certainly brought him results. He delighted in a find, a well-earned reward for the patient work necessary in the regular checking of thousands of shorebirds.

He was a fighter who spoke out fearlessly when he thought the situation warranted it. Sometimes it would put him offside, but this would not perturb him. He could disagree in the most courteous manner, entirely without rancour, which often proved disarming to the opposing view.

There were many demonstrations of the affection that people had for Hetty and Ross. Three very special occasions revealed this particularly. The first was the gift of a trip to the United States. It was made possible by an endowment to an Illinois University's Biology Department. Their first use of it was to choose Ross to be a guest speaker. He had helped members of their staff, as he had helped many other visitors to New Zealand. It was a wonderful trip for the McKenzies, something they had never expected. Later there came a time when their faithful Chevrolet, carrier of so many birders, came to an end of its days. Numerous friends felt privileged to help with a replacement. The response was immediate and overwhelming. Within just a week, the plan became a reality, and the shared excursions continued in a Holden, whose automatic transmission made driving easier, extending the time that Ross was able to enjoy driving. The third occasion arose when Ross retired as Regional Representative for South Auckland in 1973. Friends gathered in Clevedon, some coming from great distances. A history of birding days shown in slides, some copied from very old photographs, was a joyful surprise to Hetty and Ross. A specially commissioned painting of a Kokako, always a special bird to Ross, and an album of photographs sent from all over the country were received with delight and a few tears.

After Hetty's death, although Ross' health declined he continued to write, as was his habit of many years. He never lost his dry sense of humour. Toward the end of his life he moved to Hamilton but still enjoyed the visits of a steady stream of friends. He will be

remembered with great affection by the many whose lives were enriched by his gifts of friendship and dauntless example.

Fall, winter, fall; for he,
Prompt hand and headpiece clever,
Has woven a winter robe,
And made of earth and sea
His overcoat for ever,
And wears the turning globe.
— A. E. Housman

— Beth Brown

For indomitable courage in the face of recurring surgery and never really free from pain resulting from his wartime injuries, I regarded Ross as a man without peer. Along with so many others, I was privileged to count him as a close friend, a friendship which was cemented by our close association throughout the 1960s in the affairs of OSNZ, to the welfare of which Ross was wholly dedicated, and in which he was aided and abetted by our well-beloved Hetty. Ross always acknowledged that it was largely due to Hetty's encouragement that he first took up the study of botany, to become an expert in that field, and then to turn to ornithology.

Incidentally, a project dear to Ross's heart over a number of years prior to the end of a richly rewarding life was the establishment of Kokako on Little Barrier Island, and he would have been gratified to have seen this now coming to fruition.

— A. Blackburn