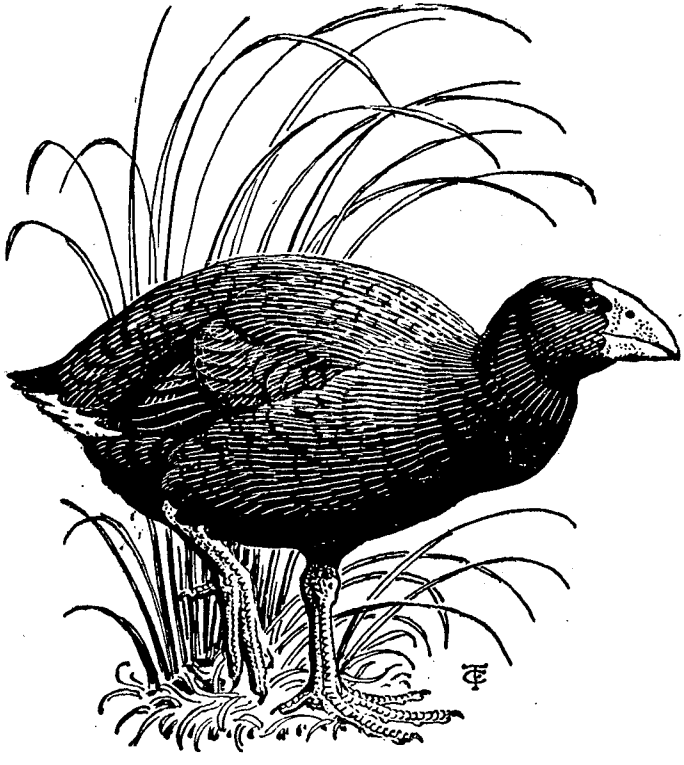
NOTORNIS



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NOTORNIS

In continuation of New Zealand Bird Notes

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Contents of Vol. 16, No. 4: December, 1969

KERMADEC ISLAND EXPEDITION REPORTS

THE SPOTLESS CRAKE *(Porzana tabuensis plumbea)*

By M. F. SOPER

Spotless Crakes were found only on the two Meyer Islets. They were seen exploring the tide-line, the adjacent zone of low, tangled, salt-tolerant vegetation, the accumulated litter under the coastal scrub association (which covers the greater part of the Meyer Islets) and the clumps of *Cyperus, Paspalum* and *Sicyos.* Notable was the frequency with which they hunted for food in trees and they appeared to be the only species utilizing this niche. They were as often to be seen obtaining insects from the foliage or around noddy nests as they were to be seen skulking about on the ground. They also explored petrel burrows and penetrated them to their furthest limits. Worthy of note is the frequency with which they were seen during both day and night.

The total population was difficult to assess and was probably fewer than 40 individuals. The Meyer Islets are small and easy to scramble round and when I left after a divided stay totalling 28 days I knew of only 14 pairs. The birds were always to be found in the same places and it was evident that territories were being adhered to.

Nests proved difficult to find and much time was spent searching likely areas of dense cover. The only occupied nest found was discovered purely by accident. On 27/12/66 I all but trod on a bird in an area of *Paspalum* overgrown with *Sicyos.* The crake exploded from under my foot and when I parted the vegetation four recently hatched chicks scrambled out of a nest into the surrounding cover.

The nest was a flat platform of grass, with no great amount of material, and was about 4 inches across. It was situated in the centre of a dense clump of *Paspalum.* There were no egg-shell remains. The chicks were dry and fluffy, about the size of a ten cent piece, covered in jet black down and had disproportionately long legs and feet. I estimated them to be about 24 hours old. When I revisited the site with camera equipment a short time later no sign of either adults or chicks could be found. Two unoccupied nests were found on North Meyer by J. F. Anton; one, in a clump of *Digitaria,* appeared recently constructed on 9/1/67, and the other, also in *Digitaria,* was apparently freshly vacated on 19/1/67. Both were similar in construction to the nest described above.

A large downy chick was seen on 23/11/66.

No crake was ever seen to fly in the accepted sense of the term. If cornered they would use their wings to propel themselves up steep banks or rock faces but so far as I could see, such " flying " was little more than wing-assisted running.

Like other rails, the Spotless Crakes on Meyer were found to be predators of other birds' eggs. This behaviour first came to notice when abandoned eggs of Wedge-tailed Shearwaters and Black-winged Petrels placed on the side of the track for collection on return to camp, regularly vanished without trace. Then on 16/1/67 J. F. Anton saw a crake eating the contents of a Kermadec Petrel's

egg in an unguarded nest. Presumably the eggs of the White-capped Noddy may also be included as part of the crake's diet and if this is so then it may in part explain not only the frequency with which crakes were seen in trees but also the otherwise inexplicable high disappearance rate of noddy eggs.

Measurements (in millimetres) of Adult Crakes collected on South Meyer Islet: (Measurements are those used by the Ornithological Society of New Zealand's Beach Patrol Scheme and described by Heather (1966).)

Dominion Museum Number	Date Collected	BILL				Mid-toe and Claw	Tarsus	Wing	Tail
		Sex	Length	Width	Depth				
12400	27/12/66	M	22	7.2	7.7	39.5	30	85	45.7
12401	26/12/66	F	18.7	5.7	7	37.3	29	81	46

REFERENCE

HEATHER, B. D., 1966: A Biology of Birds. Teach and Test Publications Ltd., Lower Hutt.

★

SHORT NOTE

A NOTE ON THE LOCAL DISTRIBUTION OF BULLERS SHEARWATERS

Over the past ten years there seems to have been a noticeable increase in the numbers of Bullers Shearwaters *(Puffinus bulleri)* about coastal waters south of Auckland.

Notes kept on East Coast passages up to five years ago show that Bullers could be expected in decreasing numbers across the Bay of Plenty, with an increase in numbers about the East Cape. They were then seen in smaller numbers off the East Coast; and always noted, but again in small numbers, about the Wairarapa Coast. Only rarely were they noted south of Cook Strait.

On the West, the shipping to Westport from Cape Reinga passes well off the coast, and it was unusual to see these Shearwaters more than sixty miles south of Reinga. From Beach Patrol records it is obvious that some move south of this but closer into the coast.

Last year (1968) on the East Coast large numbers were seen about East Cape, rafts of up to two hundred birds being not uncommon. In summer there were invariably Bullers Shearwaters in view south to Lyttelton and they were regularly seen between Lyttelton and Dunedin, an area where years ago they were very rarely recorded.

On the West Coast of the South Island in mid May 1969 20+ Bullers were seen off Westport and 30+ just north of Greymouth; and a few between Cook Strait and Greymouth. A fortnight later on 2/6/69 as I sailed south in daylight from Cape Brett only 4 were seen near the Poor Knights. It was obvious that most of the population had moved away and only a few laggards remained. Then on 2/9/69 when our position was three miles north of North Cape lighthouse (1300 hrs; wind S. 05 knots; air temp. 64°; sea temp. 60°F.) I spent about 40 minutes studying a gathering of well over 5000 petrels, shearwaters and gulls. To me the most interesting were three Buller's Shearwaters, my first for the new season.

— JOHN JENKINS

NEW AND RARE BIRDS AT SNARES ISLAND DURING 1968 - 69

By JOHN WARHAM and B. R. KEELEY
Zoology Department, University of Canterbury

(University of Canterbuy Snares Islands Expeditions, Paper No. 10)

The University of Canterbury's field station on the main island of the Snares Group was occupied from 14 November, 1968, to 25 February, 1969, when long term studies of the ecology of littoral and forest invertebrates and of sea birds were continued. The following notes give details of ten species of birds hitherto unrecorded on the islands and of other birds reported in the past but not seen in recent years.

The work was made possible by a grant from the Nuffield Foundation which was supplemented by University and Departmental funds. Information from fellow members, S. L. Bennington, D. B. Cameron and R. J. Mackay is gratefully acknowledged. We are also indebted to Lloyd Young of Bluff and the crew of " Kutere " and to Bernard Walker of Christchurch for help with transport and to Mr. N. G. Robertson, N.Z. Meteorological Service, for providing data on wind frequencies in Foveaux Strait.

As in previous years, a number of crested penguins, mostly immatures, came ashore to moult. Since one member of the party devoted his whole time to observing penguins and ranged widely round the island, the sightings of these were more numerous than hitherto. They included about 20 Fiordland Crested Penguins *(Eudyptes pachyrhynchus pachyrhynchus)*, about 15 Erect-crested Penguins *(E. p. sclateri)* and about 12 Rockhoppers *(E. crestatus)*. Not all the latter were light-throated juveniles. The greatest number of these visitors was seen at the important landing slope on the east side of the North Promontory which serves the numerous penguin colonies in that area.

A feature of the 1968/69 bird sightings was an increase in the variety of European passerines and of wading birds, an increase not accounted for by the longer period of observation than that maintained during previous visits. The weather preceding our arrival had been bad and according to data from Invercargill weather station, during October and November, 1968, there was an unusually high frequency of gale force westerlies in Foveaux Strait. That such gales also extended south to the Snares is suggested by the unusual number of recently thrown *Olearia* trees found in many parts of the main island during 1968/69.

Such winds seem unlikely to have helped birds from southern New Zealand to the Snares as the latter lie too far to the south west but would be in the right direction to assist dispersal from Tasmania and south eastern Australia. In view of the arrival, apparently under calm conditions, of Australian Tree Martins on Snares (see below) and of such species as Blackbirds, Silvereyes and Goldfinches as far afield as Macquarie Island in the past, an Australian origin for the finches on the Snares cannot be ruled out. Furthermore, P. M. Johns has drawn our attention to the appearance in New Zealand

of an unusual number of Australian lepidoptera from September to December, 1968. This trans-Tasman crossing has been documented by Fox, Gibbs and Dugdale in separate communications (1969, N.Z. Ent. 4). It concerns a butterfly, *Vanessa kershawi,* and eight noctuid and one arctuid species of moths. The records, mainly from the western coastlines, range from southern Stewart Island to North Auckland and are attributed to wind-assisted migration from south-eastern Australia following prolonged westerlies. This migration supports the hypothesis that the origin of the Snares Island finches was Australia. On the other hand for dispersal with following winds from Southland and/or Stewart Island the period from 21 to 24 August seems to have been most propitious being the only period during the three and a half months preceding our arrival with strong north to north easterly winds. For birds coming from Stewart Island wind assistance may, of course, not be necessary bearing in mind that from the top of that island the Snares are just visible to the human eye under really clear conditions.

The waders, of three species, were unexpected visitors to a coastline as rock-bound as that of the Snares and none remained for very long.

Not included in the following list is a Mallard-Grey Duck hybrid first noticed on 18 November and assumed to be the male partner of a normal plumaged Grey Duck seen with four ducklings on 27 December.

Blue Penguin *(Eudyptula minor)*

A single bird, fat in anticipation of moult, was seen on 9 February. From the depth of its blue colouration it was judged to belong to the southern race.

Macaroni Penguin *(Eudyptes chrysolophus)*

Although a watch was kept for Royal Penguins *(E. c. schlegeli)* which were expected visitors, the appearance of a Macaroni Penguin on 10 January was a surprise, for the nearest breeding place of this bird at Heard Island is about 3,000 miles more distant than Macquarie Island where *schlegeli* nests. When the present bird (Plate XXXII) turned up near the biological station it weighed 3825 grams and its bill and flipper lengths were 65.5 and 196 mm. respectively. The bird appeared to be a male. It was not in pre-moult fat condition and on release returned to sea and was not sighted again.

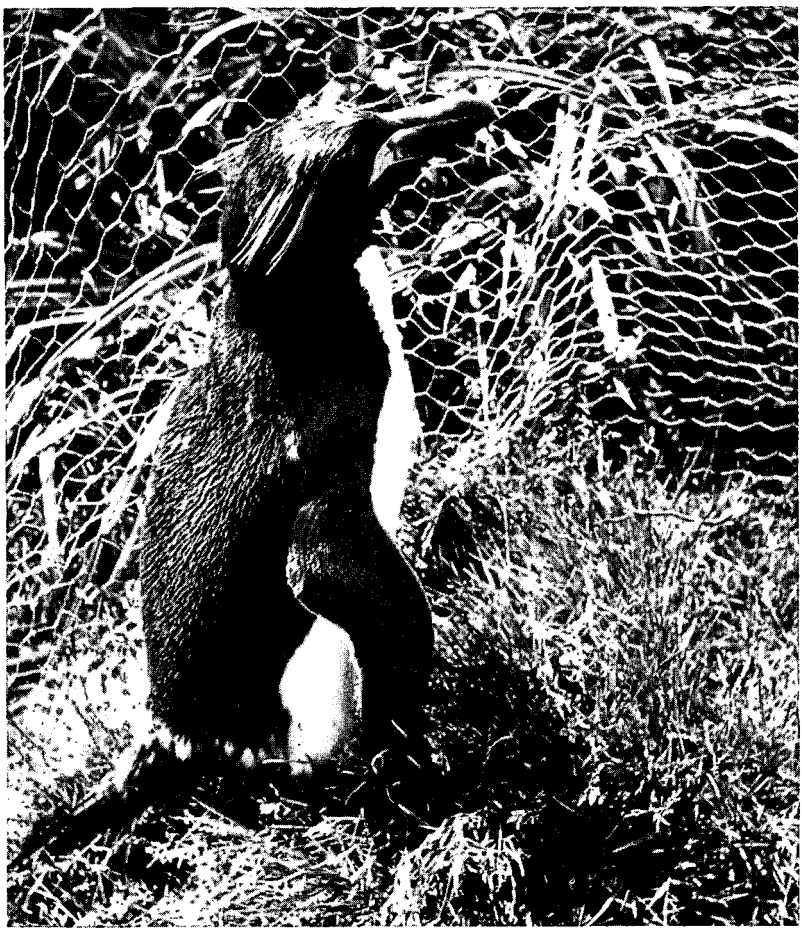
This comprises a new record for New Zealand although the Royal Penguin, which is often only regarded as sub-specifically distinct and which includes a very small proportion of black-faced birds, has been recorded as a straggler on several occasions.

White-throated Shag *(Phalacrocorax melanoleucos)*

There were 10 sightings of black and white shags during the period, two being seen on one occasion, but not until 3 December was any close enough for positive identification. The birds were of the extreme white-throated form and they were only noted along the east coast where the only inlets suitable for these birds to feed are to be found. It was here in 1967 that an unoccupied nest, thought to be of this species, was seen (Warham, Notornis 14: 134).

Sharp-tailed Sandpiper *(Erolia acuminata)*

A single example of this bird was present between 15 and 28 November. It was tame and spent much of its time feeding among



[D. B. Cameron

Plate XXXII — Macaroni Penguin, Snares Island, 10 January, 1969.

pools and along the muddy margins of certain inland colonies of the Snares Crested Penguin. A familiar bird to the senior author, its diagnostic characters (*vide* Serventy & Whittell, Handbook of the Birds of Western Australia, ed. 3, page 201) were noted — the white outer tail feathers, straight but almost imperceptibly down-turned bill and olive green legs and streaked rufous, buff and black upper parts.

Greenshank *(Tringa nebularia)*

A single example was present at least from 20 November to 13 December. The long bill, long greenish legs, white tail and familiar 4-note call were noted. The bird's feeding grounds were along the tidelines of the Boatharbour and of the inlets to the north and south of there.

Tattler *(Tringa brevipes/incana)*

A lone tattler was feeding with the Greenshank on 9 December. It was less timid than that bird and about two-thirds of its size. This wader gave good views and the uniformly grey upperparts (except for a slightly darker head), white underparts not sharply delineated from the upper parts as in *T. nebularia,* dark eyestripe; long tapered bill, darker distally were readily seen. It gave a two-note cry when flushed and was not seen subsequently. The nasal groove was not seen clearly enough to separate the bird specifically but it was most likely *T. brevipes,* as this is the commoner species recorded from New Zealand and in south-eastern Australia and has a double call note.

Black-billed Gull *(Larus bulleri)*

One bird was present with the party of Red-billed Gulls at the Boatharbour on 18 November and remained with them until at least 10 December after which there were no further sightings, although two were seen flying on 20 November.

Southern Black-backed Gull *(Larus dominicanus)*

Although seen in 1947 (Fleming, 1948, N.Z. Bird Notes 2: 182) and 1948 (Richdale, n.d. Wild Life on an Island Outpost, 115) and evidently rare then, this bird was not encountered by the University of Canterbury teams in 1961 or 1967. One adult appeared on 24/1/69, when it was found scavenging among Giant Petrels. Three days later two of these gulls were noted in the vicinity of Ho Ho Bay where they continued to be sighted until 6 February. The last record was of a singleton two days later.

Hedge Sparrow *(Prunella modularis)*

Stead (1948, N.Z. Bird Notes 3: 79) is the only previous visitor to record this species. Its presence in 1968 was soon noted because of its song and a single bird was seen or heard between 19 November and 21 December.

Australian Tree Martin *(Hylochelidon nigricans)*

Two used the radio aerial as their perch between feeding forays from 18 to 20 February. The dull white rump, slightly forked tail, brownish undertail coverts contrasting with the whiteness of the remaining underparts were well seen and prevented confusion with *Hirundo neoxena.*

Greenfinch *(Chloris chloris)*

A pair on 15 November was feeding on seeds of *Poa annua.* The species appears to have been scarce during the period reviewed, the only other sighting being of a single bird in flight on 5 February.

Goldfinch *(Carduelis carduelis)*

Seen by the 1947 and 1948 expeditions but not previously by those from this University. Sightings of single birds and of groups of up to 5 were common during November and through to 12 January, the same individuals probably being involved on most occasions.

Yellow hammer *(Emberiza citrinella)*

A male found under a rock ledge near the Station on 14 February had been dead for some time but was still readily identifiable.

These additions bring the bird list of the group to 45 of which 23 species are believed to breed.

NEW AND RARE BIRDS ON CAMPBELL ISLAND

By F. C. KINSKY, Dominion Museum

INTRODUCTION

Campbell Island is one of the best known of the New Zealand subantarctic islands, not only because it was visited fairly regularly during the late nineteenth and early twentieth century, but also because it has been permanently inhabited since 1941 (first as a coast watching station during the 1939-45 war, then as a permanent weather station established in 1945). The two most comprehensive bird lists recently published are contained in Westerskov's (1960) "Birds of Campbell Island" and in Bailey and Sorensen's (1962) "Subantarctic Campbell Island." In these two publications the authors have collated all available information on Campbell Island birds, and the resulting lists can be accepted as complete, considering all the information then available. In their introductory chapter to the birds of Campbell Island, Bailey and Sorensen (1962: 91) state that "sixty-one species of birds have been recorded from Campbell Island. Only twenty-six have been definitely noted breeding, but it is entirely likely that additional ones will be observed in the days to come." In the short period of six years, Bailey's above prediction has become a fact, mainly thanks to the intense interest taken in the island's fauna by numerous members of the meteorological parties occupying the island, of which several spent more than one year (the usual length of stay) on Campbell Island.

The following list contains birds not previously recorded from Campbell Island and in addition, some notes on species previously considered very rare, or included in the Campbell Island list from a single reported sighting.

This list, *inter alia,* contains nine species new to Campbell Island, including three species newly established, and has been compiled from the writer's own observations during his visit to Campbell Island in January, 1968, and from reports received from the following members of meteorological parties:

C. M. Clark, Officer-in-Charge 1961/62 and 1964/65.
A. Wright, Officer-in-Charge 1962/63.
C. G. Surrey, Cook 1964/65, 1965/66 and 1967/68.
D. Paull, Meteorological observer 1964/65 and 1966/67.
A. M. Bromley, Meteorological observer 1966/67.

ACKNOWLEDGEMENTS

The writer's thanks are due to the above members of the meteorological parties for their informative reports, and in particular to Messrs. G. Surrey, D. Paull and A. Bromley for their generous assistance during the writer's visit to Campbell Island in January, 1968. Thanks are also due to Mr. B. D. Bell, a member of the 1969 Canterbury University Campbell and Antipodes Islands expedition for permission to peruse his field notes and to publish his observations on Little Shags made during the expedition's visit to Campbell Island.

The kind help of the Ministry of Transport, Raoul and Campbell Island Administration, and the hospitality extended to the writer during his stay on Campbell Island is herewith gratefully acknowledged.

FAMILY SPHENISCIDAE (Penguins)

Up to 1964, six species of penguins had been recorded from Campbell Island. Three species are known to breed there, i.e. Yellow-eyed Penguins *(Megadyptes antipodes)*, Rockhopper Penguins *(Eudyptes crestatus)* and Erect-crested Penguins *(Eudyptes pachyrhynchus sclateri)*.

Three other species have been recorded as stragglers only. King Penguins *(Aptenodytes patagonicus)* occur on Campbell Island mostly as single individuals, but fairly regularly every year; Royal Penguins *(Eudyptes chrysolophus schlegeli)*, occur as regular straggles from Macquarie Island, but sometimes visit Campbell Island in small groups often coming ashore to moult; and two Fiordland crested Penguins *(Eudyptes p. pachyrhynchus)* were recorded on Campbell Island; the first in January, 1945 (DM 14755), and the second on 21st January, 1969 (R. H. Taylor, pers. com.).

Two additional species of penguins can now be recorded from Campbell Island.

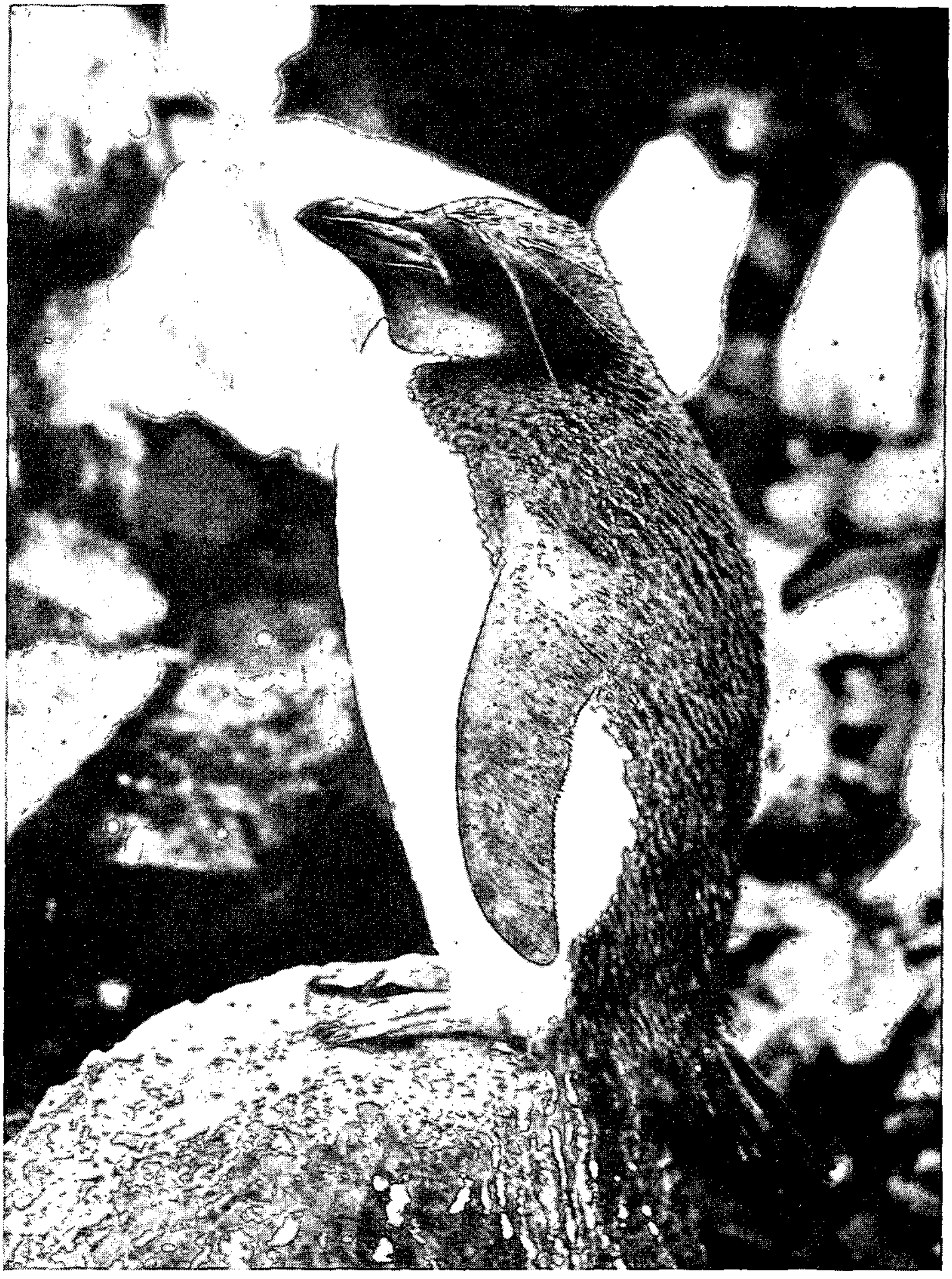
Gentoo Penguin *(Pygoscelis papua)*

An individual of this species was seen and photographed near the jetty in Perseverance Harbour on 29 December, 1964, and was seen in the same vicinity on 9 January and 3 March, 1965. An additional sighting of the species was made on 8 August, 1965, near Shoal Point (also in Perseverance Harbour). This was most probably a straggler from Macquarie Island, where *P. papua* breeds in numbers. If these sightings were all of the same bird, it must have remained in Perseverance Harbour for at least eight months.

Macaroni Penguin *(Eudyptes c. chrysolphus)*

During the writer's visit to the large penguin colony in Penguin Bay on 19 January, 1968, a group of five *Eudyptes chrysolophus* was found resting together on a steep slope in the middle of breeding Rockhopper Penguins. Four of these birds were Royal Penguins *(Eudyptes chrysolophus schlegeli)*, whereas one was a Macaroni Penguin *(Eudyptes chrysolophus chrysolophus)*. This bird was collected and its identification was later confirmed by Dr. R. A. Falla. The skin of this specimen, an adult female, is now in the Dominion Museum (DM 13265). This bird had been seen and noted " as unusual " by station personnel in the same area in December, 1967, and is the first of its kind ever to have been collected in New Zealand. Two other specimens are known to have occurred in the New Zealand region, i.e. one bird was sighted on Snares Island during the 1968/69 summer (Warham, 1969: 285) and a third bird, an adult male, was collected by Dr. Falla on Macquarie Island in December, 1957. This specimen is now in the Dominion Museum collections (DM 8963).

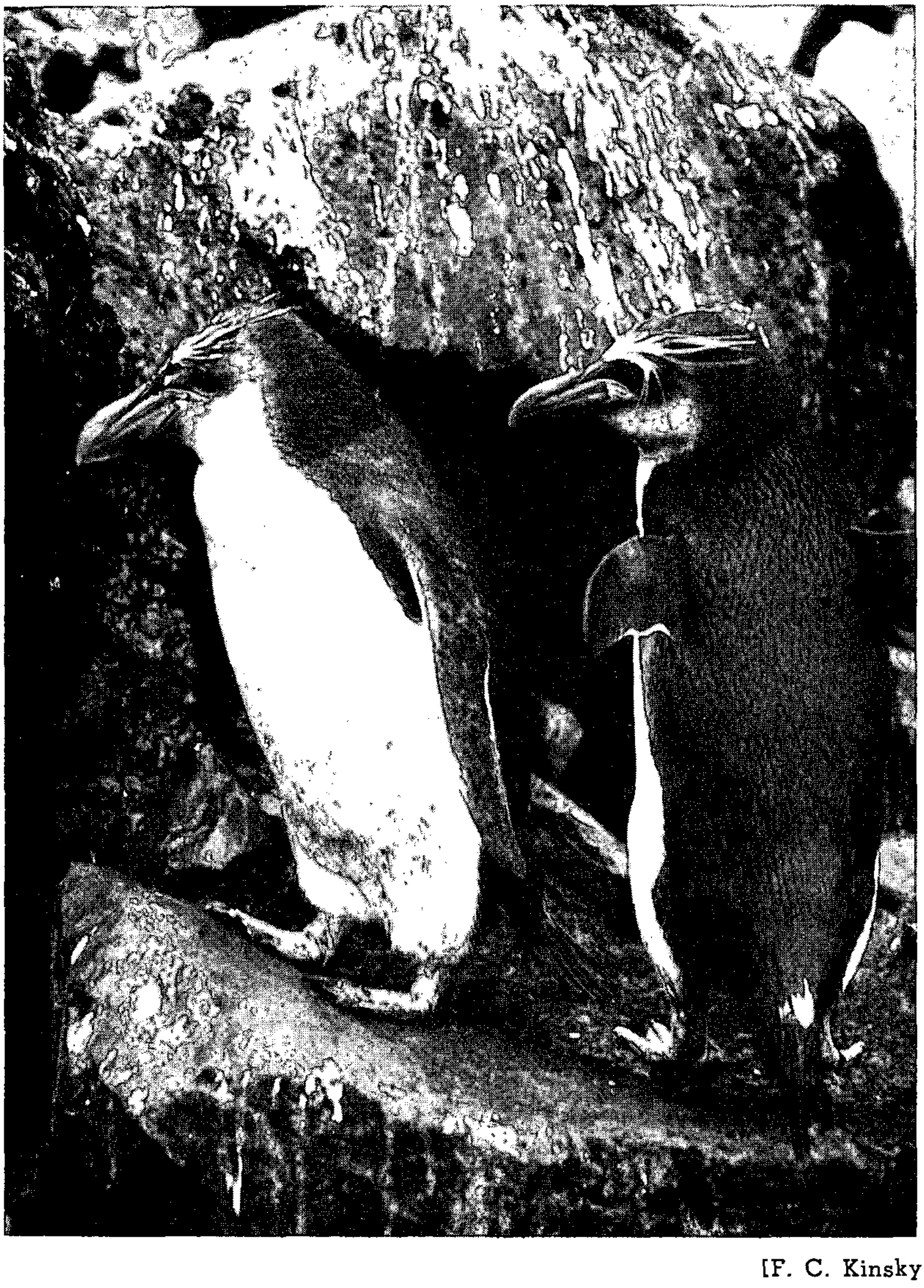
Macaroni Penguins breed in large numbers on subantarctic islands in the Indian and the Atlantic Ocean sectors, but only recently have they been found straggling to the Ross Sea and New Zealand areas. In addition to the above three specimens, two immature birds were collected respectively at Cape Hallett, in February, 1964, and on Sabrina Island, Balleny Islands, in March, 1964 (Hatherton *et al.*, 1965).



[F. C. Kinsky

Plate XXXIII — Macaroni Penguin **(Eudyptes c. chrysolophus)** adult female, Penguin Bay, Campbell Island, 19 January, 1968.

Two subspecies of *E. chrysolophus* have been described up to the present time, i.e. Macaroni Penguin *(E. c. chrysolophus)* and Royal Penguin *(E. c. schlegeli)*. Dr. Falla, who studied the Royal Penguins on Macquarie Island, kindly informed me of additional differences between the two subspecies concerned. The Royal Penguin,



[F. C. Kinsky

Plate XXXIV — A pair of Royal Penguins **(Eudyptes c. schlegeli),** Penguin Bay, Campbell Island, 19 January, 1968. The left bird, considered to be a male, is close to the usual colouring of this subspecies, whereas the right hand bird, considered to be a female, has silvergrey cheeks and throat. Allowing for the size differences between sexes, note the strikingly large bills of this subspecies.

breeding on Macquarie Island only, usually has white cheeks, chin and throat, and a strikingly large bill (usually stronger in males than in females). Some individuals on Macquarie Island, however, have either *silver grey* or *jet black* cheeks, chin and throat, though they have the typically large bills of this race. Macaroni Penguins, in general very similar to dark-chinned Royals, can be separated from Royals by their distinctly *grey-black* cheeks, chins and throats, and by their comparatively (allowing for size variation with sex) smaller bills.

FAMILY PROCELLARIIDAE (Petrels)

Snares Cape Pigeon *(Daption capensis australis)*

Both Westerskov (1960) and Bailey and Sorensen (1962) comment on the abundance of Cape Pigeons around Campbell Island, including Perseverance Harbour, and on the fact that although present throughout the year, nesting on Campbell Island or outlying stacks had not been observed. Westerskov (1960) refers to this species as an " uncommon migratory breeding bird," and Bailey and Sorensen (1962) quote G. Thompson, the Officer-in-Charge during the time of Bailey's visit to Campbell Island, who reported having found a Cape Pigeon " on nest high on rocky cliffs on the south coast below Mt. Dumas on 27th October, 1957."

G. Surrey, a very keen bird observer, saw five birds " breeding " on inaccessible cliffs on the east side of Mt. Eboule Peninsula, above Monument Harbour (on the south coast of Campbell Island) on 14 December, 1967. This therefore is a second colony of Cape Pigeons on the main island.

White-headed Petrel *(Pterodroma lessoni)*

Bailey and Sorensen (1962) include the White-headed Petrel in the list of Campbell Island birds on the basis of one specimen collected in Perseverance Harbour on 2 March, 1957. However, this species was not included in Westerskov's (1960) list.

Two further specimens of this species have been recorded recently from Campbell Island. An injured bird was picked up in front of the hostel on 23 March, 1960, and a second bird was found dead near the meteorological station on 6 June, 1968. The latter specimen was subsequently forwarded to the Dominion Museum for identification, and is preserved as a skeleton (DM 14614).

Fairy Prion *(Pachyptila turtur)*

No substantiated records of Fairy Prions having been collected on Campbell Island were in existence until very recently. This species was not included in Bailey and Sorensen's (1962) list. However, Westerskov (1960) quotes Filhol as mentioning sightings of Fairy Prions at sea when approaching Campbell Island in 1874, but points out that the birds seen by Filhol were more likely to have been " some of the other prions recorded *(desolata* or *belcheri)*." Nevertheless, Westerskov does not discard the possibility of Fairy Prions possibly being carried to Campbell Island by strong northerly winds but points out that confirmation was still needed.

The occurrence of Fairy Prions on Campbell Island has recently been confirmed. Three specimens were picked up on the island on

16 February, 1963, 16 May, 1968, and 17 February, 1969, respectively. All three specimens were forwarded to the Dominion Museum for identification and are preserved as study skins (DM 10060, 13518 and 14601).

FAMILY HYDROBATIDAE (Storm Petrels)

Grey-backed Storm Petrel *(Garrodia nereis)*

Westerskov (1960) did not include this species in his list, but it was listed by Bailey and Sorensen (1962) in considerable detail. Grey-backed Storm Petrels were not known from Campbell Island until 1957, when the first of this species was collected on 3 March, after having hit a station window during the previous night. Since then this small storm petrel has been observed regularly and in seemingly increasing numbers.

During the last eight years a total of 85 Grey-backed Storm Petrels were caught around the hostel during foggy or stormy nights. These birds were banded and released in Perseverance Harbour, but no recoveries were reported up to the present time. They occur on Campbell Island throughout the year but seem to be much more plentiful during late summer than at any other time of the year.

Breeding of this species on the island has not yet been proved. However, the monthly distribution of the birds caught is much more likely to indicate that breeding occurs in the area, than that it reflects the number and distribution of foggy nights occuring on Campbell Island throughout the year. Out of 59 birds caught, banded and released during a three year period (1966-1968) 37 were caught between February and April, i.e. the latter part of the breeding season, whereas the remaining 22 birds caught were distributed between May and January. The majority of birds therefore were caught during the time when adult birds are feeding chicks, and young birds are becoming fledged and are leaving their burrows. It is therefore very possible that Grey-backed Storm Petrels now either breed on Campbell Island proper, or on some of its offshore stacks.

Black-bellied Storm Petrel *(Fregetta tropica)*

The inclusion of this species in both Westerskov's (1960) and Bailey and Sorensen's (1962) lists is based on W. R. B. Oliver's observation of one bird at sea off Campbell Island on 1 April, 1927.

Since then two specimens were collected on Campbell Island proper. The first was found dead on 18 May, 1960, and the second, an adult male, was found on 16 April, 1968, outside the hostel, after having struck the building during the previous night. Both specimens were forwarded to the Dominion Museum for identification, where they are preserved as a spirit specimen (DM 10321) and as a study skin (DM 13517) respectively.

Wilson's Storm Petrel *(Oceanites oceanicus)*

The first Wilson's Storm Petrel ever recorded from Campbell Island was seen and reported by D. Paull in 1967. The first time the bird was seen was on 5 February, 1967, when it was observed close inshore in Garden Cove at the head of Perseverance Harbour. A second sighting of possibly the same bird was made on 22 March, 1967, just inside the Perseverance Harbour entrance.

The excellent description of the bird observed (size as for Grey-backed Storm Petrel, nearly completely black, with prominent white rump and brown area on upper wing) eliminated any possible error in its identification, even though the colour of the bird's webs was not noticed at the time.

FAMILY SULIDAE (Gannets)

Australian Gannet *(Sula bassana serrator)*

The southern-most sightings of Gannets in New Zealand up until 1967 were made off the Auckland Islands (50°50′ South Lat.) in January, 1963 (B. D. Bell, pers. com.). On 20 December, 1967, a Gannet was observed in Perseverance Harbour, Campbell Island (52°33′ South Lat.), which stayed within the harbour for nearly a week and was seen daily, cruising around and diving for food. The bird was seen again by the writer just outside the entrance to Perseverance Harbour on 2 January, 1968. These sightings now constitute the most southerly observations of Gannets within the New Zealand region.

FAMILY PHALACROCORACIDAE (Shags)

Little Shag (*Phalacrocorax melanoleucos* ssp.)

Westerskov (1960) does not include this species in his Campbell Island list. However, Bailey and Sorensen (1962) included the species and mentioned five different occasions between June and October, 1958, on which shags of this species were allegedly observed on Perseverance Harbour. Also included in this list is an account submitted by G. Poppleton, leader of the Campbell Island meteorological party in 1959, describing a group of shags observed on Perseverance Harbour on 13 July, 1959. From the features given in this account, however, it is quite evident that the shags described were not *P. melanoleucos.*

During a routine visit to the Giant Petrel breeding colonies near Six Foot Lake on 4 November, 1966, D. Paull observed two shags on the lake, which he described as being smaller than the Campbell Island shag, well known to him at the time, and being black above and white below, including the under neck and the face. These were later identified as Little Shags from excellent photographs supplied by the observer. Both these shags were seen regularly on the lake throughout 1967, and a nest containing two eggs was found on 20 September of the same year. This nest, built of small twigs and lined with tussock grass, was found on a large branch of *Dracophyllum* overhanging the water, at about 4 feet above the surface of the lake and near its north western corner. On 4 November, 1967, three non-flying chicks were seen swimming in the vicinity of the then empty nest. As these chicks were never seen again it can be assumed that they fell prey to Giant Petrels, which frequent the lake in fairly large numbers, or to marauding Skuas.

A second clutch of four eggs was laid by the same pair of shags in the same nest immediately following the loss of the chicks, and during a visit to the lake on 4 December, 1967, one of the adult birds was flushed from the nest revealing four small naked chicks about two to three days old. However, the nest was found empty again on 1 January, 1968, and one chick, about three weeks old, was found dead, floating on the surface of the lake in the vicinity of the nest.

[D. Paull

Plate XXXV — Little Shag (**Phalacrocorax melanoleucos** ssp.) on nest in **Dracophyllum cockayneanum.** Six Foot Lake, Campbell Island, October, 1967.

On 8 January, 1968, Six Foot Lake was visited by the writer, and the pair of adult shags was observed swimming on the lake. The nest on that day was found to contain one fresh egg, the first egg of this pair's third clutch for this season. On 28 January, 1968, one of the adult birds was found incubating a full clutch of five eggs and on 18 February five chicks, now between one and two weeks old, were occupying the nest. The area was again visited on 24 February and on 17 March when all five chicks were still present. During the latter visit, three of the chicks had reached flying stage, whereas the two youngest chicks were still in the nest, although to all appearances fully fledged.

On 1 April, 1968, the adult pair and three immature birds were observed together on the lake. The young birds at that stage were described as being black above, with undersides white, but strongly smudged with black. At the same time the nest was found to contain two fresh eggs, which during later visits in April were found being incubated by one or the other of the adult pair. During the first week in May, the nest was found abandoned, but still containing two, now cold, eggs.

In New Zealand, Little Shags *(P. melanoleucos brevirostris)* are normally considered to be single-brooded, although some pairs will without doubt lay a second clutch following the loss of their first clutch (E. Saul, pers. com.). However, the Six Foot Lake pair produced four clutches of eggs in the same nest during the one

breeding season, and the fourth clutch was laid following the successful rearing of at least three chicks. The four clutches contained three, four, five and two eggs respectively and chicks were hatched from all eggs (12) of the first, second and third clutches, and at least three chicks were successfully reared from the third clutch.

During the Canterbury University expedition to Campbell and Antipodes Islands (January and February, 1969), B. D. Bell visited Six Foot Lake on 21 January, 1969, and found four adult Little Shags (all of the pied phase) present on the lake. He also found two nests in the same area of *Dracophyllum* scrub at the north western end of the lake, where the one pair of shags had nested during the 1967/68 breeding season. Both nests were occupied and at the time of his visit contained two and five eggs respectively. Two adult pairs therefore were breeding on Six Foot Lake during the 1968/69 breeding season, whereas only one pair was present the year before. From this it can be assumed that either a second pair of this species had reached Campbell Island some time during 1968, or, that two chicks of the 1967/68 season had formed a pair and were breeding already when not fully one year old. This, however, is not very likely.

The origin and taxonomic status of the Campbell Island Little Shags is difficult to state. They could have been blown south from New Zealand and, if this is the case, would belong to the pied phase of *P. melanoleucos brevirostris.* However, as both adult birds were of the pied phase, and their progeny showed strong signs of being pied also, it can just as well be argued that the original pair was blown over to Campbell Island from Southeast Australia or from Tasmania. They would therefore belong to the nominate subspecies, *P. m. melanoleucos,* called in Australia the Little Pied Shag. The latter assumption is the more likely, as true pied birds are relatively uncommon in the New Zealand population. Pied birds are fairly plentiful only in Northland, where the proportion of true pied and the white-throated phases is estimated to be about one to three or four (Falla *et al.,* 1966).

FAMILY SCOLOPACIDAE (Curlew, Snipe & Sandpipers)

Turnstone *(Arenaria interpres)*

A Turnstone was observed in Tucker Cove (Perseverance Harbour) first on 15 November, 1967, and later was seen repeatedly at irregular intervals near the head of the harbour and in the vicinity of the camp up to 2 January, 1968.

This bird, unknown to any member of the station staff, was identified by the writer from an excellent colour slide made by A. Bromley.

FAMILY STERCORARIIDAE (Skuas)

Antarctic Skua *(Stercorarius skua maccormicki)*

An Antarctic Skua was seen near Beeman Camp on 20 February, 1968, and it stayed on Campbell Island for at least nine days. The bird had a U.S.A.R.P. (United States Antarctic Research Program) band on its right tarsus. Efforts were made to either trap the bird or at least to read the band number with binoculars. However, the bird was shy and did not allow close approach, neither did it enter the trap. It is most probable that the bird was originally banded in the Ross Sea area, but could of course have been banded on one of the Antarctic Peninsula research stations.

FAMILY STERNIDAE (Terns)

Antarctic Tern *(Sterna vittata)* and Arctic Tern *(Sterna paradisea)*

Antarctic Terns were fairly plentiful on Campbell Island during the 1967/68 summer, when the writer counted at least 22 adult pairs in Perseverance Harbour alone. During his stay five nests containing eggs were found, including one nest at the very summit of Beeman Hill.

The writer was also fortunate in seeing several immature birds of this species in the rather confusing plumage they acquire early during the second year. Antarctic Terns acquire full adult plumage, as do northern hemisphere terns of comparative size, either late during their second year, or possibly not till their third year. Juveniles, when ready to fly, are very different in colour from adult birds. They are heavily mottled and barred with black and brown on their back and upper wing coverts and they have strong buff colouring on their neck and upper breast and a dark streaked cap. Their tail is short and streaked with black and buff at the tips of the rectices and the outer webs of the outermost three pairs of tail feathers are dark grey. Their bills at that stage are blackish brown and their tarsi and feet are dark brown.

During the post-juvenile moult, occurring shortly after reaching the flying stage, the heavily barred feathers on the back are replaced by uniformly grey feathers (the barred upper wing coverts being retained), the underparts change to pure white and the forehead and crown turn white, leaving only a black patch in front of the eye and a heavy black line leading back from each eye to converge into a large black area on the nape. The bill remains black. This colour phase is reached by some birds already in April, whereas others still have streaked backs as late as June of the same year.

During the first full moult, which takes place in December and January, the immature birds change into a plumage very similar to adult birds, except for the colouring of the head, underside and soft parts, and for the length of the tail, which remains somewhat shorter than those of adult birds. The head remains very similar to the colouring acquired during the post-juvenile moult (as described above), the back and upper wing coverts change to a uniform light grey, but the undersides remain white. The bill at this stage is very dark reddish brown (appearing nearly black in the field) and the tarsi and feet are of a similar colour.

The above observations on juvenile and immature plumages are based on a series of specimens in the Dominion Museum.

Arctic Terns have never been collected on Campbell Island, but several sight-records have been reported (Guthrie-Smith, 1936: 220; Westerskov, 1960: 73-74; Bailey and Sorensen, 1962: 279). Considering the similarity in plumage colour between immature Antarctic Terns and Arctic Terns in winter plumage, and considering the descriptions of the birds concerned as given in the above publications, it could be that most, or possibly all, of the so called " Arctic Terns in winter plumage " seen on Campbell Island, were in fact Antarctic Terns in immature (second summer) plumage.

FAMILY ALAUDIDAE (Larks)

Skylark *(Alauda arvensis)*

Skylarks have never been reported from Campbell Island. On 28 August, 1968, G. Surrey, while trapping Redpolls in the vicinity of the jetty near Beeman Camp for banding purposes, caught a bird which he was unable to identify, and therefore forwarded to the Dominion Museum. The bird concerned was a Skylark, an adult female. It is now a study skin in the museum's collections (DM 13521).

Following its identification, two members of the meteorological staff remembered having heard what they considered at the time to be Skylarks singing but, as this species had not been reported from Campbell Island previously, they were reluctant to report this species from song alone. D. Paull had heard Skylarks singing, without being able to sight the bird(s), several times whilst working in the area of St. Cole Peak during the 1966/67 summer period. A. Bromley reported having heard skylark song fairly regularly around the Beeman Camp area, in the vicinity of St. Cole Peak and on the grassy slopes south of Filhol Peak during the 1967/68 summer.

Skylarks, therefore, must have reached Campbell Island some time before or during 1966 and have since managed to establish themselves.

FAMILY PLOCEIDAE (Sparrows and Weavers)

House Sparrow *(Passer domesticus)*

Bailey and Sorensen (1962) do not include the House Sparrow in their list of Campbell Island birds, but Westerskov (1960) mentions that " sparrows " were reported from Campbell Island previously and assumes that these reports applied to Hedge Sparrows. Although he considers it quite likely that House Sparrows could have at some time or other reached Campbell Island, they had up till then failed to establish themselves. He also considers that Campbell Island provided no suitable habitat for House Sparrows and states that it was most doubtful that they would ever be able to establish themselves there.

The first reliable record of House Sparrows seen on Campbell Island came from A. Wright, who reported having seen a male bird in January, 1963, close to Beeman Camp.

The next report was received from C. Clark in February, 1965, i.e. two years after A. Wright's report. C. Clark reported in a letter as follows, " This time there is absolutely no confusion. We have a small flock of about 9 House Sparrows, which travel between the fowl run and the spot on the shore where kitchen scraps are dumped. We could capture one as a specimen if necessary."

During the writer's visit to Campbell Island in January, 1968, House Sparrows were observed in the vicinity of Beeman Camp almost daily and three sparrow nests were found. On 4 January one pair was observed collecting nesting material and evidently completing a nest situated in a *Dracophyllum* bush in a small area of mixed scrub close to the main hostel. Another pair was feeding three small chicks in a nest about 30 - 40 yards distant in the same area of mixed scrub, and also built in a *Dracophyllum* bush not more than five feet from the ground. A third nest was found in Camp

Cove, approximately half a mile distant, on 19 January, 1968, once again built in an overhanging *Dracophyllum* bush about 10 feet above the water. This nest was unoccupied at the time, but contained a fresh layer of chicken feathers, evidently collected from the fowl run close to the camp proper.

House Sparrows therefore have now managed to establish themselves on Campbell Island and further observations will show if they increase in numbers and spread to other areas of the island.

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SHORT NOTE

HOOKGRASS CAPTURES HEDGE SPARROWS

Merilees' (1969) report of five Silvereyes *(Zosterops lateralis)* being captured by hookgrass *(Uncinia spp.)* has prompted me to record the following observation on a Hedge Sparrow *(Prunella modularis)*.

A Hedge Sparrow was found fluttering in some hookgrass beside the Torrent Bay Track in Abel Tasman National Park on 9/1/64. Examination of the bird showed that some black, near-mature hookgrass seedheads had become attached to the primary, secondary and covert feathers on the undersurface of the right wing. Although the bird was still active when found, it had little chance of escape as I had difficulty in freeing it. This caused the removal of several feathers but it was able to fly when released.

Although I have tramped many miles of bush track throughout New Zealand I have not seen a similar occurrence. In one year the following birds were handled in a mixed Podocarp/Broadleaf Forest near Wellington: Chaffinch 32, Fantail 38, Hedge Sparrow 20, Rifleman 11, Pied Tit 51, Grey Warbler 58, Silvereye 463, Shining Cuckoo 2, House Sparrow 1, Whitehead 25, Bellbird 75, Song Thrush 30, Blackbird 84, Tui 15, Morepork 21, Pigeon 3. Although hookgrass was plentiful in this forest none of its seeds was seen on any of these birds.

These observations suggest that birds are rarely trapped and killed by hookgrass but such a novel form of mortality seems worth recording. I ame indebted to A. H. Whitaker of Animal Ecology Division, D.S.I.R., for the above figures.

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— JIM HILTON

GENETICS OF MELANISM IN THE FANTAIL RHIPIDURA FULIGINOSA

*By GRAEME CAUGHLEY**

ABSTRACT

Melanism in the South Island Fantail is controlled by a single, dominant gene held at equilibrium by heterosis and panmictic mating at a frequency of 7%, and thereby holding the frequency of melanics at 13%.

The Fantail *Rhipidura fuliginosa* occurs in Australia, New Zealand and the Chatham Islands. Only the North Island and South Island races are reported to contain a melanistic colour phase. Table 1 shows the frequency of black and pied forms in sample counts. I am grateful to those people listed in the table who allowed me to use their data.

TABLE 1: Frequencies of melanistic and pied Fantails

Race	*Area*	*Pied*	*Black*	*Observer*
Australian				
	N.S.W. and Qld.	97	0	G. Caughley
N.I.				
	Central N.I.	80	0	C. N. Challies
	All N.I.	339	0	G. Caughley
		419	0	
S.I.				
	Canterbury high country	10	0	G. Caughley
	Coastal Canty.	35	8	L. W. Best and G. Caughley
	Fox Glacier to Haast	70	12	G. Caughley
	Haast to Arawhata	92	9	C. N. Challies
	Fiordland	91	15	R. E. Lambert and K. G. Tustin
		298	44	

black = 12.87%

Although I have seen 97 birds of the Australian race no black forms were recorded. The incidence of melanism must be low or zero.

Between us, C. N. Challies and I have counted 419 birds of the North Island race and have seen probably five times as many that were not counted. Neither of us has seen a black fantail in the North Island. However, the black form is present (Fleming 1953) and its distribution suggests that it does not comprise only immigrants from the South Island. Its frequency is almost certainly less than 0.05% and may not be much above the rate of mutation.

* Forest Research Institute, Rotorua, New Zealand. Present Address: School of Biological Sciences, Zoology Building, University of Sydney.

The South Island samples could not be shown by Chi-square testing to be heterogeneous. The total of 342 birds have a melanistic frequency of 13%. Oliver (1955) reported a 20% frequency in Dunedin but did not record the raw frequencies required to test whether this differs significantly from the percentage reported here.

No intermediates between black and pied fantails have been reported although interbreeding and mixed broods are common. The genetic factor is therefore likely to be a single gene.

The information in Table 1 does not, of itself, reveal whether the gene for melanism is dominant or recessive, but Oliver (1955) has collected information on crossing that allows a test. His data are:

(a) of 17 broods resulting from pied x black matings, 15 were mixed, one consisted of four pied chicks and one consisted of three black chicks;

(b) the 17 crosses produced 31 black chicks and 30 pied chicks;

(c) six black x black matings each produced mixed broods; and

(d) one pied x pied mating produced one black and two pied chicks.

Oliver interpreted these data as indicating that pied is dominant over black. The fit of the data to this hypothesis will be re-examined.

From the calculated frequency of 13% melanics in the South Island we can calculate from the Hardy-Weinberg model the number of homozygotes and heterozygotes to be expected in a random sample if " pied " is dominant (Table 2).

TABLE 2: Expected frequencies of homozygotes and heterozygotes, and gene frequencies, if pied is dominant

Form	*Genes*	*% Frequency*	
homozygous pied	PP	40.9	87% pied
heterozygous pied	Pb	46.1	
homozygous black	bb	13.0	13% black
		100.0	
" pied " gene	P	63.9	
" black " gene	b	36.1	
		100.0	

We can now calculate the relative frequency of heterozygous and homozygous pied birds in the crosses reported under (a). Table 2 shows that the expected frequency of pied birds that are homozygous is 47%. The observed frequency as indicated by (a) is equal to or less than 6%.

The ratio of black to pied chicks expected from the black x pied matings is compared in Table 3 with the observed number reported under (b). The observed frequencies are at variance with expectation if pied is dominant over black.

TABLE 3: Frequencies of 61 offspring of pied x black matings to be expected if pied is dominant

Parents Pied	Black	*% Frequency of crosses*	*Offspring* Pied	Black
PP x	bb	47	28.7	0.0
Pb x	bb	53	16.15	16.15
		Expected =	44.8	16.2
		Observed =	30	31

Data under (c) is totally inconsistent with dominance of piedness. By this hypothesis no pied chick should result from a black x black mating. However, data under (d) is consistent with hypothesis.

The information presented by Oliver (1955) is, with the exception of one observation (d), completely at variance with his conclusion that pied is dominant over black. However, if the gene controlling melanism is postulated as dominant a different picture emerges. Table 4 shows the frequency of heterozygotes and homozygotes to be expected in a random sample of South Island fantails. Here the expected frequency of homozygotes amongst the black parents would be 3% as against an observed frequency (a) of equal to or less than 6%; a good agreement.

TABLE 4: Expected frequencies of homozygotes and heterozygotes, and gene frequencies, if black is dominant

Form	*Genes*	*% Frequency*	
homozygous pied	pp	87.0	87% pied
heterozygous black	pB	12.6	
homozygous black	BB	0.4	13% black
		100.0	
" pied " gene	p	93.3	
" black " gene	B	6.7	
		100.0	

Table 5 shows that the observed frequencies of black and pied offspring of black x pied crosses are also close to that expected were black dominant. The offspring of the six black x black matings reported under (c) is in agreement with expectation. The result of the pied x pied cross (d) is not.

TABLE 5: Frequency of 61 offspring of pied x black matings to be expected if black is dominant

Parents			*% Frequency of crosses*	*Offspring*	
Pied		*Black*		*Pied*	*Black*
pp	x	BB	3.0	0.0	1.8
pp	x	Bp	97.0	29.6	29.6
			Expected =	29.6	31.4
			Observed =	30	31

To sum up: the hypothesis of pied being dominant over black is grossly at variance with the data, whereas that of black being dominant provides a close fit between observed and expected. One observation — of two pied birds producing a mixed brood — is against the hypothesis that black is dominant, but also is against the weight of evidence indicating that the hypothesis is correct. I interpret this record as a misidentification of one parent.

Stead observed in 1932 that "there has not, I think, been any general alteration in the numerical proportions of Black to Pied Fantails in the South Island over the past thirty years," and there is no evidence of a change subsequent to 1932. The most likely explanation of such stability is that the frequency of the "black" gene is held steady by heterosis. The close fit of the Hardy-Weinberg equilibrium model to the observed frequency of heterozygotes deduced from (a) indicates that mating between and within colour phases is close to random.

These findings argue against Oliver's (1955) contention that melanistic and pied fantails are "semi-species," either in the sense of that term employed by Oliver or in the sense previously defined by Mayr (1940, 1942).

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OBSERVATIONS ON THE BREEDING BEHAVIOUR OF THE DIVING PETREL Pelecanoides u. urinatrix (Gmelin)

By ASA C. THORESEN

ABSTRACT

Observations on the Diving Petrel (**Pelecanoides u. urinatrix**) were made on Green Island, Mercury Group, and other small islands in New Zealand in 1966 and 1967. The various calls and communications are described and weights and measurements given of adults and of growing chicks. Various behaviour patterns are briefly compared with the Northern Alcid, the Cassin Auklet (**Ptychoramphus aleutica**).

Incubation was recorded by assistants for one egg at 53 days. Chicks reach the adult weight by 30 days of age and attain the average at rest body temperature of the adult about the same time. Daily growth rates of the various body parts, total length, closed wing, tarsus, toe, culmen and tail are given for developing chicks. Fluctuations in incubation temperature of two eggs are given. Other eggs showed considerable tolerance to lowered temperatures. The difference between at rest and active body temperatures of adults is indicated at approximately 2°C.

The adults arrive at the breeding site early in April with a peak of actviity by the end of May. The egg-laying period is calculated to begin early in August and last for about one month. Average body weights of 20 adults in April were about 18 grams more than in June and October.

Apart from the morphological comparisons by Loomis (1918: 66-67), the general accounts of Murphy and Harper (1921. 495-554), and Murphy (1936: 771-792), studies by Richdale (1943, 1945) have been the only contribution to our knowledge of the biology of the Diving Petrel. Richdale made his observations mainly on Whero Islet near Oban, and Stewart Island, New Zealand. Falla (1934: 246) mentions some early seasonal activity on islands in the North of New Zealand, but no extensive studies have previously been reported in the northern part of the range. Storer (1945: 439) gives anatomical comparisons of the alcids with *Pelecanoides* and states that there is no doubt anatomically that *Pelecanoides* is related to the petrels.

METHODS

The present data was collected on Green Island, Mercury Group, New Zealand, from 10 October, 1966, to 16 July, 1967. During the period 10 October to 20 December, while the young were being reared, I remained camped on Green Island taking only a week-end break every other week. Visits were made to the island every second week during the early premating stages from 10 April to 16 July when my study had to be terminated.

Some observations were also made on The Brothers, islands in Cook Strait, and a brief visit was made to Whero, near Stewart Island, on 12 January, 1967, to record the progress of the colony that Richdale studied. It was noted that the ecological situation on Whero had changed radically since Richdale's reports and that there is now little evidence that the Diving Petrel nests there. This small islet is now largely taken over by a colony of Stewart Island Shags *(Phalacrocorax carunculatus chalconotus)*, a race which was previously only an occasional visitor on Whero (Richdale, 1942: 87).

On Green Island, 10 October, 1966, many Diving Petrel's eggs were hatching. Some chicks, ten to twelve days old (age calculated later when accurate weights and measurements were available), were found in burrows at this time. Fifty nests were located that were suitable for study and daily records kept until the chicks had grown and left their burrows permanently. Descriptions of the area and population figures were presented in a previous paper on the ecology

of the island (Thoresen, 1967: 182-200), and Atkinson (1964: 325-402) has described the vegetation of Green Island. Measurements were made in the field with a millimeter steel rule and vernier calipers. Weights were recorded on a Ohaus triple beam balance and temperatures were recorded with an Atkin thermistor instrument with an accuracy of ± 1% of the scale. Different probes suitable for humidity readings, soil, air, and body temperatures were used. Rectal temperatures were recorded immediately upon capture with a polyethylene covered medical probe inserted 1 inch through the cloaca for 60 seconds. Incubation temperatures were recorded with the same type of probe inserted into and left in the air space of the egg. The probes were held in position with paraffin wax and adhesive tape.

Nocturnal activity of the adults was observed in several ways. A small portable generator was tried to provide light with low wattage bulbs suspended in the trees above the study area. The noise of the generator was disturbing so I resorted to hanging several kerosene hurricane lamps in convenient positions and left them burning all night. The lights seemed to make the birds wary and they sought out the shaded areas beneath clumps of fern or hid in their burrows. However, some braver pairs co-operated well. By using flash photography and a bright 6 volt head lamp observation of the activity of the birds in dark areas was possible.

Adults were captured at night and their temperatures recorded within one minute of capture. Records of weights and measurements were also made at the same time.

Comparative data on the Cassin Auklet *(Ptychoramphus aleutica)* mentioned here were collected on the Farallon Islands, California, during a study reported earlier (Thoresen, 1964).

CALLS AND COMMUNICATION

The Maori name for the Diving Petrel is " Kuaka." It quickly became obvious that this name is derived from a common sound that the birds make. That is, they utter their Maori name, " Kuaka." But this is only one of the common sounds. It is produced alone or with several differing intonations following. The rather resonant sounds would come from dozens of birds in chorus. Often one would imagine that every individual of the colony was contributing to the noise at the same time. Because of this and the darkness it was practically impossible to interpret the meaning of each individual sound. The variations noted are as follows:

1. " Kuaka," uttered frequently and sometimes during flight early in the season.
2. " Kuaka-did-a-did." This is perhaps the most common call of all especially when the birds first arrived in numbers in the evening. This sound was also occasionally heard from burrows in the daytime during the incubation period. Sometimes the third syllable was more clipped than usual, sounding more like " Kuaka-kit-a-did "; or more rarely a syllable was added to the end such as " Kuaka-did-a-did-a."
3. " Kuaka-ku-ku " or just an abbreviated " Kuaka-ku."
4. Sometimes a syllable was completely omitted. From one burrow during the feeding period, I noted " Kua-kit-a-did, Kua-kit-a-did." In another burrow a bird skipped the usual fourth syllable as " Kuaka-did-did."

5. " Ku-ku-did-did " was another variation noted occasionally on Green Island and I was interested to find that this variation was predominant at The Brothers colony and only rarely was the distinct resonant " Kuaka " heard at the latter colony.
6. A " Ku-ku-ku " was uttered while in flight and from a burrow early in April.
7. Other variations noted only at The Brothers colony include: " Ku-ku-ka-did," " Ku-ku-meow," " Ku-ku-did," and " Ku-ku-did-a-did-a-did."
8. In the evening hours but predominantly nearer dawn during departure ceremonies at both colonies a clear, ascending " Meow " was uttered in chorus. It almost sounded as if many guitarists were sliding their fingers up the strings.
9. During feeding and as soon as the adults entered the burrow the chicks kept up a constant, rasping " Squeer."

PRE-EGG-LAYING STAGE

No accurate data is available as to the earliest date and occupation of the breeding territory in North New Zealand by Northern Diving Petrels. According to Sladden (1924: 184) possession of the shallow burrows takes place about July on Karewa Island. Falla *et al.*, (1966: 67) gives the breeding season from August to December; however, Falla (1934) indicates that they are active in April and that the annual moult is completed in March. Chittleborough and Ealey (1950: 103) found the South Georgian Diving Petrel in burrows late March and early April.

I made my first winter trip to Green Island on 10 April, 1967, and found a limited number of birds already active cleaning their burrows. Later visits to the colony approximately every other week indicated a build-up of a number of active individuals at the nesting site. In order to establish the relative numbers a frequency index was established by counting the number of birds seen between the hour 19:00 and 20:00 each night (see Figure 1). In handling many birds on 25 April for measurements, weights, and banding, John Jenkins and I noted that several were still moulting the contour feathers as indicated by the fact that feathers readily dropped out in normal handling. By May, all contour feathers were fresh and firm. On the same date in April we saw many pairs sitting together billing and nebbing. From a burrow near my tent I heard one of a pair using the " Meow " call while its mate made a " Ku-ku-ku " - " Ku-ku-ku " sound. While banding birds in the evening several were heard to utter " Kuaka " sounds while in flight. At midnight heavy rain and thunder set in during which the divers engaged in considerable noise making. Between showers at 03:00 hours I inspected the study area and counted only 5 birds above ground. Most of the noise was coming from the shelter of the burrows.

Two birds were seen to skirmish in front of a burrow on a steep slope. They held each other by the bill and flapped their wings in a pushing-pulling action until one lost the grip and fluttered down the bank. Later, a similar incident was witnessed involving another pair. By 05:30 the " Meow " chorus reached its climax and began to wane as the birds gradually made their way towards the sea.

On 26 April we located one Diving Petrel in its burrow at 14:00 hours and during the month of May birds were found more frequently in the burrows during the daylight hours. My notes for 10 May read, "One adult was found in a burrow and released to observe its behaviour in flight from the top of the cliff. It dived straight down toward the water and flew rapidly out to sea along the surface of the water in zig-zag flight, tilting to the right and left, until it splashed into the water when almost out of sight. Another adult in a burrow near my tent has been making 'meow' and 'kuaka' sounds periodically all day."

All night long Diving Petrels flew in circles and criss-crossed the island uttering loud "Kuakas" which reminded me very much of the "Kreekier" sound of the Cassin Auklet, but these flights were distinctly petrel-like in character. From their underground retreats I could hear "Kuaka-did-a-dids" and "Meows" all through the night. One bird close to my observation point sat and peered into a burrow entrance from which came "Meow" calls. It peered this way, then that, responding to the subterranean sounds with "Kuaka-did-a-dids." As usual the whole island seemed to resound with "Meow" crescendos about an hour before sunrise and by 06:00 the area was peaceful and quiet once again.

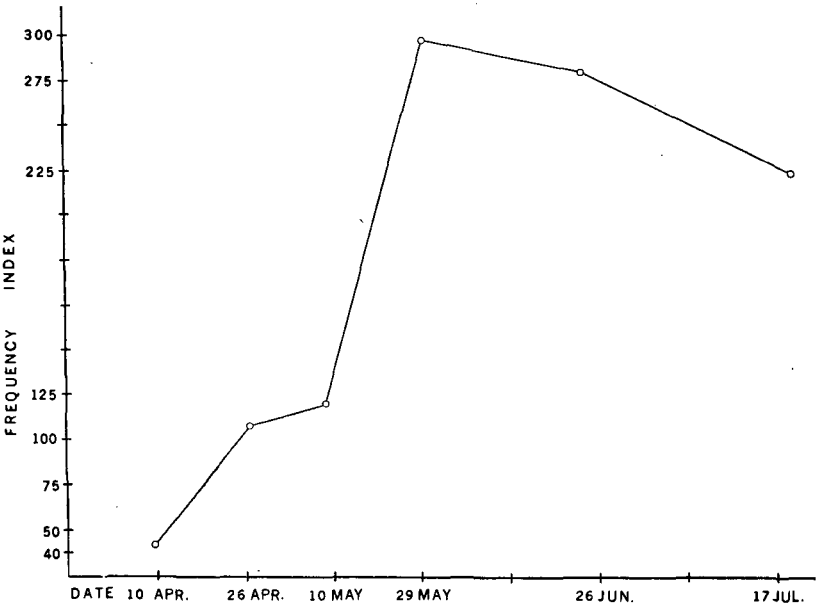


FIGURE 1 — Frequency index of adult birds counted in the study area during one hour, recorded on the various dates, show that most birds returned to the island to begin breeding activities during the month of May, 1967.

At sea, not far from Mercury Bay headlands, we saw many 'Divers' during most of the winter excursions. They were usually in groups of four to six. As the boat approached they would fly short distances close to the water, splash into the sea and immediately dive under. When emerging they would take to wing as soon as they surfaced. One bird was seen to make a series of short shallow dives in a straight line as the boat went by.

On 29 May, the first birds arrived at Green Island at 17:50 about 45 minutes after sunset. They were very active and noisy immediately after their arrival. Birds that were banded on previous trips were recaptured and examined closely for the development of the incubation patch. All birds examined on this date showed some thinning of the down over the incubation patch. Some had inflamed and swollen cloacas and at first I thought that this feature may be a way defiinitely to tell the female from the male as suggested by Serventy (1956: 213-214). However, I discovered that in individuals sitting side-by-side as pairs both birds may have inflamed and swollen cloacas. This led me to doubt the assumption that this was a good way to sex the bird at this stage of the breeding cycle. Perhaps the method may be more accurate later on during the egg-laying period.

By 20:00 hours the birds had mostly settled down and were sleeping. I watched one bird preen and scratch its head with its claws, as a cat or dog scratches. Only three or four possible attempts at copulation were observed above ground at this time. On two occasions I witnessed what looked like fights lasting for about 30 seconds. Both times the birds had mutual holds on the other's breast feathers so that they assumed a venter to venter posture as they tumbled over and over while flapping the wings. I thought that perhaps these may have been copulation attempts.

At 03:30 on 30 May the birds were all "meowing" but most of the noise was still in the burrows. A few pairs sat together above ground and slept with the bill tucked in the body coverts, a few were heard vocalizing from the air above. Fresh soil sprayed from the entrance of burrows and this together with the fact that a large number of individuals were seen with soil caked to their bills indicated that active digging was still going on below the ground. A few birds were seen with all their feathers literally caked with mud. In order to discover what engagements were taking place underground, burrows were opened at the rear and blocked during the day with rocks. Every time I observed these nests I witnessed no more than a pair of birds sleeping.

On 9 June I arrived on The Brothers in Cook Strait for two weeks' observation at this more southerly colony. Here I found several artificial nesting boxes placed among the rocks by some former investigator. Two of the boxes were occupied by Diving Petrel pairs. Observations made on 13 nights indicated that the birds entered the nests, billed and vocalized for a few minutes, then went to sleep side-by-side. Early in the mornings they would stir, "Meow" to each other for about a half-hour or more, then leave for the day at sea.

I soon noticed that on The Brothers, the Diving Petrels are in direct competition with the Fairy Prions *(Pachyptila turtur)* which outnumber the divers about four to one. Apparently they have similar feeding habits (one prion regurgitated euphausid-like shrimp, when captured), nest in the same niche at the same time, and often are seen fighting together at night. The Prion usually wins over the smaller Diving Petrel. I caught and examined one Diving Petrel after witnessing a fight in the light of my headlamp and found it to be bleeding slightly around the base of the bill. Divers may be able to enter a slightly smaller burrow entrance than Prions but I doubt this to be a factor in preserving their coexistence since the Prions can easily enlarge the cavity.

Once a pair of Prions was found imprisoned in a rock wall. Apparently the rocks had shifted slightly, making the entrance too small to squeeze through. One of the pair was already dead, the other was severely injured by its attempts to escape. I released the live bird.

Immediately north of The Brothers rip tides constantly churned up food material for sea birds. I spent hours during the day observing the motions of hundreds of Diving Petrels feeding in the rips. They kept up a constant cycle all day long. By dropping into the west end of the rips and disappearing for 15 - 20 seconds for each dive. they would drift with the current eastward and then coming to the end of the food source, they would fly west again to begin the interrupted submarine journey over again. During the brief pause on the surface at the end of each dive, the wings were held partly open apparently in preparation for the next dive. In watching them I could detect little difference in the habit of flight from the Cassin Auklets. They seem to fly exactly like an auklet, tilting from side to side and sometimes gliding briefly before splashing into the water. They usually dive immediately. Occasionally, one would hesitate on the surface to rotate a few times or make several short shallow dips before diving.

They also dip their bills in the water while floating as do the Alcids. I have seen this habit also in the Flesh-footed Shearwaters in which the habit is definitely a peering underwater for prey. Flesh-footed Shearwaters often follow down fisherman's line bait and I have seen them at close view locate the bait by peering underwater for it, then diving to retrieve it off the hook.

The wind was blowing at 55 - 60 knots over The Brothers on the evening of 21 June and only a few birds visited their burrows. It was difficult to understand how even the few that came were able to fly in such a high wind.

Back on Green Island, Mercury Group, on 26 June, I found most burrows complete with fresh leaves and twigs in the nesting chamber. Nocturnal activity of the birds had not changed except that they were less often making calls while on the wing. One pair taken for anatomical study on 27 June indicated the testes enlarged to 27 mm. in length in the male and the ovary well developed in the female. There were no eggs in the oviduct, but the incubation patch was markedly supplied with blood vessels and the down that covered it showed definite thinning.

There was little change in the activity on my last visit on 17 July and the density of down over the incubation patch of twenty birds examined was about one-half the thickness that it was one month earlier. Many were active billing and several pairs were seen to attempt copulation near their burrow entrance.

On The Brothers two of the lighthouse keepers, John Dunn and Trevor Porter, continued an active interest in my study. Trevor Porter kindly kept daily records of the activity of one pair which were using an observation nesting box. He recorded that fresh nesting material, leaves and twigs were placed in the nest on 19 August and that the activity of the birds on 24 August was outstanding. His notes say, "Birds are sitting in sheltered places all over the island. I have never seen so many. The noise is terrific."

He noticed that the bird in the box had its feathers fluffed up on the nights of 29 and 30 August. On 31 August the bird stayed all day and laid her egg between 15:00 and 20:00 hours. John Dunn observed that this egg hatched between 24:00 hours on 23 October and 07:00 hours on 24 October, making a total of 53 days plus 8 to 16 hours. I believe that this is the first time that anyone has observed the incubation time so closely. Richdale (1945: 43) calculated the time as about 8 weeks during his study.

According to my calculations the first eggs hatched on Green Island about 1 October 1966 and the last two eggs in 50 study nests hatched on 28 October, 1966. This suggests that the egg-laying period on Green Island was from about 7 August to 4 September.

THE EGG STAGE

The behaviour of the birds during egg laying and early incubation period was largely missed in this study but some data on a few late hatching eggs in October, 1966, on Green Island are worth reporting. The measurements and weights of eggs from the Mercury Island average slightly larger than those from Whero reported by Richdale (1945: 44). See Table 1.

TABLE 1

Measurements and weights of Diving Petrel eggs from Green Island compared with Richdale's (1945: 44) figures from Whero in parentheses.

Feature	Number	Average	Range	Condition
Weight in grams	14	16.61	14.50 - 20.00	At various stages of incubation
	(27)	(14.90)	(11.00 - 18.25)	(addled or deserted)
Length in mm.	15	37.86	35.90 - 41.80	
	(39)	(37.68)	(34.50 - 42.00)	
Width in mm.	15	30.56	28.00 - 30.70	
	(39)	(29.42)	(27.25 - 31.50)	

It quickly became obvious when observing nests of banded birds that both birds incubate and that the change-over periods are usually on alternate days but often the egg is left unincubated during the day. Bartle (1968: 83) has observed similar vacations in Pycroft's Petrel *(Pterodroma pycrofti)* and Matthews (1954) has noted the same phenomenon in the Manx Shearwater *(Puffinus puffinus)*. It may well be that most species of petrels exhibit these long inattentive periods thus contributing to the relatively long incubation period known for petrels.

One deserted egg was found to be pipping. By holding it in the warmth of my hand close to my ear I could hear pecking sounds and peeps from within. The egg was checked twice a day and also during the evening hours to note its progress. I found no evidence that the parent birds ever visited the burrow at night. On the morning of the tenth day (22 October, 1966) after discovering it, the chick hatched at a burrow air temperature of 16.6°C and a humidity of 56%. I warmed the chick for the rest of the day in my shirt pocket and returned it to the burrow in the evening hoping that perhaps the parent birds may return, but the chick was dead the next morning. This seems to indicate that temperature tolerance may be more critical after hatching than before and that the egg has a remarkable tolerance to long exposure to average burrow temperatures.

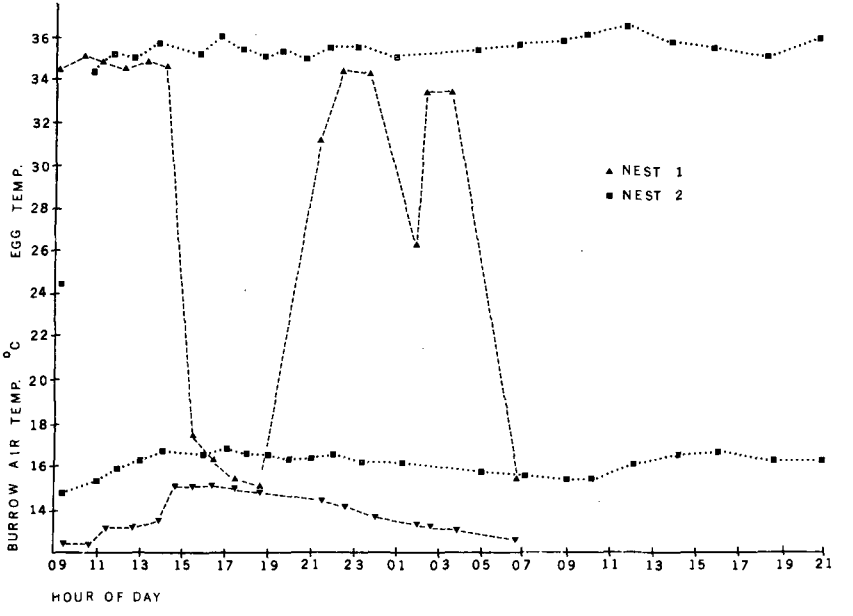


FIGURE 2 — Fluctuations in egg temperatures during late incubation in two eggs. Temperatures were recorded with the thermistor probe inserted into the air space of the egg.

Figure 2 indicates the incubation temperature fluctuations during attentive periods in two well incubated eggs recorded with the probe inserted into the air space to avoid the thermal gradient differences between the upper and lower surfaces of the egg when the egg is rolled. Egg number 1 was recorded on 15 and 16 October and egg 2 on 17 and 18 October, 1966.

No definite correlation was noted between air temperatures and incubation. The sudden drop in the temperature of egg number 1 may have been caused by my presence being detected near the burrow. Incubation resumed later in the evening but the nest was left unattended the next morning. Burrow 2 was also unattended the day following the recordings.

DEVELOPMENT OF THE CHICK

Growth of Diving Petrel chicks on the Mercury Islands closely paralleled the descriptions given by Richdale (1945: 46-51) although his earlier data (1943) is difficult to follow due to miscalculation of the ages of his chicks. Data on the growth and temperature regulation in developing chicks is presented here in Figures 3, 4 and 5. Parent birds guarded the chick by day until they were 10 - 15 days old at which time they had attained the minimum adult body temperature. Upon the day of hatching 9 chicks weighed an average of 12.1 grams with a range of 11.1 - 13.9. The average body temperature of 3 first day chicks was 35.1°C. The chicks have their eyes closed for about the first 12 hours and then only casually open them until 3 days old. When dry the primary down is about 1 cm. long, and is white-tipped giving the chick an all white appearance except for a wedge of gray tapering to a point on the belly from the cloaca. By the 10th day the white tips of the down has almost rubbed off but it sometimes persists in the ventral side for several more days. The chick is now light gray in colour, weighs 34.6 grams (average of 14 with a range of 23.5 grams - 44.5) and has an average body temperature of 36.0°C (average of 10 records). Table 2 presents the average daily measurements of Diving Petrel chicks.

At 22 - 26 days of age the chicks have reached the average at rest body temperature of the adult. Adult active body temperatures averaged 2° higher than at rest temperature.

The average age of 16 individuals when they finally left the nest was 50.5 days with a range from 45 to 56 days. Richdale (1945: 51) gives the average of 58 chicks on Whero Island at 54.26 days with range from 47 to 59 days. In my study area the first juvenile left on 22 November. They left at any time during the dark hours and from this date onward many were seen clambering between the boulders toward the sea. Once in the water they "flew" well underwater and were presumably able to catch their own food.

Handling of the birds resulted in the raising of body temperatures, but the elevation varied considerably with the individual. For example, in one bird a temperature of 38.3°C rose after 5 minutes to 38.6°C and in the second one it rose from 38.2°C to 39.5°C after 3 minutes and to 40.1°C after 5 minutes. For this reason temperatures were recorded during the first 60 seconds of capture. Temperatures recorded at rest mean that the bird was sleeping with head tucked in the lateral coverts when captured.

TABLE 2

Average measurements in millimeters of developing Diving Petrel Chicks

Age in Days	No. of Specimens	Body Length	Closed Wing	Tarsus	Midtoe	Culmen	Tail
0	8	69.6	15.4	11.4	13.3	8.3	--
1	6	72.5	16.5	11.8	13.2	8.6	--
2	6	74.5	18.0	12.4	13.3	8.7	--
3	5	75.0	18.2	13.3	13.9	8.8	--
4	10	79.6	18.7	13.5	14.3	8.9	--
5	10	84.6	19.6	13.9	14.8	9.0	--
6	10	86.5	21.2	14.9	15.9	9.3	--
7	13	86.5	21.7	15.3	16.8	9.6	--
8	9	88.0	22.7	15.7	17.0	9.6	--
9	12	91.3	24.0	16.3	17.8	9.9	--
10	14	96.1	23.5	16.4	18.4	10.2	--
11	10	97.3	26.8	17.3	18.9	10.3	--
12	10	101.3	27.3	17.6	19.0	10.3	--
13	10	112.1	29.3	18.5	20.6	10.6	--
14	10	112.9	29.7	18.8	21.5	10.6	--
15	7	118.6	32.0	19.5	22.2	10.7	--
16	11	124.0	33.1	20.2	22.4	11.0	--
17	6	128.0	36.0	20.8	23.2	11.4	--
18	7	134.3	37.7	21.2	23.5	11.5	--
19	12	137.6	39.9	22.3	24.8	12.0	--
20	8	139.9	43.0	22.5	25.6	12.0	--
21	11	146.4	46.0	23.1	26.0	12.4	--
22	2	146.0	45.0	23.2	27.0	12.3	--
23	9	145.0	45.2	24.1	27.6	12.6	2.0
24	6	157.5	53.8	25.1	29.2	13.0	3.0
25	5	156.0	61.0	25.3	29.6	13.4	3.5
26	7	160.0	64.0	25.7	30.2	13.6	4.7
27	6	165.0	68.0	26.9	32.5	14.1	4.9
28	5	167.0	69.0	27.3	32.7	14.5	7.3
29	4	171.2	69.8	27.6	32.8	14.5	9.0

TABLE 2 (Continued)

Average measurements in millimeters of developing Diving Petrel Chicks

Age in Days	No. of Specimens	Body Length	Closed Wing	Tarsus	Midtoe	Culmen	Tail
30	--	--	--	--	--	--	--
31	5	175.0	77.0	28.2	24.2	15.1	16.0
32	2	180.0	82.2	28.0	34.2	15.8	17.0
33	1	180.0	83.0	27.7	33.7	15.3	14.0
34	--	--	--	--	--	--	--
35	2	182.0	92.0	27.9	34.4	15.7	19.0
36	1	180.0	92.0	28.1	34.0	16.0	22.0
37	5	184.0	95.2	28.1	34.8	16.0	24.8
38	5	186.0	96.2	27.9	34.6	15.9	28.0
39	4	186.2	102.0	28.0	35.0	16.3	32.2
40	6	189.2	97.5	28.0	33.8	16.0	32.0
41	4	185.0	96.0	28.0	34.3	16.0	31.0
42	5	188.0	104.4	27.9	34.3	16.2	36.0
43	9	188.0	102.7	27.9	34.3	16.2	35.0
44	5	188.0	105.8	28.0	34.4	16.3	38.2
45	11	187.3	106.3	27.3	34.5	16.1	37.1
46	6	190.0	111.5	27.9	34.2	16.3	42.0
47	8	190.0	111.8	27.7	34.1	16.2	41.4
48	5	189.0	111.2	27.4	34.2	16.3	42.2
49	7	189.0	115.1	27.8	34.4	16.3	43.6
50	2	192.5	114.0	27.9	34.1	16.3	44.0
51	1	195.0	116.0	28.0	34.5	16.3	43.0
52	2	190.0	117.5	27.4	33.8	16.4	45.0
53	2	192.5	117.5	27.6	33.3	16.3	45.0
54	2	192.5	118.0	27.6	33.3	16.3	47.5
55	1	195.0	123.0	28.0	34.5	16.3	50.0

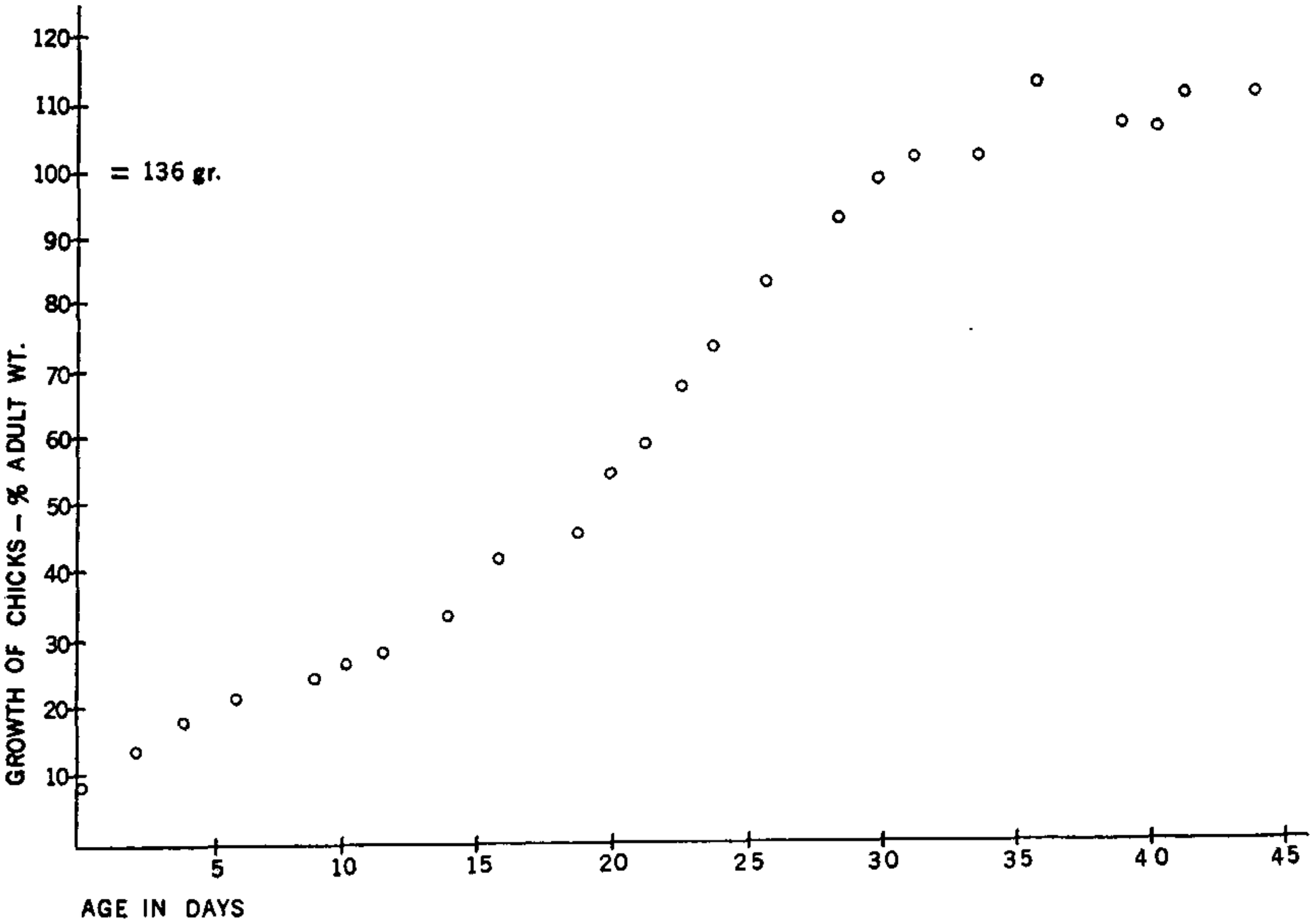


FIGURE 3 — GROWTH curve of Diving Petrel chicks expressed as percent of adult average weight. Adult weight is the average of 14 birds weighed in October.

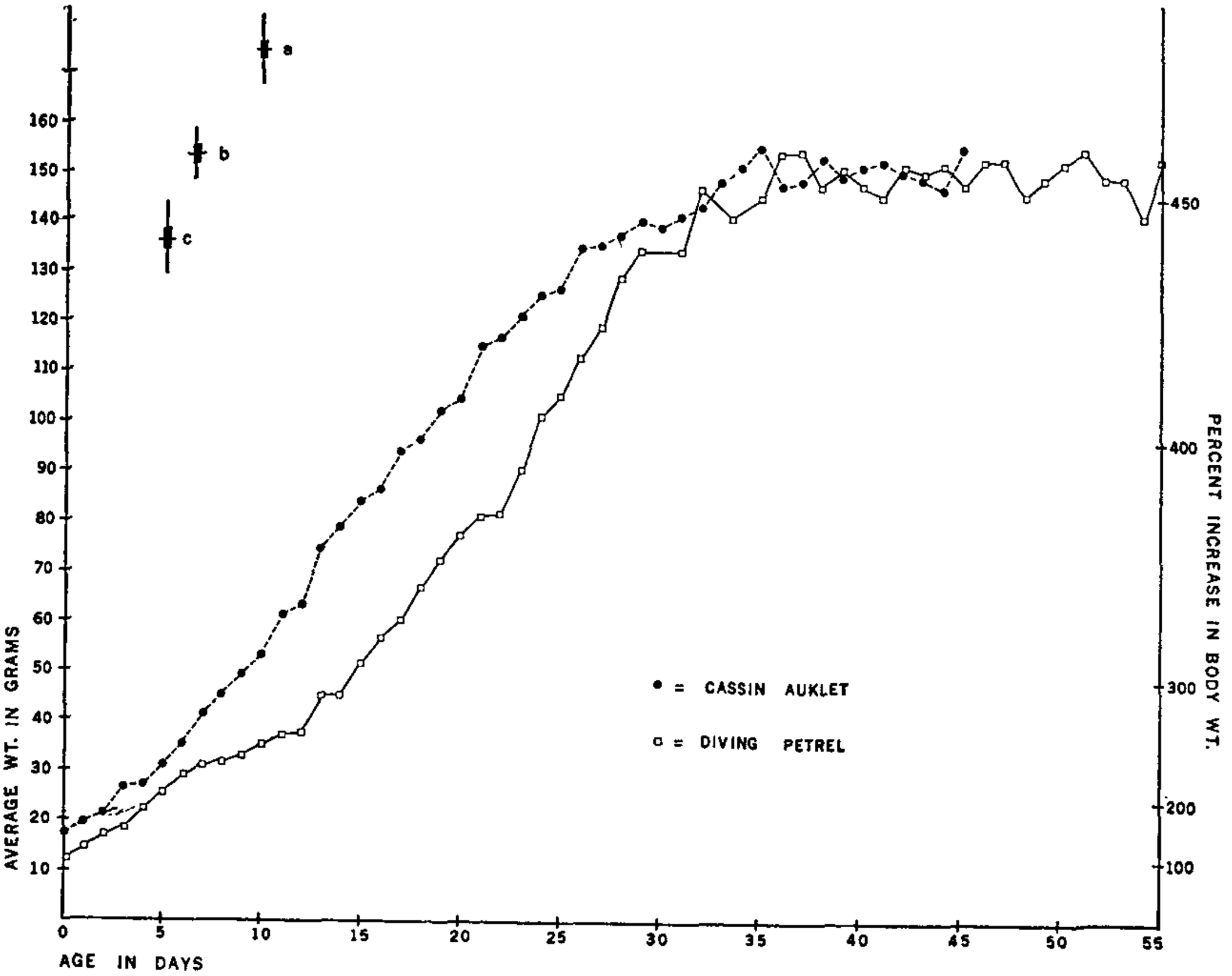


FIGURE 4 — Daily growth by weight comparing the Cassin Auklet with the Diving Petrel. a. represents the weight of 19 adult Cassin Auklets with standard error and deviations indicated. b. is the average weight of 20 adult Diving Petrels in April and c. is the average weight of 14 adult divers in October. Note that the Cassin Auklet chicks fall short of the adult weight at fledging time. The number of Diving Petrel chicks weighed corresponds to the figures given in Table 2 for each day of age.

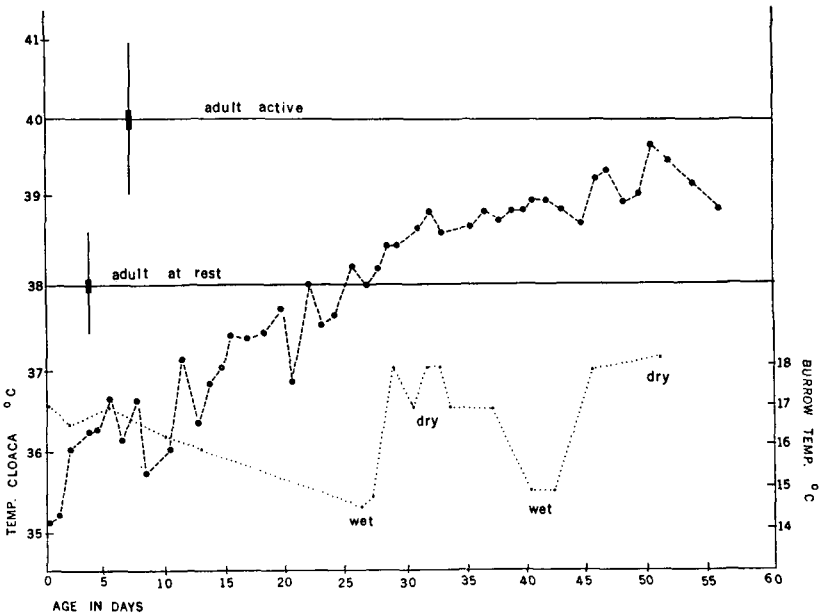


FIGURE 5 — Development of temperature regulation in 10 Diving Petrel chicks compared with 122 active adults and 60 adults at rest. The temperatures of the chicks were measured between 13:00 and 15:00 hours each day.

FEEDING OF THE YOUNG

Observations on the method of feeding the young were accomplished by digging out the rear of a burrow to expose the nest area and young. The excavation was kept covered with a flat rock during daylight hours and removed after dark. The incoming adult bird, unaware of the change, would enter the real entrance and proceed to feed the young. By shining my headlamp to one side I could view the activity without disturbing the bird and also focus to take flash pictures.

The chick frantically begged as soon as the adult entered the burrow. It set up a constant rasping " Squeer " and waggled its head up and down, back and forth and around the parent's bill until, with a satisfied peep, it ravenously sipped the slowly oozing mixture of pink " whale krill " (probably an Euphausid shrimp) which was regurgitated from the parent's bill.

I was never able to witness the adult rubbing the chick's head as described by Richdale (1943: 37). During my many hours of observation it was always the chick that made the motions contributing to the wearing of the down from the chick's head.

MORTALITY IN THE YOUNG

Young birds were frequently found dead outside of their burrows especially in areas where the Flesh-footed Shearwaters

(Puffinus carneipes) were active. In my study area seven Diving Petrel chicks met their fate in this manner. On another occasion I found two mortally injured chicks at the foot of a cliff from which they had fallen when their burrows slid away. Of the fifty nests under study two were deserted in the egg stage, two others failed to hatch, four chicks died before the age of 5 days, one was found dead in the burrow at 40 days of age for no apparent reason, and one juvenile died of a broken neck after crashing into a boulder on its way to the sea. It appears from these observations that the most critical period is the first few days after hatching.

Another critical period is when the juveniles vacate their burrows. At this time they do not fly well and actually often roll off the cliffs to clamber between the rocks to the water. It seems that they have the best chances of surviving if the tide is full when they make their excursion. I found many juveniles around the island that were injured or had met their death by falling. One had a leg missing and the left manus amputated. I placed it in deep sheltered water hoping it could survive in the sea, but it could only hopelessly propel itself in circles underwater. Others were seen floating dead in the sea. At this time of the year numbers were also found in the stomachs of snappers *(Pagrosomus asuratus)*, one of the local commercial fish. Southern Black-backed Gulls *(Larus dominicanus)* were seen to feed on dead juveniles and a Harrier *(Circus approximans)* was responsible for the death of at least 10 juveniles on the summit of Green Island early in December.

NEST SANITATION

The fecal material consists of a mass of whitish fluid containing chunks of red matter resmbling squashed raspberries. I noted that it is almost identical to that of the Cassin Auklet which has similar food types. However, in the auklet the feces is squirted toward the burrow entrance, whereas the Kuaka deposits its wastes in the back end of the burrow where it becomes an odorous mass of moisture filled with fly maggots. Accumulations of this material drive the chicks, as they get older, further forward in the burrow and after the age of forty days they actually do considerable digging of new side tunnels. I have found burrows completely remodelled after this time and have seen the juveniles actually digging and occupying the clean side passages.

OTHER ACTIVITIES OF THE ADULTS

Compared to the auklets the Diving Petrels are rather uninteresting birds. At least their displays and behaviour are simple in comparison. Both species dig their holes in much the same fashion, scattering soil for a couple of metres from the hole. But the activity is less ceremonious than in the auklets. Both species use old burrows if available and these are ready for occupation earlier than new holes.

Upon arrival in the evening the Diving Petrels drop through the tree canopy on to the ground with a thud. Often they would sit somewhat dazed or stunned for several minutes, otherwise they would dash off on tiptoes and wings flapping into their nearby burrows. Each night it was necessary to toss birds out of my tent and from the sagging plastic sheet that I used to catch rain water.

I returned after a rainy week-end to my camp to find two, one drowned the other very exhausted, birds floating in about 3 gallons of water collected in the plastic catchment. They were unable to climb the slippery plastic sheet or fly out of the pool.

Social activities such as circling, passing, wing-raising, bowing, head-waggles and bobbing demonstrated by auklets are not seen in these petrels, but billing and nebbing are common to both species.

Diving Petrels frequently sit with their wings dropping which gives them a rather ovate flat appearance from above. A few minor squabbles were seen in which the two birds engaged in brief forward-jabbing and bill-pulling sessions. Departure ceremonies involved only the " meow-chorus " previously described. Apart from these actions, the noisy two hours in the evening and the " meowing " early in the morning, the adult birds did little but sleep with the bill tucked under their coverts.

On one occasion I witnessed a brief encounter of a Kuaka with a Flesh-footed Shearwater, when the Kuaka accidentally dashed into the large bird and frightened it. On another night a Tuatara *(Sphenodon punctata)* ran into a sleeping petrel which awoke with such a fright that it leaped about a meter in the air then scuttled away up the hillside.

As soon as the eggs hatch the incubation patch begins filling in and in about 35 - 40 days the bare patch is completely covered with short dense down. By the end of November the adults show considerable wear on the feathers. The remiges and rectrices were all frayed at the tips; however, I detected no evidence that the moult had begun. Payne (1965: 221) reports that the wing moult in the Cassin Auklet begins while still raising young.

Apparently, the Divers' moult later while at sea. By the end of November, the number of adults coming in at night was diminishing and by 10 December very few were seen or heard. Watson (1968: 182-183) has recently indicated the synchronous moult of remiges and rectrices in the Diving Petrel.

EXTERNAL PARASITES

Ectoparasites were frequent on the Diving Petrel. These included fleas, lice, ticks and mites.

The fleas were identified as *Parapsyllus jacksoni,* and according to Dr. R. L. C. Pilgrim (personal communication), this is the first record of this species of flea on the Diving Petrel. Three different lice were found: *Pelmatocerandra setosa, Halipeurus* sp. (possibly *H. falsus pacificus*), and *Austromenopon elliotti,* one pair of which has been deposited in the British Museum of Natural History. The ticks were identified as *Ixodes auritulus zealandicus.* The mites are yet to be determined.

Ticks were often found attached to the flesh around the eye of the young birds in the burrow, but no effects upon the growth of the individuals was obvious. None was found on adult birds. The fleas seemed to prefer the belly down of both the chicks and the adults.

WEIGHT CHANGES IN THE ADULTS

A definite increase in body weight was noted to occur during the post-breeding period at sea. This excess weight was rapidly lost after the nocturnal visits to the breeding grounds began. By a month before egg laying the average body weight had declined to the October level when the adults were feeding young (Figure 6). The data indicate that the main loss of weight occurs before the eggs are laid. This may be due to the shortening of daily feeding periods after the nocturnal activity on land begins. However, it is not known positively that the birds feed at night while at sea. Baird (1965: 426) notes that Leach's Petrel is unlike other petrels in that it feeds at night. Richdale (1947) suggests that the weight may increase during the incubation period and then fall again when feeding the young. More data is needed during the incubation period and during the feeding period to fully understand the phenomenon.

Bartle (1968: 85) noted unusual weight losses in breeding Pycroft's Petrels even when food was apparently plentiful. These losses corresponded to the weight losses in birds that were incubating and thus not feeding.

Since the Diving Petrel tends to change incubation roles on an alternate night basis, weight loss due to long periods without feeding would not be expected. It is apparent then, that the weight loss in the Diving Petrel is related to increased breeding activity and less time spent in feeding.

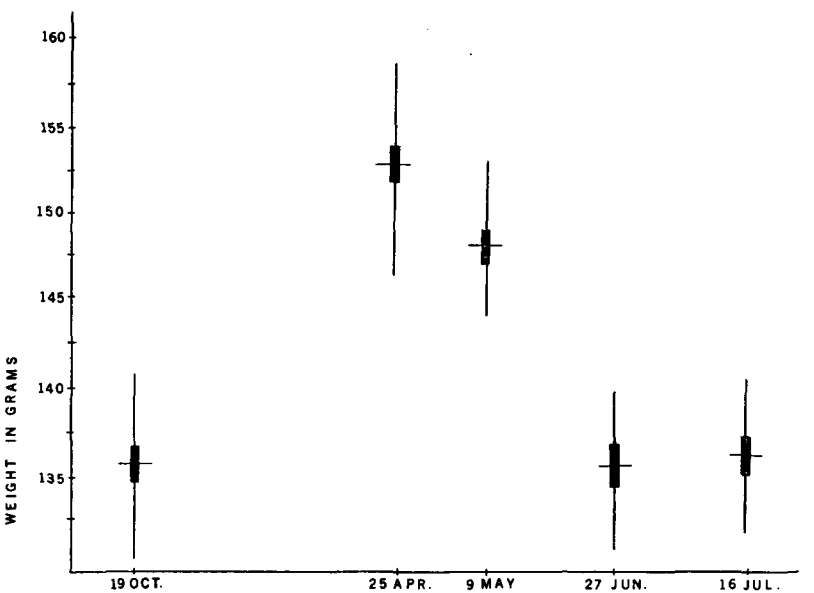
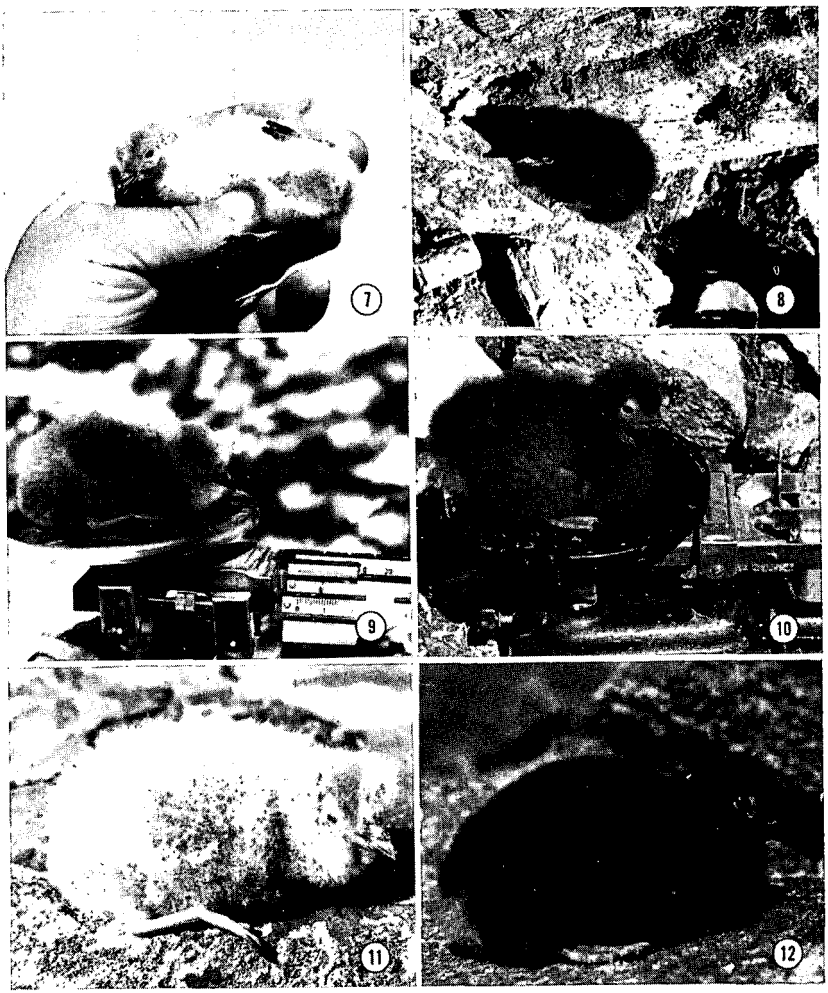


FIGURE 6 — Weight changes in adults recorded at difficult months of the year. For the October entry n = 14 and for April to July n = 20. Standard error and deviations are indicated.



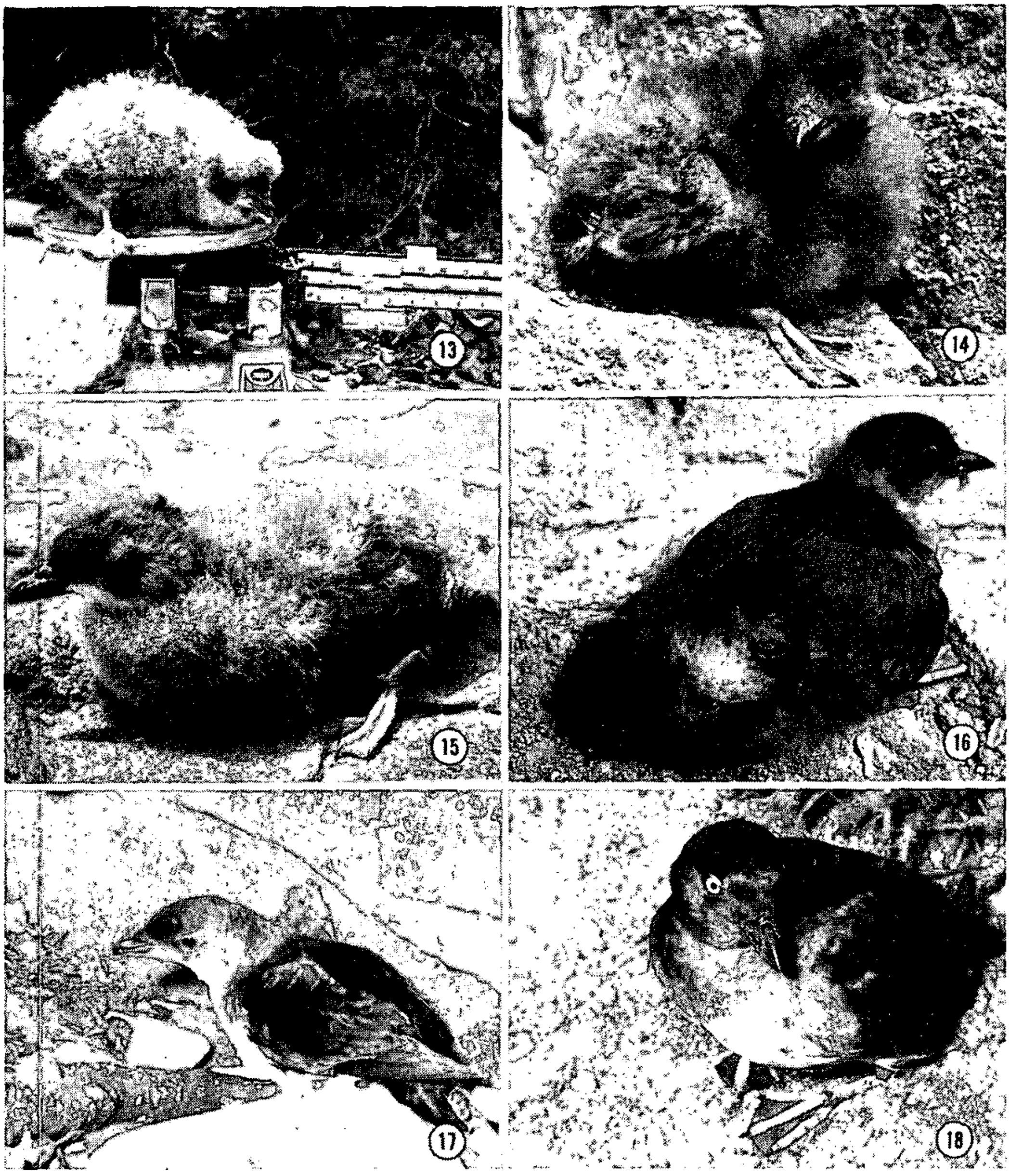
FIGURES 7 - 12 — Illustrations of Diving Petrel and Cassin Auklet chicks of comparable ages. Divers are shown on the left, auklets on the right.

7: A three or four-day-old diver chick showing the wedge of darker down on the venter.

8: A 24-hour-old Cassin Auklet chick.

9 and 10: Chicks 18 - 20 days old.

11 and 12: About 25 days old.



FIGURES 13 - 18 — Continuation of growth in divers (left) and auklets (right).

13 and 14: Chicks 28 - 30 days of age.
15 and 16: About 35 days.
17 and 18: Adult birds.

Falla (1934: 246) suggests that during courtship, adults probably refrain from eating, for he found nothing in the stomachs of those he examined. Harris (1966: 22) noted that adult Manx Shearwaters during incubation lost an average of 10 gm. a day but that the average weights throughout different stages are reasonably constant. However, he did not record weights of birds during the time of initial return from inter-breeding time at sea.

TABLE 3

Summarizing Comparative Habits of the Cassin Auklet and Diving Petrel

CASSIN AUKLET (**Ptychoramphus aleutica**)	DIVING PETREL (**Pelecanoides urinatrix**)
Nests	
Burrows in soft soil in open areas. Often no nest material used, but occasionally a few leaves or blades of grass are used. Fecal wastes deposited toward burrow entrance.	Burrows similar to auklets in soft soil under tree cover or in the open. Leaves often used as nesting material. Fecal material deposited in rear of burrow.
Incubation	
Continuous, male and female alternates, no incubation patch present in adults. At least 37 days duration. Temperature tolerance unknown. Fresh eggs may be found through several months of the year.	Egg sometimes left to cool, male and female alternates. Have well developed single incubation patch. Approximately 53 days duration. Demonstrate remarkable tolerance to lowered temperatures. Fresh eggs limited to 3 or 4 week period.
Pipping	
2 - 3 days.	Same.
Fledgling Period	
Adults stay with young only 3 - 4 days. 41 - 50 days spent in nest. Do not fly well when they enter water. Juveniles reach lower limits of adult weight before fledging.	Adults stay with young 10 - 15 days. 48 - 56 days spent in nest. Do not fly well when they enter water. Juveniles reach upper limit of adult weight before fledging.
Moult	
Adults moult while feeding young. Primaries are moulted a few at a time (Payne, 1965: 225). *Previously this has been considered a* petrel-like trait.	No evidence of moult while feeding young. The moult takes place at sea after breeding *is completed. According to Murphy and* Harper (1921: 509), this is an auklet-like trait.
Behaviour of Adults	
Arrival at night similar in both species. *Flight and swimming similar.* Food habits similar.	Similar. *Similar.* Similar.
Social Activities	
Digging of burrows ceremonial in auklet. Exhibits billing and nebbing. Sleep posture—bill tucked in lateral coverts. Circling, passing, weed plucking. Jabbing. Face-to-face combat with feet used. Wing-raising. *Head-waggles, head-bobbing and bowing.* Departure ceremony includes display.	Less ceremonial but otherwise similar. Similar. Similar. Not seen in divers. Similar in divers. Engage in bill pulling but not with feet. Not seen in divers which rather tend to drop their wings. *Not observed in divers.* Confined to "Meow" chorus with no apparent display.
Calls and Communication	
At least 10 variations: " Krick-i-er," " Kut-reeah," " Kut-reeah." Location and begging calls of young a constant " Squeer."	At least 9 variations: " Kuaka," " Kuaka-did-a-did," " Meow." Similar to auklet.
Feeding Young	
Adult assumes hunched posture and regurgitates. Young beg by sound.	Adult sits flat, regurgitates. Young beg by sound and head waggles.

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SHORT NOTE

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HARRIER HAWK — NEST BUILDING TO EGG LAYING

In "New Zealand Birds," the author quotes Stead as saying that nest building "takes about a fortnight . . . . and adding more material after laying." The following observations of two nests in the Te Akau district, may thus be of interest owing to the length of time taken from when nest building was first observed to the laying of the first egg. Both nests were in the same swamp, one found in 1968 and the other in 1969. The 1968 nest building was first observed on 14/9/68 when I was in a hide further down the swamp photographing Pied Stilts. Two Harriers *(Circus approximans)* were seen circling over an area of raupo, one decsending into it and then flying over to a nearby hillside. While two Hawks were in attendance only one was seen to carry nesting material. I visited this nest from time to time and it was not until 6 p.m. on 13/10/68 that the Hawk flew off as I approached and one egg was seen to be in the nest. Even if the Hawk had been building for the very first time on 14/9/68 this still makes the time lapse nearly a month. However, the 1969 nest-building to egg-laying period was even longer. A Hawk was noticed building on 23/8/69 when the writer, his wife and R. B. Sibson were on a bird-watching circuit of the Te Akau - Waingaro district. The weather was warm and sunny. The Hawk appeared to be building in haste, visiting the nest with material four times in 10 minutes. It was observed once picking up material in its beak and transferring it to its feet in flight. This building in August is quite an early record, but yet the nest was not laid in till 4/10/69. On this date I visited it and the Hawk flew off revealing one freshly laid egg. The length of time from nest-building to egg-laying in this instance must have been at the very least 42 days.

— D. W. HADDON

SOME ASPECTS OF THE FEEDING OF THE HARRIER

*By ROBERT E. REDHEAD**
Department of Zoology, University of Otago, Dunedin

ABSTRACT

A study of the food habits of the Harrier Hawk (**Circus approximans gouldi** Bonaparte) was made in the southern part of the South Island.

Observations were made in the field and on two hawks kept in captivity, one an adult, the other a young bird.

A quantitative-qualitative analysis was carried out on 129 crops and 129 stomachs between February 1966 and December 1967; during this time 254 food items were identified.

The percentage occurrence of various groups of food items eaten between these dates are: traces of sheep 18.5%, small mammals 28.8%, Passerines (including eggs and nestlings) 30.8%, ducks (Grey and Mallard) 5.0% and miscellaneous items 17.8%. Of the Passerines 5.0% of their occurrence was either nestlings or traces of egg shell, the remaining 25.8% was adult birds. Eleven of the 13 duck food traces were found in hawks collected during the duck hunting season.

One interesting observation made during this research concerned sex determination.

Some books have stated that eye colour can be used as a sex determinant for differentiating between adult males and adult females. However, after determining the sexes of these specimens by dissection and gonad inspection it was discovered that, of 29 females considered to be adults 18 had yellow irides, 7 had brown ones and 4 had occluded irides. In comparing some of the yellow irides of the adult females with some of those found in adult males no distinctive differences could be observed.

The average weight of female hawks (juvenile and adult) was 822.5 grams with a variation from 622 to 1044 grams. The average male weight was 633 grams with variations from 392 to 725 grams.

In captivity, an adult with an average weight of 722 grams consumed an average of 111.5 grams of food per day or 15.4% of its body weight.

A young hawk was captured at 22 plus/minus 1 days of age. A food intake record was kept between days 24 and 55, and a weight record was kept between days 23 and 55. The average daily weight of the young hawk was 635 grams and it consumed an average of 128.8 grams of food per day between days 24 and 55. This is 20.3% of its body weight. Up to and including day 40 it consumed an average of 147.6 grams per day or 23% of its body weight while having an average weight of 635.4 grams. After day 40, a noticeable decrease in the average weight of food consumed was recorded. Between days 41 and 55 it consumed an average of 104.3 grams per day amounting to 16.4% of its average body weight of 635 grams.

INTRODUCTION

The New Zealand avifauna is unique in that there are only four established raptors, two nocturnal and two diurnal. One of the two nocturnal species was introduced while the other three raptors are native to New Zealand.

The ranges of the two diurnal raptors overlap little. The Harrier Hawk *(Circus approximans gouldi)* is confined mainly to the open country and to the edges of the native forests. The New Zealand Falcon *(Falco novaeseelandiae)* is restricted with a few exceptions to the native forests. The only major range overlap that exists between significant numbers of different species of raptors is that between the diurnal Harrier Hawk and the introduced, nocturnal Little Owl *(Athene noctua)*. Some competition for food exists between the Harrier Hawk and some of the mammalian predators such as the Weasel *(Mustela nivalis)*, Stoat *(Mustela erminea)* and the Rats (*Rattus* sp.) but this limited competition is unlikely to have any major effect on the diet of the hawk.

The hawk's competition for food with other predatory species in pre-European times was less than it is now judging from the few

* Present Address: C/o P.O. Box 156, Prince George, British Columbia, Canada

predatory animals then present. The number of hawks present was probably smaller than their present day population because at the time they lacked a plentiful food supply and an extensive range.

It is likely that the hawk's numbers increased considerably with two coinciding events. One was the clearing of forested areas to some extent by the pre-European Maoris for hunting but more so by the early Europeans for their large farms and stations. The destruction of native forests either for hunting purposes or to create new grazing land increased the potential range of the hawk. The other event was the introduction of potential prey species such as the European Rabbit *(Oryctolagus cuniculus)* and small passerines. Many of these new prey species have utilized this new range and supplied sufficient food for a sizeable population increase by the hawks.

The rabbit, because of its numbers, may have played an important part in the increase of the hawk population, but unfortunately there is no accurate account of the relative numbers of both species up to this time. However, firsthand accounts by long-time residents in the study areas have suggested that until twenty or twenty-five years ago, the hawk population was considerably larger than it is today.

Now that the rabbits are effectively controlled in most areas, their numbers have decreased markedly. This decrease in one of the major food sources of the hawk may reduce the number of hawks to suit the reduced number of prey unless the hawk can find a new food supply or seek a compromise by having its numbers reduced to suit a new-found food supply.

There has been no formal, published study done on the food habits of the Harrier Hawk with which a present day food analysis can be compared. Reports have been written, however, on occasional sightings of its capturing food and of some very limited gut content analysis as done by Travers (1866).

This study is an attempt to analyse the present-day food habits of the Harrier Hawk in the south-eastern two-thirds of the South Island. A quantitative and qualitative analysis has been done on 129 hawks collected from throughout this area. At the same time, the methods used by the hawks to capture, manipulate and eat food as well as their post-meal activities were studied with two hawks (one adult and one juvenile) kept in captivity at different times between March 21, 1967, and January 14, 1968. An analysis was also done, using these two birds, comparing their food intake to their body weight.

METHODS AND TECHNIQUES

Collection

Specimens of the hawk were collected by two methods. The first method was trapping which depended largely on the hawk's type of nutrition. The second method was by shooting them.

The Harrier Hawk, by choice, depends to a large extent on scavenging for its nutrition. Consequently trapping it during the autumn and winter, when food is relatively scarce, is reasonably easy. The main method of trapping was to place a sheep or some other dead animal out in a field where it would be easily visible to foraging hawks. Traps were set around this bait and held to the ground by an iron spike. A spike was also placed through the bait to prevent it from being dragged away.

Another method of trapping but less likely to injure the birds, was used by myself. The jaws of the traps were padded with one inch foam rubber held in place by friction tape. A piece of nylon cord about three feet long was attached to the chain.

These traps were placed on fence posts and the cord was attached to the middle strand of wire. The bait was suspended on the top strand of wire one foot to eighteen inches away from the post. The hawks would land on the post since it was the nearest vantage point to the food, and become caught. The trap would then fall to the ground and remain attached to the wire by the nylon cord. The cord was long enough so that the hawk would not become suspended upside down from the post, thus preventing unnecessary suffering.

The second method of obtaining specimens was by shooting. This was easily done when the hawks were coming into roost or after they had finished eating and were resting in fields or on fence posts.

Shooting hawks when they were coming in to roost is done with the aid of a call. The call is made by taking two spent shot-gun cartridges, detaching their bases, and knocking their detonators out. The open ends are fitted together forming a short cylindrical tube and small opening at either end where the detonators were. Blowing through this creates a shrill whistle almost like the distress signal of a hare or rabbit.

Originally it was hoped to collect approximately 200 hawks, 50 from each season, but only 129 were collected. The numbers collected in the spring and summer fell short of the set goal.

The lack of numbers during these two seasons was attributed to two reasons. During the spring and summer most of the hawks have separated into breeding pairs and do not roost communally as they do in the autumn and winter. The difficulty arises in that there is no high concentration, and therefore no easily obtainable numbers of hawks. Also during the spring and summer there is sufficient, easily accessible natural food so that the hawks do not have to rely on scavenging as much as they do in the autumn and winter; this makes it difficult to capture birds in set traps.

The months were grouped into seasons in the following manner: Spring (September-November), Summer (December-February), Autumn (March-May) and Winter (June-August).

Upon receiving a specimen the stomach and crop were removed and the contents were separated and identified immediately or they were labelled and put into a freezer until sufficient time was available.

Before the specimen was discarded its sex and iris, cere and leg colour were noted, a rump covert was also taken and tagged with a specimen's number for later use in attempting to find field sexing aids.

Sexing

Difficulties arise in sexing the Harrier Hawk in the field and sometimes even in the laboratory. In the field these difficulties are compounded by the additional problem of distinguishing between young adult and juvenile birds of the same sex. So far only two partially successful ways have been discovered that enable one to distinguish between adult males and females in the field. One method is by

colouration. The females of the same general age group tend to be darker than the male. The other method is by weighing the birds; here the female is generally heavier than the male. There are, of course, many difficulties arising from both of these methods. The females are said to have brown irides and the males yellow irides. This theory has been found to be invalid. Besides the adult females having yellow as well as brown irides, another complication is that juveniles of both sexes all have brown irides.

In this study 29 adult females were collected, 18 of these had yellow irides, 7 had brown irides and 4 had irides that were occluded through the birds having been hit on the head, the blood vessels around the eyes then rupturing.

TABLE 1 — BIRD WEIGHTS

	Number Examined	*Average Weight*	*Maximum Weight*	*Minimum Weight*
Adult Males	42	649.0	725.5	542.0
Adult Females	29	839.0	1044.0	744.5
Juvenile Males	32	617.0	720.0	392.0
Juvenile Females	21	806.0	1002.0	622.0

During this study an attempt was made to differentiate between adult males and females by the use of rump covert colouration. It was noted during a few casual observations of the specimens that the rump coverts of the adult males appeared to have a lighter background colouration than those of the adult female. The adult females also have a wider proximal and distal brown bar as well as a darker background colouration of the feathers. The brown vertical stripe up the rachis, between the bars, is wider in the adult females than in the adult males, where it is sometimes non-existent. The overall background colouration of the rump coverts in the adult males is almost pure white while in the adult females it ranges from a buff to a light cream colour.

From the results of these observations it is believed that iris colour, like feather colour, becomes lighter as the birds get older, and that apart from dissection the next most effective method of determining the sex of adult birds is by weighing them, possibly used in conjunction with rump covert characteristics.

SEPARATION OF FOOD CONTENTS

Frozen crops and stomachs were preferred for the weighing of the contents from these two organs, since frozen contents are easier to handle.

Separation of the food contents was carried out by the flotation method commonly used in industry. The crop or stomach contents were put in a glass beaker or bowl and placed at an angle on a frame containing a fine wire mesh over a sink. Water was run slowly into the container; at the same time the food was mechanically dissociated with a glass rod. The lighter contents such as feathers, grass and hair eventually passed over the top of the container with the slowly running water and became caught in the fine mesh.

The food contents of the mesh were separated under a gentle stream of water. The separated articles were put into separate dishes.

The heavier contents still in the container were poured on to the mesh and separated in a similar manner.

A small sample from each of the various dishes containing different, identifiable contents such as hair and feathers, was taken and dried for later use in identification while the remainder of the food contents was measured volumetrically. Contents of less than 0.5 cc. were considered to be traces. After the volume was determined, the feathers, hair, grass and bone constituents were left to dry and the meat was preserved in a solution of 8% formaldehyde.

The small samples from each of the dishes containing identifiable hair or feathers were then washed in xylol to remove the dirt and fat that coats them in the stomach. The feathers were dry mounted because mediums such as Canada balsam and depex have a refractive index that makes the nodes on the feather barbules very difficult to see. Hair mounted in depex is more easily identified because the medulla becomes visible whereas in dry mounts only the scale patterns are visible and these are not as distinctive as those of the medullary patterns.

IDENTIFICATION TECHNIQUES

In the gut contents of hawks, characteristics such as size, colour and shape of food items are lost, making identification by the use of whole animals impossible except in a few cases. In many cases only a single hair or feather was found in the gut contents; quantitative analysis will then depend upon being able to identify these hair and feather remains.

(i) HAIR IDENTIFICATION AND TECHNIQUE

There are generally two types of hairs found on animals. There is the guard hair which is long, straight and usually pigmented and there is the fine hair which is short, sharply bent or curled, fine, slightly pigmented and more numerous than the guard hairs.

The guard hair has a narrow proximal shaft with no constrictions and a flattened shield section which narrows to a tip.

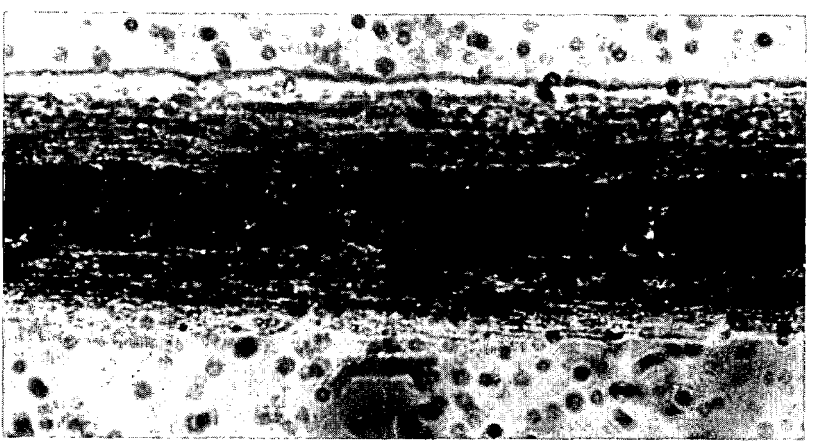


FIGURE 1: The hedgehog has an extremely thick, pigmented cortex, with two layers of keratin in the medulla. x 400.

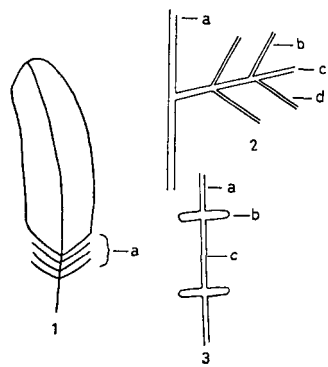
The fine hair has a less pronounced shield section with constrictions in the proximal shaft. Most hairs have three layers of keratin (Fig. 1). There is the scaly cuticle which surrounds the hair and is readily seen in dry mounts. There is the cortex which varies in thickness in different species of animals. Finally there is the medulla consisting of loosely packed cells often containing air.

(ii) FEATHER IDENTIFICATION TECHNIQUE

For use in microscopic feather identification body feathers are the most helpful. The downy area at the proximal end of these feathers (Fig. 2) contains the features most useful in diagnosing the order of the bird. Barbules in this area have no hooks or ridges thus giving the feather a downy appearance in this area. This is also very helpful in making these barbs easy to separate for diagnostic purposes. Day (1966) calls these the " downy barbules."

FIGURE 2: Diagram of the gross anatomy of the feather.

1. Body feather.
   (a) downy barbule region
2. Portion of a body feather showing positions of proximal and distal barbules.
   (a) feather rachis
   (b) distal barbule pointing to the tip of the feather
   (c) barb
   (d) proximal barbule pointing to the base of the feather
3. Barbule of a galliform with characteristic nodes.
   (a) pennulum
   (b) node
   (c) internode region

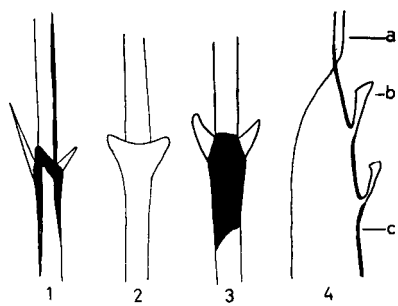


The structure of the downy area was examined before any attempt was made at describing diagnostic characteristics.

The barbules in this area have a short broad base followed by a narrower portion, the pennulum, swollen at intervals to form nodes. The unswollen lengths between the nodes are called internodes. It is the size, shape and distribution of these nodes (Fig. 3) that aid in determining to what order of bird the feather belongs.

FIGURE 3:—

1. Node of Falconiformes.
2. Node of Anseriformes.
3. Node of Passeriformes.
4. Passerine barbule, showing —
   (a) beginning of pennulum
   (b) villi
   (c) base of barbule



HARRIER HAWK PREDATION ECOLOGY

In discussing the various food items or possible prey items of the Harrier Hawk two important things must be considered. The first is the availability of the prey and the second is its vulnerability.

The 'availability of a prey species' simply means that if a particular prey species is present, it is an available food.

Vulnerability encompasses many things but is well summed up by Craighead (1956) as being "the result of the physical and biological conditions that cause one species to be preyed upon more heavily than another." These conditions include prey risks such as: protection, cover and food availability, concentration and dispersion of the prey, its health, and the speed, agility and escape reactions demonstrated by the prey species.

The density of the predator is the factor other than prey risk that should be taken into consideration in discussing predation.

(a) *Protection, Cover and Food Availability*

Cover for prey species or populations is one of the most important things determining prey risk. Despite the fact that hawks are often seen hunting hedgerows, these hedgerows offer good protection to small bird and mammal populations. It is when these potential prey leave this cover or it is destroyed that they become vulnerable to predation. If there is considerable cover and nesting facilities in these areas for small prey species, but litle food, then the number of prey individuals in this area will be low or else their vulnerability will rise because of the excursions that will take place away from the area of cover, in order to obtain food.

(b) *Concentration and Dispersion of Prey*

These factors may operate to increase or decrease the vulnerability of prey. An example of an increase in a prey population increasing its vulnerability is in the spring and summer when the numbers of a prey species may increase through breeding thus making these species more vulnerable. Most adult species have a tendency to protect their young, thus making the adults more vulnerable than if they fled. This increase in numbers of a particular prey species brought about by breeding causes an increase in vulnerability especially if this is a preferred food species. Also the young of a species are generally more susceptible to predation than the adults, thus making the species as a whole more vulnerable to most forms of predation.

The effect of dispersion of a prey species upon their predation is obvious. If there are none or few of these potential prey within a given area then the predation upon this species in this area will be nil or light.

(c) *Movement, Activity and Habits*

Movement by a prey species increases its risks of predation by making it more conspicuous and exposing it more frequently. Thus if a potential prey has to move about in search of water or food, then its chances of being captured by a predator have increased in proportion to the amount of time that it is foraging. Ducklings would be particularly vulnerable because they must search for food and water within a day after they hatch. A passerine that is feeding young also has its vulnerability increased because of the increased number of food gathering trips that it must make.

Activities of any species can modify its vulnerability to predation. For example, both opossums and hedgehogs are nocturnal, making them practically invulnerable to the hawk which is a diurnal predator. There are, of course, instances of overlap in the foraging times of these animals but in general they do not frequent the same area at the same time.

The habits of potential prey can increase their vulnerability. The voices of Blackbirds *(Turdus merula)* and Song Thrushes *(Turdus ericetorum)* draw attention to their presence, while the seclusive Hedge Sparrow *(Prunella modularis)* escapes detection. The habit of the Skylark *(Alauda arvensis)* of exposing itself to sing makes this bird particularly vulnerable to predation by the hawk.

(d) *Age*

The age of an individual prey item must be taken into consideration. The vulnerability of a prey species increases during the spring and summer because of the large influx of young which are particularly susceptible to predation. After an accessible nest containing young or eggs has been discovered by a hawk it is usually only a matter of time until all the occupants are taken.

During this period most young are incapable of defending themselves and usually make no attempt to escape the predator.

On the other hand, particularly old animals of a prey species, whose reflexes have slowed and senses have dulled become more susceptible to predation than the younger, more agile and alert individuals.

(e) *Size and Strength*

Large, strong animals are less susceptible to predation than those of smaller and weaker of the same or different species. An animal such as a mature Sheep (*Ovis* sp.) under normal conditions is not likely to fall prey to a hawk because of its size and strength but young rabbits and European Hares *(Lepus europaeus)* would be easy prey if they are accessible. It is possible, though, for a hawk to take by surprise prey that are larger than itself. One instance of this is the taking of a White-faced Heron *(Ardea novaehollandiae)*. This was observed by Mrs. E. Hannah.

(f) *Health*

The health of a potential prey individual or species, for that matter, is important. The number of ducks taken by hawks during the hunting season compared with the rest of the year lends strength to this. Far more ducks were taken during this period than the total for the remainder of the study period. During this time of year many wounded ducks escape the hunter but are unable to escape the predation of the hawk whereas under normal conditions they would have no difficulty in escaping. The hawks, because of this seasonal increase in vulnerability of the ducks, tend to congregate around the swamps in larger numbers than there normally are.

(g) *Speed, Agility and Escape Reactions*

There is no doubt that speed and agility reduce the predation risk of individuals and species. Small, elusive birds such as White-eyes *(Zosterops lateralis)* and Fantails *(Rhipidura fuliginosa)* have much

better chances of eluding the hawk in flight than less manoeuverable species. Birds such as small waders *(Scolopacidae)* and adult ducks are faster than the hawk. The only way a hawk may have of catching a healthy bird of these orders is by surprise.

Two other factors determining predation of a collective prey should be mentioned. Craighead (1956) said that " predation is in general roughly proportional to the relative prey densities." That is, if, in a collective prey population one species is more abundant at any time than any of the other species, then the more abundant species would receive a greater amount of predation pressure than the less abundant species, provided that their vulnerability levels are relatively equal.

The second factor determining prey vulnerability and closely related to prey densities is predator density. An increased prey density or an increased prey vulnerability in given areas will tend to increase predator densities. The most common example of an increase in predator populations increasing the vulnerability of prey populations in a given area is in the duck hunting season. During this time the hawk populations over hunted ponds and marshy areas increase noticeably. This increases the vulnerability not only of the wounded ducks, which are the prime prey of the hawks, but of all the other prey species in this area.

While discussing the different prey species, the health of the separate prey items, except in one or two specific cases will not be drawn into the discussion, because unless one sees the actual taking of the prey it is difficult to say what state of health an individual prey item is in. Gustaf Rudebeck (1951), in his observations of hunting raptors, noted that they were more successful when hunting injured or lame prey: in the case of the Sparrow Hawk *(Accipiter nisus),* 6 out of 23 successful prey captures showed some deviation from the normal.

(h) *Seasonal Food Variation*

Because the Harrier Hawk is capable of taking a wide variety of food, its diet may vary depending upon the densities of its prey populations or the availability of certain foods at different times of the year. There are two main ways that a hawk may change its food habits to suit the availability of the food.

Firstly, it may migrate to areas where foods which are more accessible to it are present. This does not seem to be true of Harriers. According to Watson (1951) it was found that adults tend to stay within a radius of about five miles, while some of the young disperse up to several hundred miles. It is likely that this dispersal is caused by factors other than a seasonal variation of food.

The second manner in which a hawk may react to seasonal fluctuations in food is by eating other foods than its preferred ones. These are said to be staples. For example, during the spring and summer the hawk shows a predilection, or natural food preference, for the young and eggs of many passerines. These are considered to be preferred foods because they are chosen above all other foods available at this time. However, during the autumn and winter

TABLE 2

SEASONS	SPRING		SUMMER		AUTUMN		WINTER	
NUMBER OF BIRDS EXAMINED	12		9		52		56	
KIND OF FOOD	a.	b.	a.	b.	a.	b.	a.	b
Sheep (Ovis sp.)	1	3.9	3	12.0	12	11.4	31	30.0
European Rabbit (Oryctolagus cuniculus)	5	19.2	1	4.0	10	9.5	3	2.9
European Hare (Lepus europaeus)	1	3.9	0	0	6	5.7	3	2.9
Brush-tailed Opossum (trichosurus vulpecula)	0	0	2	8.0	6	5.7	3	2.9
Eurasian Hedgehog (Erinaceus europaeus)	0	0	1	4.0	11	10.5	12	11.6
Mouse (Mus musculus)	0	0	1	4.0	4	3.8	5	4.8
Norwegian Rat (Rattus norvegicus)	1	3.9	0	0	0	0.0	0	0.0
Unidentified hair	0	0	1	4.0	0	0.0	2	1.9
Blackbird (Turdus merula)	3	11.7	0	0	4	3.8	7	6.7
Song Thrush (Turdus e. ericetorum)	4	15.4	1	4.0	2	1.9	2	1.9
Skylark (Alauda arvensis)	0	0	0	0	4	3.8	0	0.0
Goldfinch (Carduelis carduelis britannica)	0	0	1	4.0	4	3.8	0	0.0
House Sparrow (Passer domesticus)	0	0	0	0	0	0.0	3	2.9
Unidentified Passerines	1	3.9	0	0	7	6.7	10	9.5
Ducks	1	3.9	1	4.0	10	9.5	1	1.0
Unidentified birds	0	0	1	4.0	6	5.7	8	7.6
Blackbird eggs	2	7.8	0	0	0	0.0	0	0.0
Song Thrush eggs	3	11.6	0	0	0	0.0	0	0.0
Skylark eggs	2	7.8	7	28.4	0	0.0	0	0.0
Miscellaneous birds	1	3.9	1	4.0	5	4.8	11	10.6
Lizards	1	3.9	1	0	1	1.0	1	1.0
Insects	0	0	2	8.0	12	11.4	2	1.9
Trout (Salmo trutta)	0	0	1	4.0	1	0.9	1	1.0
TOTAL	26	100.8	25	100.4	106	99.9	105	101.9

a = number of individual food traces
b = percentage of total

when these preferred foods are not available, the hawk must eat something else, which, though not necessarily a preferred food, is still considered to be a staple of the hawk's diet. Such foods are road killed opossums, hares and rabbits and dead sheep that may be found in fields.

The Harrier relies heavily on the preferred foods of nestlings and eggs in the spring and summer, with the staples such as road kills, sheep and adult birds forming a smaller percentage of its diet. During the autumn and winter, upon the disappearance of the eggs and nestlings, the staple foods take over the major role in the diet of the hawk.

FOOD HABITS:
FOOD ANALYSIS AND DISCUSSION OF RESULTS

During a crop and stomach analysis certain unavoidable difficulties are bound to be encountered which may lead to vagueness or in some cases error. Some of these difficulties apply to both gut content and pellet analysis while others apply only to gut analysis. The main areas that these problems are likely to arise in this gut content analysis are: determining the number of individual items in the gut; the failure to examine each hair in the gut; and the lack of knowledge of differentiating characteristics.

The difficulty in enumerating individual items in the gut or contents occurs particularly when the hawk has been eating large prey and all that may remain in the stomach is hair or feathers. Under these circumstances, it is very difficult, if not impossible, to tell the number of prey or carrion items of that particular species on which the hawk has been feeding, since there is nothing that can be used as a basis for counting the items. When the hawk has been eating smaller food items such as small birds, mice or lizards the task of enumeration is not so difficult. Since, with these smaller items the whole individual is usually consumed there is no difficulty in counting birds' feet, beaks, mouse skulls or even incisors.

The failure to examine every hair or feather of the gut under the microscope can be well understood. This method of individual examination would take a very long time, so hairs and feathers were grouped microscopically at first and then representative sections of these groups were mounted on slides and identified. In some cases similar hairs of two separate species may have been placed in the same group and identified as one individual.

The lack of knowledge of differentiating characteristics is aggravated by the fact that there is no key available for differentiating the feathers of young Passerines. The problem was made even more difficult by the destruction of some of the identifying features by the physical and chemical action of the stomach. In pellets, feathers tend to be well ground and even powdery and the hair broken with the characteristic medullary patterns lacking, thus making very few complete hairs or feathers available for study.

Many of the contents of a gut like seeds and small grit (labelled detritus) may have been the result of the prey having eaten another animal and then having its crop, gizzard or stomach release these contents inside the hawk's stomach. These secondary foods may cause one to assume, for example, that the hawk has been eating insects,

TABLE 3

SEASONS OF THE YEAR	SPRING		SUMMER		AUTUMN		WINTER	
NUMBER OF BIRDS EXAMINED								
KIND OF FOOD	a.	b.	a.	b.	a.	b.	a.	b.
Sheep (Ovis sp.)	91.3	13.0	1053.3.	64.8	13.0	8.2	34.5	19.7
European Rabbit (Oryctolagus cuniculus)	173.3	24.8	1.8	0.1	17.0	10.7	83.7	47.7
European Hare (Lepus europaeus)	60.3	8.6	2.0	0.1	0.0	0.0	0.0	0.0
Brush-tailed Opossum (Trichosurus vulpecula)	47.1	6.7	1.4	-	0.0	0.0	0.0	0.0
Eurasian Hedgehog (Erinaceus europaeus)	45.0	6.4	133.7	8.3	0.0	0.0	3.6	2.1
House Mouse (Mus musculus)	8.1	1.2	20.0	1.2	0.0	0.0	0.0	0.0
Blackbird (Turdus merula)	8.1	1.2	35.1	2.2	64.0	40.2	0.0	0.0
Skylark (Alauda arvensis)	1.6	0.2	0.0	0.0	0.0	0.0	9.6	5.4
Goldfinch (Carduelis carduelis britannica)	1.5	0.2	0.8	-	0.0	0.0	5.0	2.8
House Sparrow (Passer domesticus)	0.0	0.0	72.5	4.5	0.0	0.0	0.0	0.0
Song Thrush (Turdus e. ericetorum)	3.2	0.5	81.5	5.1	52.7	33.0	0.5	0.3
Passerine	5.0	0.7	61.6	3.8	0.0	0.0	0.0	0.0
Miscellaneous birds	17.5	2.5	7.7	0.4	0.0	0.0	0.0	0.0
Duck	161.7	23.2	0.0	0.0	12.2	7.7	0.0	0.0
Brown Trout (Salmo trutta)	6.7	1.0	22.5	1.4	0.0	0.0	33.2	19.0
Unidentified meat	58.8	8.4	104.5	6.5	0.0	0.0	0.0	0.0
Bone	0.5	-	0.0	0.0	0.0	0.0	0.7	0.4
Plant matter	0.5	-	3.6	0.2	0.0	0.0	0.0	0.0
Detritus	9.0	1.3	12.4	0.8	0.5	0.3	4.0	2.3
TOTAL	699.2	100.2	1613.8	99.4	159.4	100.1	175.6	99.5

a = volume of food items
b = percentage of total

where in fact these are secondary foods. One of his prey may have eaten the insects and they were released from the prey's stomach or crop.

The final possibility of error is the fact that the hawk may have ingested some of its own feathers usually after having preened itself. In cases such as this the author's judgment was used to determine which cases were from preening and which were actually from prey or carrion.

In general most of the food items were discussed under the following topics: introduction, range, availability and vulnerability.

The heading introduction was discussed with reference to the means by which the species in question came to be in New Zealand. If it was introduced by Europeans its site was noted and a very brief history of its spread was given.

The range was considered from the standpoint of the present day distribution of the species. This of course ties in very closely with the vulnerability of the species. If, for example, the ranges of the food species in question and the Harrier Hawk show low signs of coincidence, then the availability of the food species in question will be low to foraging hawks. On the other hand, if the ranges of the food species and the hawk show considerable overlap the availability of the species will increase proportionately.

In discussing the availability of a food species the main factor taken into consideration was the range overlap between the hawks and the food species. In effect range overlap was equated with the degree of availability since as discussed earlier, availability was taken to mean the degree of presence of a food species in the hawk's range.

The discussion of the vulnerability of an animal took into consideration the attributes of each food species as discussed under the headings of: protection, cover and food availability, concentration and dispersion of prey, movement activity and habits, age, size and strength, health and the animal's speed, agility and escape reactions. All these points were assessed and the animal in question was given a vulnerability rating ranging between high and extremely low.

FOOD HABITS: BIRDS IN CAPTIVITY

(a) *Adult*

The purpose of this section of the study is to study the feeding habits of captive birds in conditions as close as possible to normal.

The food consumption of an adult bird and a partly fledged nestling were determined. These birds were kept in captivity and it is very likely that the food consumption of a wild bird would be greater than the results obtained here, if only because it is likely to be more active. At all times, except when experiments would not permit, these two birds were handled by normal falconry methods.

Keeping birds in captivity should have little effect on the manner in which the birds manipulate their food. Some of the food was obtained from road kills consisting for the most part of Rabbits, Hares, Opossums and an occasional Hedgehog, Thrush and Blackbird. The food item had to be recently killed to be considered suitable for consumption. This diet was supplemented by an occasional mouse, useful for tracing pellets, or meat purchased from a shop.

A certain amount of roughage, such as bones, hair and feathers, must be included in the hawk's diet. This roughage enables the

hawk to form pellets, which remove a layer of waste material that builds up on the inside of the stomach. The presence of this layer of waste, over a period of time, will cause the hawk's health to decline.

Another reason that makes it necessary to include roughage in a hawk's diet, is that the hawk's beak remains sharp and well trimmed through its pecking at the bones. If the hawk does not receive enough roughage in the form of bones the beak tends to become thick and recurved (Fig. 4). This will eventually prevent the proper closing of the lower mandible and therefore possible starvation. Also, the falcon tooth, not usually prominent on Harriers, tends to enlarge (Fig. 4). If symptons occur on a hawk's beak kept in captivity, the beak must be trimmed.

(a) (b)

FIGURE 4: (a) Beak deformation because of lack of roughage.
(b) Normal beak.

The casting of pellets often occurs just before feeding. The hawk points its head downwards, opens its mouth wide, draws its shoulders up around its neck, shakes its head sideways several times and then disgorges its pellet.

During the food consumption study, the following procedure was followed. At 4.30 p.m. the food for the day was weighed on a pan balance to the nearest gram and then put on a stand in the mews (a room where raptors are kept) at 5 p.m. The hawk had been removed from the mews at 1 p.m. and weighed on a specially constructed beam balance. It was then put outside on its weathering block or flown if time permitted until 5 p.m. when it was returned to the mews and released until 1 p.m. the next day .

Enough food, about 275 grams, was always put into the mews to ensure that it was never all eaten.

Certain precautions were taken to ensure that as little weight as possible was lost by the food. All doors leading to the mews were shut preventing any cats or dogs from getting in. A screen and fly netting were put over the window to stop flies from getting

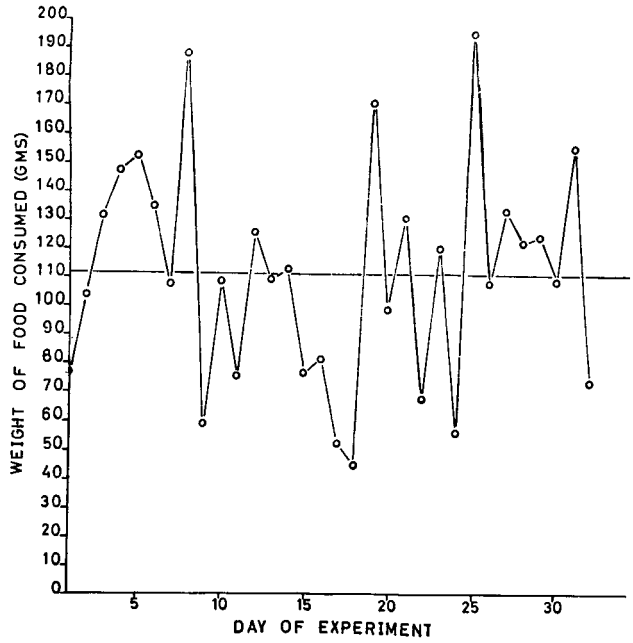


FIGURE 5a: Daily food consumption of the adult Harrier kept in captivity. The straight line is the average daily food consumption.

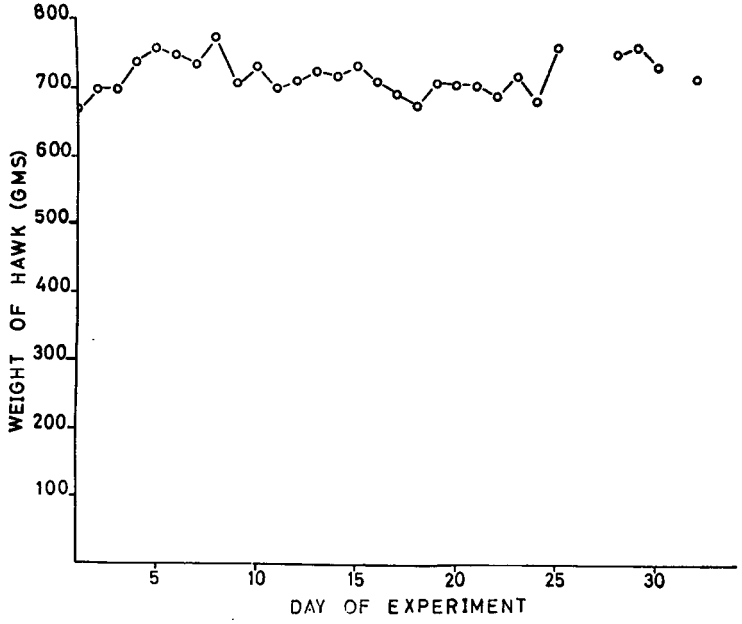


FIGURE 5b: Daily weight fluctuations of the adult Harrier kept in captivity. No weights were recorded on days 26, 27 and 31.

in during the summer. No mice or mouse traces were noticed during the year that the room was used as a mews. The only controlled factor of weight loss by the food was evaporation.

It was found that the average daily weight of food consumed by the adult hawk was 111.5 grams. The average daily weight of the hawk throughout the 32 day experimental period was 722 grams. The hawk was therefore consuming approximately 15.4% of its body weight in food per day (Figs. 5a and 5b).

On day 8 the food consumption was unusually high (188.0 grams) because the weighing took place at 3 p.m. rather than 1 p.m. This means that more food was consumed on day 8 and less on day 9 because of this extra meal on day 8's food. A similar situation occurred on day 25. On days 26, 27 and 31 I was away collecting the nestling and therefore unable to weigh the hawk, but the food was put into and removed from the mews at the prescribed times by a technician. The food that was removed daily was stored and weighed later.

For several months before the study of the weight relationships between the hawk and the weight of food it consumed, observations were made on the food habits of the captive bird.

The methods the Harrier used to capture and kill its prey were studied. The first experiment consisted of having the Harrier capture an already dead Blackbird, to which a length of string was attached. The lure was dragged past the Harrier in order that it might be caught without too much difficulty.

After the Blackbird was "captured" the string was given several sharp jerks to give it life-like qualities. After these jerks the hawk delivered its coup de grace to the "struggling" bird: in very quick succession, it lifted its feet a fraction of an inch off the Blackbird's body and thrust them down again so that the hind talons penetrated the body of its prey. After each foot was thrust down and the hind talon had entered the body of its prey, the Hawk then clenched its foot causing the inner and hind talons to slide closely past one another.

These two talons are extremely strong and it is with these that hawks kill their prey. These talons are almost directly opposed to one another and when the foot is closed the hind talon passes on the outside, between the inner and middle talons so that a pincer-like movement is obtained (Fig. 6). The middle and outer talons only serve to manipulate and hold food. The third or longest toe is often used to remove pieces of food that become stuck on the end of the hawk's bill.

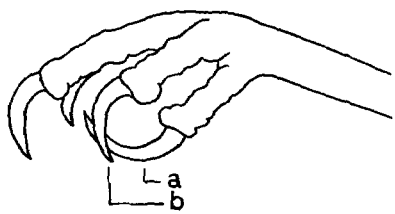


FIGURE 6: The pincer-like movement of the back (a) and inner (b) talons of the hawk.

Mice were obtained and released in the mews in order to study from close quarters the methods by which these hawks capture, kill and eat their food. Here is a description of a typical capture and killing of a mouse.

The hawk jumped off its perch and landed on the running mouse, striking it with its back talons. These two back talons are actually the leading part of the hawk's feet when it stoops (dips) at a prey (Fig. 7). After capturing the prey in its talons the hawk would fall forward thus causing the tendons operating its back talon to lock them automatically into its prey. The hawk, righting itself, would then begin mincing its feet in the manner described above. In some cases this failed to kill the mouse; if this happened, the hawk would then take the mouse's head in its beak and crush its skull.

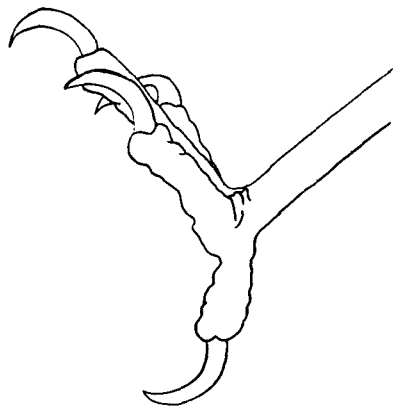


FIGURE 7: The hind talon is the leading part of a hawk's feet when striking a prey while in flight.

If the hawk missed the mouse on its initial attempt the hawk would then chase it on the floor until it became cornered. The hawk would then open its wings to their full extent across the corner and then catch the mouse with quick jabs of its feet.

An intact, but dead, hedgehog was given to the hawk to determine how it would go about eating one. The initial entry into the body was made by the hawk tearing the hedgehog's throat just below the chin. After the skin was broken it was peeled down to the lower abdomen. The hawk then removed and ate all the ribs. The backbone was broken off at the atlas vertebra and removed intact for about threequarters of the body length, but it remained attached by the last lumbar vertebra to the pelvic girdle.

Pluming takes place when the hawk obtains a meal covered with either hair or feathers. The action consists of taking a beak-full of hair or feathers, ripping them off the animal and disposing of them with a short, sharp, sideways flick of the head. This action continues until a suitable area is cleaned for eating or gaining entry into the muscular tissue. This may constitute a whole animal as in the case of birds brought to the nest for feeding the young, or it may only be a few square centimeters as in the case of a road-killed opossum.

Closely associated with pluming is the removal of grass, leaves and sometimes soil from the food. The disposal of the offending matter is carried out in the same manner as with hair or feathers.

After the plucking has taken place and the skin is broken open, the hawk begins eating, but it does so in such a way that it removes all the meat from under the skin in the area of the opening and occasionally pulls it back, often ripping it. This has the effect of skinning the animal.

If the hawk is hungry when receiving food, or whenever its food is in jeopardy, it will assume a mantling posture (Fig. 8). This consists of raising its feathers, spreading and lowering its wings and tail and assuming a $\frac{3}{4}$-crouch position. At the same time the head is lowered and sometimes the mouth is opened. Also, on occasion, the hawk may emit a loud piercing scream, but this occurs only when an approach towards the food is made.

FIGURE 8: The mantling posture is commonly used in defence of food.

When eating, all hawks stand on their food. This enables them to exert an efficient leverage on the food enabling them to hold it steady while eating it. Tearing food consists of taking food in its bill and giving it a quarter twist of the head and an upward jerk all in the same motion. If the food is easily torn only the upward vector of these two forces may be used.

Evidence of the forces exerted by a hawk while tearing its food was observed one day after a dead rabbit had been in the mews with the hawk overnight. Next morning the skull had been broken into pieces, none of which were more than one square inch.

When eating meat, especially soft meat such as liver or kidney and even tissue that is more muscular, it occasionally becomes lodged on the upper palate or stuck on the tip of the upper mandible. This is removed by shaking the head violently, by hooking it off with its middle talon or with its tongue.

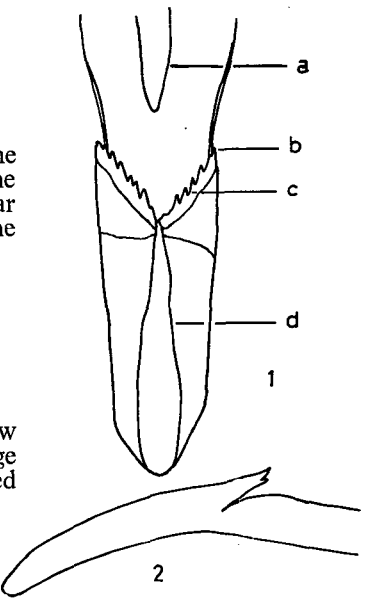


FIGURE 9: The two points and the serrated edge on the back of the hawk's tongue enable it to clear food off the palate or from the tip of the beak.

1. (a) opening to larynx
   (b) point
   (c) serrated edge
   (d) groove.
2. A tongue in position to show how the posterior serrated edge rises when food is being removed from the palate or beak.

The hawk's tongue (Fig. 9) is triangular in shape with the apex of the triangle forming the tip. The base of the tongue is serrated and has two prominent projections, one on either side, pointing towards the back of the mouth. When meat becomes stuck at the front of the mouth, the tongue is flicked forward and upwards and then drawn back in an attempt to catch the meat on these two projections or serrations and dislodge it by drawing the tongue back into the mouth.

After finishing its meal, the hawk begins to clean up. First it picks any remaining pieces of meat, no matter how small, off its talons, then it proceeds with a process known to falconers as feaking. This is simply a method of cleaning the beak by rubbing its sides and bottom alternately on anything that happens to be near such as a block of wood, the ground or even a rock. After this initial cleaning the hawk often dips its beak into water and then shakes it after removing it from the water.

Occasionally the beak must be cleaned while plucking food since the hair or feathers become stuck in the mouth. This is done in one of two ways, either by feaking or less commonly by raising one of its wings, inserting the head and beak under the wing, lowering the wing and then drawing the beak out thus removing the hair or feathers on the undersurface of the wing and on the body.

Another act that takes place during short pauses while eating, as well as after eating, is the controlled movement of food from the crop to the stomach. There are two ways of accomplishing this. The first consists of raising the head in an upward and slightly backward direction. The head and neck are both moved forward in this

raised position so that they come over the crop which is now trapped between the neck and the V-shaped furcula. The neck is lowered thus putting pressure on the crop and causing the food to be forced into the stomach. The second manner in which this is done is by a shrugging of the shoulders which raises the crop against the curved neck with the result that the food is again forced into the stomach.

(b) *Nestling*

A Harrier's nest was discovered in the Otapiri Gorge in Southland by Mr. Roger Sutton. It was observed by Mr. Sutton at least once and sometimes twice a week. The nest originally contained 6 eggs. Two chicks hatched on the 13th or 14th of November, 1967. Two more eggs hatched on the 18th or 19th of November, while the remaining eggs showed no signs of hatching. On the 26th of November the two older chicks and one of the younger ones were present while the other small one was missing. On the 4th of December only two large chicks and two eggs remained at the nest. The two eggs were cold and it is assumed that they were addled. Their measurements were 51.4 x 36.3 mm. and 48.9 x 39.4 mm. The eggs were absent when the chick was taken from the nest on the 11th of December. By this time the chicks were approximately 22 days old. The remaining chick was banded and left at the nest.

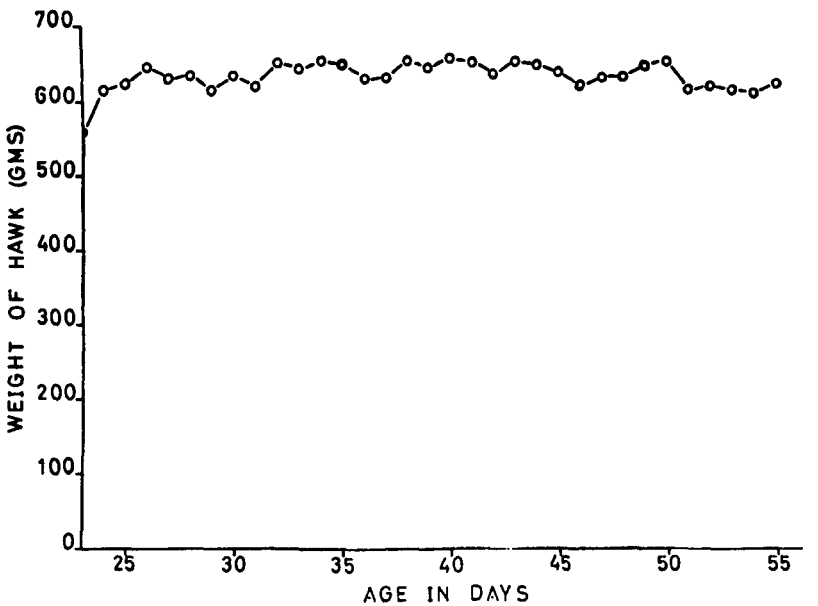


FIGURE 10: The daily weight of a 23 day old Harrier in captivity up to day 55.

Nothing further was seen of the two youngest chicks and it is assumed that they had both fallen victim to nest cannibalism. This is common among hawks and falcons but it contributes to their survival.

When the eggs are laid incubation usually begins with the second egg, and sometimes even with the first, thus any eggs laid after this will hatch proportionately later. This gives a staircase effect in the size of the chicks. The survival value comes at a time of food shortages. If the adults have been unable to capture sufficient food to feed the young properly, or if the adults are scared off the nest for a few hours, the larger and stronger birds will rip apart and eat the weaker ones. This extra meal increases the older chicks' chances of survival.

The chick was fed five times a day, the times being: 8 a.m., 11 a.m., 2 p.m. 5 p.m., and 10 p.m. The day's weight was taken just before the 2 p.m. feeding (Fig. 10).

On day 23 (the approximate age of the chick) the first weight was taken after a day's trip from Invercargill. During this day and the previous one the chick ate very little. This would account at least in part for the low weight at the time. There was no way of measuring the food consumed during these two days.

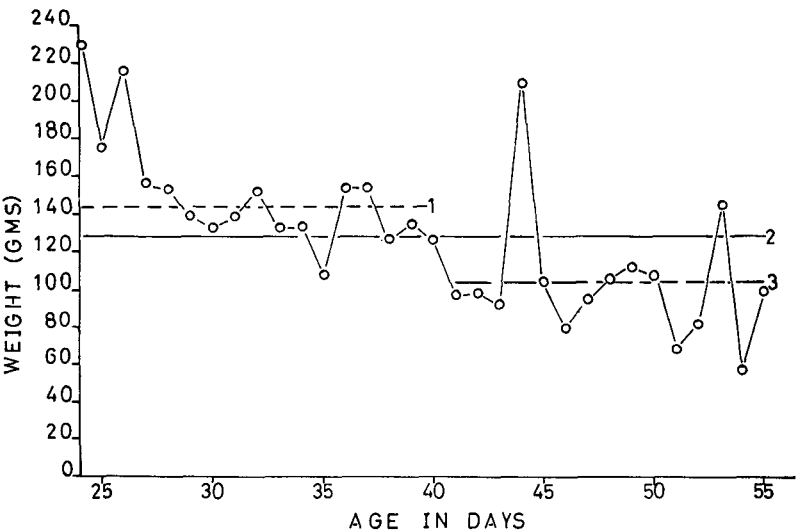


FIGURE 11: The daily food consumption of a young Harrier kept in captivity.

1. The average weight of food eaten up to day 40.
2. The average weight of food eaten during the study period.
3. The average weight of food eaten from day 41 until the completion of the study.

FIGURE 12: A young Harrier, 43 days old.

On all but two occasions, days 36 and 42, the chick was weighed just prior to its 2 p.m. meal. On these occasions, both feeding and weighing times were later. On day 29 the feeding times came two hours earlier than usual and the weighing was carried out at the regular time. This will probably explain, in part, the decrease in weight on day 29. On day 51 the chick received an injury to the right wing which caused him some pain, and probably caused some decrease in food consumption. On day 56 the injury was aggravated and no food was consumed. It was decided to end the study at this time since the bird seemed to be fully fledged.

It was found that the average weight of food consumed daily during this time was 128.8 grams (Fig. 11), while the chick's average weight was 635.0 grams. Before day 41, where the food graph drops to what appears to be about its final average judging from the results obtained from the adult hawk (whose daily food consumption in percent of the body weight was 15.4% per day) it required a daily average of 147.6 grams to support 635.4 grams of hawk. After day 41 it required only 104.3 grams to support an average of 635 grams of hawk.

	Average Chick Weight	*Average Food Consumption*	*Food Consumption expressed in terms of % of Bird's Weight*
Overall total	635.0	128.8	20.3%
To Day 40	635.4	147.6	23.0%
From Day 41	635.0	104.3	16.4%

The noticeable drop in food consumption beginning at approximately day 41 occurred at about the same time the hawk's feather growth appeared to be finishing (Fig. 12). Feather growth of this type, where all feathers are growing at once, takes a considerable amount of energy and to supply this energy the bird must eat more food than it normally would.

ACKNOWLEDGEMENTS

This paper forms part of an M.Sc. thesis at the University of Otago. I wish to thank the following for their help: Dr. K. E. Westerskov, of the Department of Zoology, University of Otago, for suggesting the topic and for supervising the project; Field Officers Messrs. R. Sutton, D. A. Kelly and C. Hughes, of the Southland, Otago and North Canterbury Acclimatisation Societies, respectively, for assistance with the collection of hawks; and the Council of the South Island Acclimatisation Societies for awarding me a research grant without which I would not have been able to complete the project.

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ARCTIC WADERS IN NORTHERN NEW ZEALAND SUMMER 1968 - 69

By A. T. EDGAR, H. R. McKENZIE and R. B. SIBSON

Of the thiry-two or so migratory arctic waders now on the New Zealand list, twenty were recorded in the northern harbours during the summer of 1968-69; and three other species were identified much further south, Grey Plover and Sanderling near Bluff (Notornis 16: 134), and Snipe at Taieri Lake. For this season no report from Farewell Spit has come to hand — a regrettable gap.

In the far north A.T.E. paid eight visits to Parengarenga Harbour between September 1968 and April 1969; and four more during the winter of 1969, so that information on this rewarding locality is fuller than ever before. The conversion of scratchy scrub-clad gumland into green pastures between Paua and Te Pua Pt. seems to have benefited rather than discouraged the waders, c.f. Notornis X, 92. Not only plovers and dotterels but also stints, sandpipers and the bigger long-legged waders have taken to frequenting the grassy paddocks.

Unfortunately no observations were made in Mid-Kaipara; but Jordan's farm, a few miles north of Kaukapakapa, well repaid the attention which it received. The Firth of Thames and Manukau Harbour were as usual under frequent scrutiny and produced their expected quota of rare visitors.

In this summary, no details are given for the two dominant migrants, Bar-tailed Godwits and Knots. As a matter of interest, summer census figures for the Firth of Thames and Manukau respectively were:—

Bartailed Godwit	12700 and 20641
Knot	4803 and 3981

To numerous contributors who supplied notes to supplement or verify our own, we gratefully acknowledge our indebtedness.

P. = Parengarenga in the vicinity of Paua and Te Pua Pt.
K. = Kaipara Harbour in the vicinity of Jordan's Farm.
B.O.I. = Bay of Islands.
M. = Manukau Harbour.
F.O.T. = Firth of Thames.

SPECIES LIST

PACIFIC GOLDEN PLOVER *(P. dominica fulva)*

P. 12 on 27/9/68; 57 on 13/10/68; c. 150 on 22/1/69; c. 200 on 23/3/69 and 7/4/69.

B.O.I. Parties visit Kerikeri Inlet on passage throughout the season, e.g. 8 in October; 16 in April, max. 25 in November.

M. (a) 7 11 from at least 7/1/69 - 22/3/69 at A.M.D.B. No. 4.
(b) Kidds Bay. 45 on 5/1/69 and 23/3/69; 84 on 19/3/69.

ORIENTAL DOTTEREL *(C. veredus)*

P. 31/8/69, 1 in fading plumage, either an early migrant or had overwintered.

LARGE SAND DOTTEREL *(C. leschenaulti)*

M. 1 at Kidd's seen often between 25/11/68 and 19/3/69.
F.O.T. 1 from 12/10/68 to 27/10/68; but not seen later.

LONG-BILLED CURLEW *(N. madagascariensis)*

P. 1 on 24/3/69; 5 over-wintering on 5/7/69; 4 on 20/7/69, 31/8/69 and 4/9/69.
B.O.I. Kerikeri Inlet. 1 on 7/9/68, 12/9/68, 13/1/69, 3/4/69.
K. 1 at Jordan's on 11/1/69.
M. 1 at A.M.D.B. No. 4 on 7/1/69.
F.O.T. 17 on 28/12/68. 27 on 23/2/69, the biggest flock recorded in the North Island; but bigger flocks occur at Farewell Spit. 25 on 9/3/69. Only 3 are known to have over-wintered, viz. 3 on 6/7/69, 3/8/69.

ASIATIC WHIMBREL *(N. phaeopus variegatus)*

P. 9 on 27/9/68; 1 on 22/1/69; 2 on 9/3/69, most likely of this form.
K. 16 at Jordan's on 11/1/69, the biggest flock so far recorded in the North Island.
M. 1 at Tararata Ck. on 15/10/68; 1 at A.M.D.B. on 27/10/68 (sub sp. ?)

AMERICAN WHIMBREL *(N. phaeopus hudsonicus)*

P. 2 on 13/10/68 and 25/11/68. 1 on 23/3/69.
Clevedon. 1 at Mataitai on 29/9/68 (Notornis 16: 64).

HUDSONIAN GODWIT *(L. haemastica)*

P. 1 on 25/3/69.
M. 1 at A.M.D.B. No. 4 at least from 1/10/68, when it was very tired, to 27/10/68. 1 over-wintering on 19/8/69.
F.O.T. 1 at White Bridge on 13/10/68 (S.C.).

ASIATIC BLACK-TAILED GODWIT *(L. limosa melanuroides)*

P. 2 on 5/7/69, over-wintering. 3 on 20/7/69. 2 still present on 4/9/69.
F.O.T. Miranda 2 from 22/10/68 to 7/4/69; also 2 on 6/7/69 over-wintering.

GREENSHANK *(T. nebularia)*

P. 2 on 27/9/68, 13/10/68, 25/11/68; 1 on 22/1/69; 3 on 24/3/69; 4 on 7/4/69. 3 at Houhora on 2/3/69, possibly the same birds.

MARSH SANDPIPER *(T. stagnatilis)*

M. 1 at A.M.D.B. No. 4 at least from 11/2/69 to 18/9/69.

SIBERIAN TATTLER *(T. brevipes)*

P. 1 on 25/11/68. 5 on 24/3/69, probably of this species; and again on 25/3/69; 3 in a tight bunch, length of nasal groove seen; but 2 were not closely observed (A.B.). 1 on 5/7/69 over-wintering.

COMMON SANDPIPER *(T. hypoleucos)*

B.O.I. 1 appeared and fed at a wader roost in Kerikeri Inlet on 20/3/69 (Notornis 16: 202-203).

TEREK SANDPIPER *(Xenus cinereus)*

P. 1 on 25/11/68.
K. Jordan's. 1 on 11/1/69 and 5/4/69.
M. (a) Kidds. 1 on 5/1/69.
(b) 1 at A.M.D.B. at least from 8/3/69 to 4/4/69.
F.O.T. 1 from 12/10/68 to 26/11/68; 2 from at least 29/12/68 to 9/3/69.

TURNSTONE *(A. interpres)*

P. c. 150 in Sept.; c. 300 in Oct.; Dec. c. 50; Jan. c. 265; c. 450 on 9/3/69; c. 600 on 23/3/69; c. 700 on 7/4/69; 8 on 5/7/69 and 20/7/69.
M. Karaka. 50+ on 28/10/68; 200+ on 25/11/68; 145 on 22/12/68; 260 on 19/3/69; 120 on 22/3/69; 10 on 1/6/69 over-wintering.
F.O.T. 20 on 9/10/68; 25 on 12/10/68; c. 60 on 10/11/68; 25+ on 23/2/69.

SHARP-TAILED SANDPIPER *(C. acuminata)*

P. 1 on 25/10/68; 6 on 25/11/68; 15 on 26/12/68. 1 on 22/1/69. 6 on 9/3/69. 11 on 24/3/69. 3 on 7/4/69.
M. (a) A.M.D.B. No. 4. 1 from 11/2/69 to 8/3/69; 3 on 22/3/69 and 4/4/69.
(b) Kidds. 1 on 29/11/68; 1 on 23/3/69.
F.O.T. 2 on 10/11/68. 14 on 24/11/68. 4 on 29/12/68. 2 on 23/2/69 and 9/3/69.

PECTORAL SANDPIPER *(C. melanotos)*

M. 1 at A.M.D.B. on 13/11/68.

CURLEW SANDPIPER *(C. ferruginea)*

P. 3 on 27/9/68; 4 on 26/12/68; 2 on 9/3/69, 24/3/69 and 7/4/69.
F.O.T. 3 on 24/11/68. 9+ on 10/1/69. 6+ on 23/2/69. 5+ on 9/3/69.

RED-NECKED STINT *(C. ruficollis)*

P. 5 on 27/9/68; 20 on 25/10/68; 18 on 9/3/69; 54 on 23/3/69; 31 on 7/4/69; 10 on 20/7/69, over-wintering.
M. At Kidds. 8 on 28/10/68; 13 on 25/11/68; 11+ on 5/1/69; 17 on 1/2/69 and 9/2/69; 10 on 23/3/69; 8+ on 27/3/69. (If a reported count of 41 on 9/11/68 is correct, it may mean that a southbound flock paused as it passed through. No such numbers were found on any other date.)
F.O.T. 4 on 9/10/68; 12 on 27/10/68; 15 on 10/11/68; 19 on 14/12/68; 16+ on 23/2/69; 13+ on 9/3/69.

BROAD-BILLED SANDPIPER *(Limicola falcinellus)*

F.O.T. 2 on 10/1/69 and 23/2/69; 1 on 9/3/69.

NANKEEN KESTRELS IN NEW ZEALAND

By A. T. EDGAR and P. GRANT

SUMMARY

Occurrences of the Nankeen Kestrel in New Zealand are listed; field notes on Kestrels seen in 1969 are given in some detail.

INTRODUCTION

The Nankeen Kestrel *(Falco cenchroides)* is native to Australia and Tasmania. The word " Nankeen " does not refer to its geographical origin but to the colour of its plumage. Nankeen was the name given to a kind of cloth originally made of naturally yellow cotton in Nanking (China); trousers made of this material were known as Nankeens.

Outside Australia, Nankeen Kestrels have bred on Lord Howe Island and occur as stragglers in Norfolk Island and New Zealand. A Field Guide to the Birds of New Zealand (Falla, Sibson and Turbott, 1966) mentions only eight reports, five in North Island, three in South Island. Unpublished sight records from the files of O.S.N.Z. Recording Scheme bring total reports for the period 1889 - 1965 to fifteen. In 1969 reports of kestrel sightings have been received from nine separate localities, in North and South Island. References to the species in *Notornis* are brief and scanty; the purpose of this paper is to summarise past reports and place on record 1969 sightings.

P.G. describes the 1969 Westland bird in detail and discusses plumage changes, with references. Field observers may have problems in determining age and sex of birds sighted, but should as far as possible try to record all relevant details. Dates of sightings plus reasonably accurate descriptions of birds seen in different localities will help to indicate whether reports refer to different individuals or to single birds which may wander widely after their arrival in New Zealand.

OCCURRENCES IN NEW ZEALAND, 1889 - 1965

Buller (Trans. N.Z. Inst., Vol. 28, page 359, 1895) records a female, shot by Mr. E. C. Studholme at Waimate, Canterbury, about 1889 and another female shot on 6/4/95 at Portland Island by the lighthouse keeper, Mr. J. R. Dickson. This is presumably the adult female preserved as a mounted specimen in Dominion Museum (locality Portland Island, no date). The Waimate bird " was amusing itself by chasing the common hawks away from the carcase of a dead sheep." The Portland Island bird was " very fat; its crop contained crickets and grasshoppers. The iris of the eye was very dark brown, pupil black. It was very shy when perched, but not so on the wing."

Mr. E. B. Jones reports an unconfirmed sighting in Rimutaka Range on 27/11/27. He had climbed up from Orongorongo River to a saddle just north of Mount Mathews and while looking over towards the Wairarapa saw a small bird of prey flying slowly over the trees and looking down on them, tail well spread. The bird flew towards the ridge on which he was standing and veered to one side when only about a chain from his point of observation. He

describes it as no bigger than an ordinary pigeon, light sandy colour above, light coloured underparts, dark streak on face. (Length of Rock Dove, 13 inches; adult Kestrel, 12-14 inches; Bush Hawk, 16-19 inches).

An adult male, preserved as a mounted specimen in Canterbury Museum, was shot by Richard Basset on 24/7/28 at Burnt Hill, North Canterbury. Oliver (1955) lists eight occurrences including West Oxford and Burnt Hill. Checklist of New Zealand Birds (1953) mentions West Oxford (1928), but not Burnt Hill. Perhaps the West Oxford and Burnt Hill records refer to the same bird, or there may have been a sight record before the bird was shot.

Mr. R. H. D. Stidolph (O.S.N.Z. Reports and Bulletins, p. 16) reports a bird at Castlepoint, Wairarapa, May 1936. In Dominion Museum there is a mounted specimen, adult female, locality Castlepoint, no date.

Oruawharo, Kaipara, winter 1942: " Size and colouring described leaves little doubt of identity; pretty habit of hovering for some time, then darting away. It was about for several weeks in open farm and scrub country where there is little bush." (H. R. McKenzie, N.Z. Bird Notes I, 25).

Near Masterton, July 1942, " an exact description given to me by a soldier." (R. H. D. Stidolph, N.Z. Bird Notes I, 25).

Wellington, " adult hunting sparrows and pigeons on and around Memorial Carillon for about a month from 20/4/48." (R. A. Falla, N.Z. Bird Notes 3, 206). Dominion Museum, mounted specimen, adult female, locality Wellington, 2/6/48.

Wellington, May 1950, sight record (F. C. Kinsky).

Bruce Bay, Westland, 16/5/56, unsexed ? juvenile, skin in Dominion Museum.

Mr. E. B. Jones reports two further sightings. On 8/2/57 as a bus in which he was travelling from Wellington city to Ngaio started to climb Kaiwharawhara Gorge he saw a small bird of prey flying over the stream and below eye level; it must either have been hovering or flying very slowly because the bus overtook it. Colour of upper surface something between rufous and cinnamon; tail appeared broadly barred rufous cinnamon and white (this impression may have been created by presence of broad white tips on the tail feathers). On 20/9/61, driving from Levin to Ngaio, Mr. Jones had just seen a harrier over flat land on his right and on looking ahead saw a much smaller bird flying slowly and hovering over the roadside ditch on his left. It was facing him and had its wings held straight out and its feet hidden in the long grass. As the car passed it he noticed the small bird of prey face, upper surface " gingery," under surface light colour with some streaks on the breast. Mr. Jones consulted Dr. Falla after the 1957 and 1961 sightings and also examined museum specimens; he is reasonably sure that his identifications are correct.

About 1957 Mr. Jock Morrison saw a Kestrel near the west coast of Northland, south-east of Ahipara and south of Reef Point. It was hovering over the sandy hills and appeared to be feeding on insects.

Mr. G. A. Tunnicliffe reports a sighting in October 1962 at Mount Harper Station in Lees Valley, mid-Canterbury. While forcing his way through a burnt out patch of *Cassinia fulvida* on Mount John

he saw a bird which appeared similar in size to a Bush Hawk but distinctly different in colour. A feature which particularly attracted his attention was the bird's ability to hover almost motionless in the air; on one occasion it dropped 20 yards from a hovering position to the ground and rose again holding what appeared to be a lizard in its talons. It was a hot calm day and a number of skinks had been seen scuttling across the ground. Mr. Tunnicliffe notes that skinks are abundant in two other Canterbury localities from which Kestrels have been reported and suggests that perhaps these creatures form an important item of diet for Kestrels reaching New Zealand. He had a good sighting of the bird at ranges down to about 15 yards and describes the upper surface as a pale coffee brown with grey rump and back, outer surface of wing tips dark brown, forehead and sides of face dirty white, undersurface light buff streaked with black on breast and sides, feet orange yellow.

In April or May 1965 Mr. B. Cooksey and Mr. C. Evans, of Dargaville, were working near Matakohe, near the north end of one of the arms of Kaipara harbour. They observed a Kestrel, which attracted attention by its hovering habit, " off and on all day."

LORD HOWE ISLAND

Mr. K. A. Hindwood, writing to P.G., says: " It may be of interest to your notes that the Kestrel now occurs on Lord Howe Island and apparently breeds here. It was seen recently (1969) and you will find some remarks in *Emu*, Vol. 50, p. 29." The relevant extract, taken from Notes on Birds of Lord Howe Island (Hindwood and Cunningham) reads as follows: " Writing to Captain J. D. McComish on April 18, 1944, Max Nicholls stated, ' a pair of small kestrels lived on Mount Eliza for a long time and have now increased to five, so it looks as if they made their nest in one of the hollow trees. When they are stationary in the air they have been mistaken for aeroplanes several times.' It is more likely that the birds nested in the cliffs nearby. The Nankeen Kestrel was seen on the island on several occasions during August 1949, by Cunningham."

NORFOLK ISLAND, 1969

Mr. K .A. Hindwood, writing to P.G., quotes a letter from George Southwell, Norfolk Island, to John Disney, Ornithologist, Australian Museum, Sydney, as follows: " One of our members, who used to live in the Mallee of Victoria, told me he had seen a Nankeen Kestrel. He described it to me in detail. Several others saw it, too, then about a month later Pat Gosling came in to tell me he had seen a Kestrel." Mr. J. L. Kendrick, Wildlife Division, Department of Internal Affairs, Wellington, reports that Mr. Gosling gave the date of this sighting as 28/6/69.

NEW ZEALAND, 1969

NORTHLAND

Whangarei

On 6/4/69 Mr. W. Stacey, Department of Agriculture, observed a Kestrel near his property of Onerahi, south-east of Whangarei. The bird flew fast, stopped in mid-air and hovered, dropped vertically to the ground, rose again, flew, hovered and flew on till he lost sight of it. He noted its generally rufous upper surface, pale under-

parts and pointed wings. Mr. Stacey has known the European Kestrel since his boyhood in England and had no doubt about the identification.

There is a further report of a bird seen near Whangarei Heads in July 1969 which, from the description, was probably a Kestrel.

Okaihau

On 12/4/69 a Kestrel appeared on a farm belonging to the Brothers Candy, situated on Puketi Road in Okaihau district, not far from the south-east corner of Puketi Forest. The Candy property has a grassed plateau alongside the road, falls away to a deep valley, part of which had been cleared and was being sown to grass at the time of the Kestrel's appearance, and rises again to bush-clad slopes beyond the valley.

At first the Kestrel's hunting area was restricted to the deep valley, where for a time it was seen daily. It then began to hunt over the plateau and adjoining farmland and as time went on ranged further afield, returning to the Candy farm at intervals though absent for increasing periods of time. One day in early August, after a long absence, it flew over, dived on a farm dog as might a magpie, and flew away again. It was still present in the area on 12/9/69.

The field notes which follow are the result of short periods of intensive observation by A.T.E., plus much information on behaviour for which I am indebted to the Candy brothers, who watched the bird closely during the early part of its stay and on its subsequent visits to their farm.

A favourite perch in the early stages was a broken limb of a dead puriri standing on the steep slope above the valley; to this perch the bird returned after each hunting or exercise flight. Later it became more catholic in its choice of perch and was seen to land on another dead puriri, on a pine, and sometimes on tree-ferns or on quite low bushes; occasionally on power poles and wires but not on houses or farm buildings. In windy weather the bird perched head to wind, body near-horizontal; in still weather it adopted a near-vertical stance. It was not at all shy and took no notice of an observer sitting on the hillside a few feet from the base of its perch.

At times it indulged in high circling flights over the plateau, wing beats sometimes fairly rapid, often more leisurely with periods of gliding. At the conclusion of this type of flight the bird would drop to its perch on a long slant. Fast horizontal flight low over the paddocks was observed on a number of occasions, also a swift " power dive " as if in pursuit of prey. Normal hunting flight was a combination of fairly rapid wing beats, occasional short glides, and hovering head to wind; the sequence was repeated again and again as the bird worked over the hunting area. When a fresh wind was blowing the flying bird would stop in mid-air and hover with hardly a movement of its outspread wings and little or no tail spread. In gentler winds hovering was achieved by some rapid fanning of the spread wings and some rudder movement of partly spread tail feathers. In still conditions the wings were winnowed rapidly and the tail spread and depressed. This hunting flight took place at levels from up to 60 feet above the ground to just over the bushes and grass. From the hovering position the bird would drop almost

vertically to the ground, or often merely to a lower level where it would hover again or continue its forward movement; in some flights there would be several such downward adjustments of altitude. After each drop to the ground the bird rose again and continued its patrol.

In April the valley bottom was alive with crickets and these probably formed the major portion of the Kestrel's food supply at this time. Later on the plucked remains of Silvereyes were found on several occasions on the Kestrel's hunting ground.

During the early part of its stay the Kestrel resented the presence of a Harrier which invaded its hunting area and drove the Harrier off by a vigorous aerial attack. No feathers flew, but the two birds produced a spectacular display of harassing tactics and avoiding action. Later on the Kestrel developed a tolerance towards the Harrier and both birds hunted in the valley without incident. A small flock of Greenfinches was seen to rise off the ground and make a pass at the Kestrel which did not attack them.

Field description: Slender body, pointed wings, longish tail. Upper parts cinnamon, feathers of the back with blackish central markings; rump more rufous; tail cinnamon-rufous, barred blackish, the terminal bar broader than the others and the tips of the tail feathers pale, almost whitish. Upper surface of wing quills darker brown, in flight and when folded. Chin, cheeks and throat buffy

FIGURE 1

[K. A. Hindwood

Imm. Ad. ♀ Ad. ♂ Imm. Ad. ♀ Ad. ♂

white, with a blackish malar stripe like a drooping moustache. Rest of underparts very light yellowish-buff to whitish, faint brownish striping on breast; underside of wings and tail whitish, extreme tips of wings dark, and a dark bar showing on the underside of the tail near the tip. Iris dark. Bill blackish, cere yellow. Feet orange yellow.

As there was no trace of grey on the upper surface this bird was not an adult male and was either a female or immature. The amount of barring on the tail may be an indication of immaturity but the streaking on the breast was by no means prominent and I am inclined to regard the bird as an adult female. It is interesting that the moustachial stripes which in this bird were a noticeable field character are mentioned as such and figured in some books, but hardly mentioned or omitted in other accounts.

Kaitaia

Mr. Ross Michie informs me that a Kestrel was seen on 6/5/69 at Reservoir Hill, Kaitaia, and in the same month at a point about a mile south of Kaitaia township.

Cape Reinga

Mr. E. D. Willis (Auckland) saw one (possibly two) Kestrels near the lighthouse in August 1969. He describes how the bird hovered, almost stationary except when buffeted by gusts, in a wind speed estimated at 20-25 knots. Several times during an hour of observation he saw it plummet down at great speed. At one time it perched within 60 feet of him, but against the sun; apart from the generally rufous colour of the upper surface no details of plumage were recorded. I visited Cape Reinga on 31/8/68; the Kestrel was not on view but a member of the lighthouse staff stated in conversation that he remembered seeing it on four occasions during the previous three months, flying, hovering and perching near buildings, on posts and once on a clothes line near his house. Locusts, field-mice and lizards are plentiful in this area.

HOBSON COUNTY

Mrs. M. Barron sends a report of a Kestrel first sighted near Poutu (North Kaipara Head) in late May or early June 1969. In early August it was "stunt flying" near two Harriers, and later perched within 15ft. of Miss Barron. Small birds showed some agitation at its presence. Reports indicate that the bird was still in the area in October 1969.

About 40 miles further north Mr. C. Evans, who saw the Matakohe Kestrel in 1965, reports two sightings; one in the first week of June at Waihue, 11 miles north of Dargaville, and the other in the same river valley but 2 miles north of Dargaville in mid July, 1969.

VOLCANIC PLATEAU

Mr. D. Bartram (Forest Service) reports sighting a Kestrel on the afternoon of 5/8/69 on the south-west edge of Kaingaroa Forest which at this point is bordered by rough scrub and grazing land. A strong S.W. wind was blowing at the time with gusts up to 25 - 30 knots. Two Harriers coursing over the rough ground nearby were buffeted and blown off course by the wind. The Kestrel hovered motionless about 70ft. above the forest margin for three minutes,

timed by watch, then dropped rapidly about 50ft., moving forward 100ft. in the process; hovered again for 1½ minutes, then veered off to the south-west over the Reporoa escarpment, moving at very high speed. Seen at a range of 70 yards through 7 x 50 bincoluars, it is described as having pointed wings, wing span estimated about 15 inches, upper surface rusty red to light brown, under surface almost pure white, legs yellow.

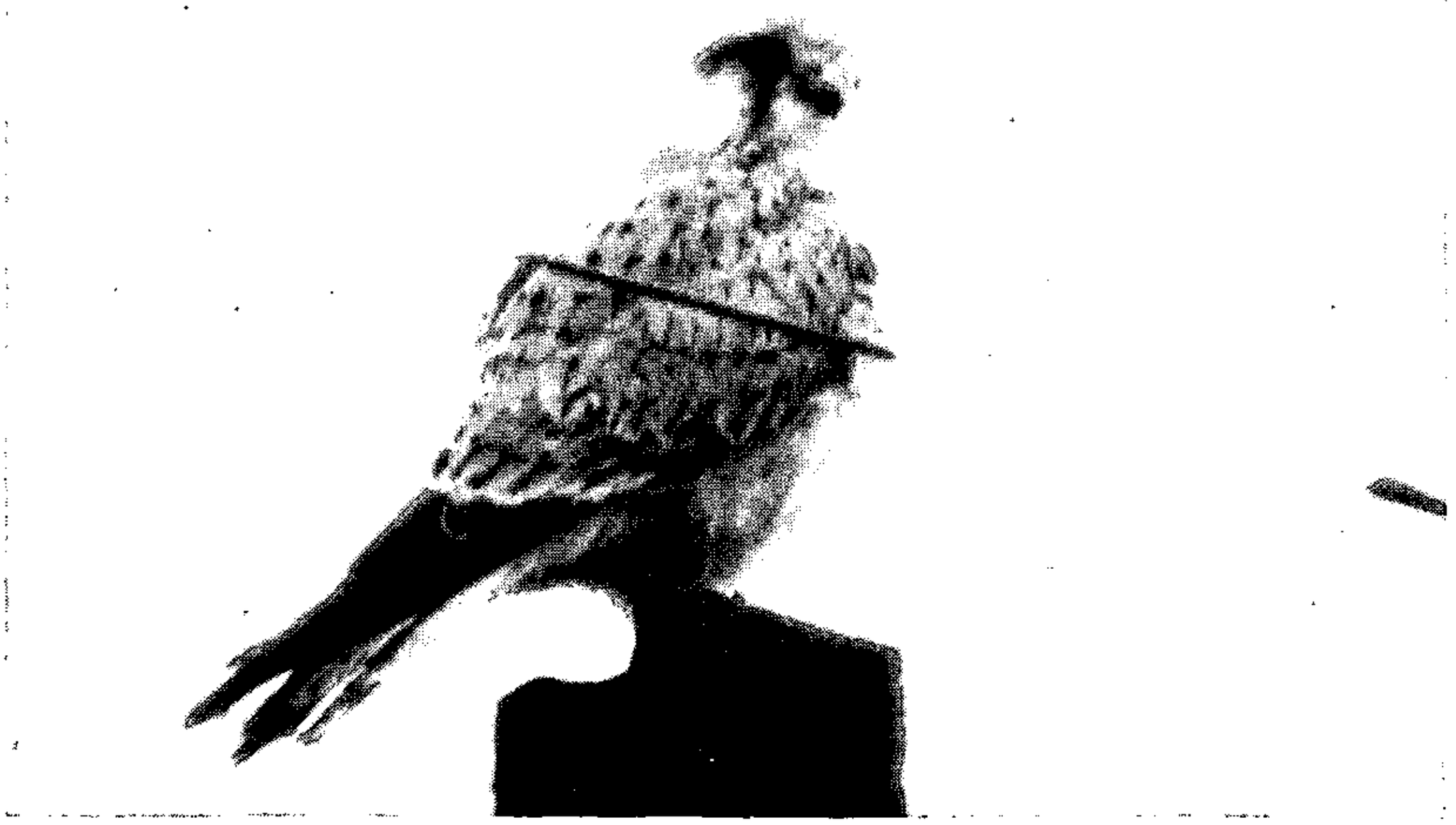
Dr. Jancarek (Czechoslovakia), temporarily at the Forest Research Institute, also saw a Kestrel while driving through Kaingaroa to Murupara.

CANTERBURY

Mr. P. M. Sagar and others observed a Kestrel in sheep farming country on Rangitata Island on 16/8/69. The day was fine and mild, with a slight easterly wind; for a fortnight prior to the sighting winds had been north-westerly. During the period of observation the bird spent much time perched on power poles. Hovering was recorded on several occasions. The Kestrel flew round and hovered over a rabbit sitting in a paddock, landed a few feet in front of the rabbit but soon flew to a neighbouring power pole; the rabbit then sought refuge in a gorse fence. Seen through 8 x 30 binoculars at distances up to 80 yards, the Kestrel is described as about 15 inches long, wings long and pointed, tail long, straight, slightly rounded at tip; upper surface light brown, primaries darker; tail grey/brown; underparts white, rump appeared white. Colour of bill and feet not recorded.

I am grateful to all those who have sent information on sightings, and to Messrs. Kinsky, Scarlett, Sibson and Turbott for valuable help in preparing these notes.

— A.T.E.



[Peter Grant

FIGURE 2 — Nankeen Kestrel at Hokitika, April 1969

WESTLAND

Mr. G. S. Cook of Kaihinu, a few miles north of Hokitika, rang me on 14th April, 1969, to let me know that he, his wife, and some members of his family had seen an unusual form of hawk about the paddocks by the Hokitika abattoir. From the description of its behaviour I assumed that it was a Nankeen Kestrel and this was confirmed by Mr. R. D. Veitch the same day. Master Noel Ward, of Hokitika, and myself joined in observations until the last confirmed sighting of the bird on 20th April. Information has been built up from observations from all people mentioned, the bird being seen mostly while perched on fence posts or railway telegraph poles adjoining the paddocks. Some observations were made while the bird perched on a dead tree or tombstones in the Hokitika cemetery on a nearby river terrace.

Close observation was made in good light in the cemetery while the bird made a very thorough job of preening, the telescope on 36X, 50X, or 75X as required for various details. The tail, owing to rapid preening movement, was difficult to observe, and the rump was not seen then. Notes were as follows:— Bill compact, black tip, blue grey at base, top of bill at nostrils lemon-pale brown; eye rings pale lemon; eye dark; top head light brown streaked with black across the nape; two lighter patches — yellowish — on each side of the nape; main coverts cinnamon with black streaks and barred black towards the extremities; pale strip around end of primary coverts; primaries black; face below eye grey with dark patch; under surface basicallv white with cream tinge faintly marked with brownish longitudinal streaks; buffish collar in front of neck; tail on top rufous or cinnamon barred black — thin transverse bars at wide intervals until near tip where broad black band adjoined faintly discernible white tip; under-tail greyish faintly barred black; legs and feet yellowish; claws dark. In flight the bird appeared to be white underneath with a band of black near the tip of the tail, the upper surface gingerish or light tan with the dark primaries contrasting sharply. Length about twelve inches.

In general, the bird behaved much like the bird reported from Okaihau. Some additional features follow. One afternoon when Harriers *(Circus approximans)* were flying high a soaring flight took place. Without any apparent wing movement a height of perhaps above 1,500 feet was attained very rapidly while we watched through binoculars and I heard a very high pitched rapid call not familiar to me but birds calling in nearby scrub made it difficult to locate the direction from which the unfamiliar call came. It may well have been the Kestrel. I thought the bird was about to depart but it dropped quickly by half shutting its wings, swooping upwards to lose momentum, then hovering again. Only once did it appear to go into a dive but this did not last long. The main food supply appeared to be from two sources. The first was a very large caterpillar which was carried from the ground to a convenient post in a claw and torn off bit by bit, the body juices being seen as they dripped to the ground. The second was mice. After capture mice were carried to a post and fur would fly while they were being eaten. Hindquarters then tail went down last. However, mice were not always eaten immediately. They were at times stowed

[Peter Grant

FIGURE 3 — Nankeen Kestrel at Hokitika, April 1969

in crevices in the tops of posts, then eaten later. Heads may be removed at this stage. On one occasion the bird was carrying a mouse in its claw and as it flew bent its head down to deal with the mouse. At times the bird rested with puffed up breast feathers and on one occasion bobbed. It did not seem disturbed when harried by Black-billed Gulls *(Larus bulleri)* but continued soaring.

Photography proved difficult as the bird was very wary of any close approach and normally faced head-on, thus making observation of the tail and rump most difficult. Exentually some passable colour transparencies were obtained using a 350mm. lens with two 2X tele-extenders on a 35mm. camera. If more time had been available 'planted mice' near a hide may have brought better opportunities for photography and clearer pictures. However, one shot of the bird on a well weathered but square post allowed a reliable calculation of its length to be made.

There was no doubt that this bird was a Nankeen Kestrel. The problem was to decide whether it was immature, adult female, or adult male. Information was sought from Mr. K. A. Hindwood of Sydney, Australia, who kindly prepared and made available colour transparencies of study skins he arranged specially in the Australian Museum and also black and white photographs. In addition he supplied extracts from various sources and also notes from his own special study of skins. These are submitted in detail so that all interested members may have the opportunity of getting information which normally would be available to very few and they also perhaps provide us with some idea of the deep waters into which we may unwittingly slip. Surely a case where 'ignorance is bliss.'

1. Description of immature bird taken from North, A. J. Nests and Eggs of Australian Birds, vol. 3, 1912, p. 290.

'Young birds resemble the adult female, but have the feathers of the rump and upper tail-coverts rufous, which together with those of the lower back have blackish sagittate markings in the centre; tips of all the quills pale rufous, passing into white on the extreme edges, scapulars, greater wing-coverts and innermost secondaries rufous, with broad blackish cross-bars; tail feathers rich rufous, more broadly barred with black, and with large whitish tips washed with rufous; head and hind neck and upper back light rufous, streaked with black more broadly on the latter; chin, cheeks and throat white, with a blackish malar stripe; remainder of the under-surface dull white, with narrow blackish shaft-stripes, the foreneck, upper breast and sides of the body pale cream washed with warm buff; under tail-coverts dull white; under wing-coverts pure white. Total length 10.5 inches.

Length of adult male given as 12½ inches in the flesh. Adult female 13½ inches in the flesh.

K.A.H. commented: 'I doubt whether it would be possible to tell a well-grown immature bird from an adult female in the field; though an immature bird could have a shorter tail.'

2. Plumages of Nankeen Kestrel, described by Gregory M. Mathews. From Mathews, G. M. Birds of Australia, vol. 5, part 3, May 1916, pp. 291-2.

'The examination of a series leads to the conclusion that plumages have not been understood, as I find male and female in every stage yet recorded. I can see four stages.

FIRST. Heavily spotted plumage; spots black, ground colour cinnamon-brown. This plumage is apparently carried only for a short time, as it is comparatively rare in collections.

SECOND. Common plumage. Birds breed and it constitutes three-fourths of specimens secured. The spots give place to narrow shaft-streaks and smaller and fewer arrow-shaped markings on back; upper-tail coverts begin to come blue-grey; striping on under-surface deteriorates; the bars on the tail decrease in size from the base.
This is usually recorded as adult female plumage, but many breeding males show it.

THIRD. The upper-surface becomes more uniform and the tail loses the barring, but the head remains unchanged. This is recorded as adult male, but females also appear in this plumage.

FOURTH. Very old birds. Tail colour previously cinnamon is replaced by grey, save for sub-terminal band of black with white tip; all the black markings on upper-surface disappear and the head becomes blue-grey with black shaft-lines. Black streaks irregularly lost from under-surface, sometimes being retained after the head has changed to bluish; in other cases all gone, though head not fully changed. A. J. North (Nests & Eggs, Australian Birds) records this plumage as 'Adult males, probably very old birds,' but I have also females in this stage.

K.A.H. commented 'Mathews' material is now in A.M.N.H. (New York). I do not know where his data on 'breeding' birds (SECOND STAGE) came from.'

3. Examination of Kestrel specimens in Australian Museum, K. A. Hindwood, 20th July, 1969.

Immature. Upper-parts cinnamon (deeper than in most adults). Crown and nape prominently streaked; back well marked with black; underparts buffy-white, prominently streaked. Tail-feathers well barred with black and with a broad black band near tip.

Adult females. Upperparts cinnamon, head finely streaked (finer than in immature birds). Underparts not so extensively nor so heavily streaked as in immature; also black back markings not so pronounced as in immature; central tail feathers cinnamon with little or no barring; in most cases upper tail-coverts cinnamon but in two instances some grey present and in one of these cases extending on to central tail-feathers which have a broad black band near the tip.

Adult male. Head more finely streaked than in female and crown feathers in most specimens dull grey, though one or two have dull cinnamon crowns. Back colour in most instances a little darker than females, the markings therein not so prominent and in some instances almost absent. In most cases the underparts are somewhat less streaked than in females. Upper tail-coverts and central tail-feathers mostly grey with a broad black band near the tip.

Generally females are larger c. 14 inches (about one inch or so) than males c. 13 inches but one male at least is, or appears to have been as large as a female. Immature birds are much the same as the 'Westland bird,' that is c. 11 inches in length.

None of the skins examined was of known age.

The fact that the Westland bird was heavily marked on its upper parts and showed a number of bars on its tail pointed towards its being an immature bird, and the length as calculated very closely at eleven inches confirmed this. The tail feathers appeared worn at the tips, and showed only the faintest suspicion of white tip in some photographs, so that the white tip if present may not always be seen readily in the field.

Perhaps Australian bush fires provided us with an interesting exercise in Nankeen Kestrels, but whatever the reason for their visit, I am left with a very strong feeling that detailed field identification — immature, adult female, adult male — may be very difficult in view of the overlapping plumages.

I acknowledge with deepest thanks the help Mr. Hindwood has so promptly and generously given — photographs, reference materials, his personal description of study skins, his comments, and his reading over these notes.

— P. GRANT

SHORT NOTE

SOME SIGHTINGS OF LIGHT-MANTLED SOOTY ALBATROSSES

The following sightings of *Phoebetria palpebrata* were made about the coasts of the South Island during June, 1969.

1. 9/6/69 N.E. of Banks Peninsular in position 43° 35′ S 173° 5′ E; wind South 18 kts; Air temp. 47° F; sea 50°F. 1 bird which flew about ship for half an hour.
2. 15/6/69 Between 46° 20′ S 166° 40′ E and 45° S 166° 55′ E, that is from south of Puysegur Point to north of Doubtful Sound; Wind N.W. 60 kts, to W.S.W. 30 kts. Mean air temp. 46° F; Sea temp. 54° F.
   4 birds followed ship throughout hours of daylight.
3. 16/6/69 Off Greymouth in position 42° 50′ S, 171° 07′ E. Wind S.W. 60 kts; Air temp. 44° F; Sea temp. 54° F.
   1 bird about vessel throughout day.
4. 17/6/69 Position as in (3). Wind S.W. 35 kts. Air temp. 48° F; Sea 54° F.
   1 bird throughout day. This could well be the same bird as in (3) above but there is no certain evidence.

Whilst these Albatrosses are sometimes found washed up on beaches as far north of 36° S, they are not often reported from about the coast. Prior to these observations, during the past thirteen years I have seen only one about the New Zealand coast and that well off the Auckland west coast eight years ago.

I had never before been in the position of (2) above but have been in the other positions on very many occasions.

An interesting comment on the colouration of these birds was provided by one of the crew who reported seeing a "Siamese" Albatross following the ship.

— JOHN JENKINS

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LETTER

Sir,

Dr. Fleming's note on RATS AND MOA EXTERMINATION is interesting and thought provoking. However, having handled, probably, more bones than most people of Moa, both midden bones and those from swamps, caves and sandhills, I am still of the opinion that the chief cause of Moa extinction was the greatest predator of all, Man. It took him several hundred years to exterminate them. This applies particularly to the larger Moa.

In the South Island, one of the small Moa, *Megalapteryx,* survived at least until late last century, if the bird described by the late Mrs. Alice McKenzie in "Pioneers of Martins' Bay" was a bird of that genus, as I believe it to have been. Before I read her book, I heard Mrs. McKenzie's vivid radio description of the bird.

There is also some evidence that *Anomalopteryx didiformis* survived until comparatively recently, say, at a guess, 200 years ago, and possibly much later. This opinion is based on the finding of

bones of this bird, in good condition, in exposed positions, where if they had been much older, the weathering should have been considerably greater. It is probable that some of the small North Island species survived for some time after the last of their larger brethren had perished. Obviously, I cannot go into all the evidence in a letter.

Aptornis and *Cnemiornis* are very rare in midden deposits — finds of *Cnemiornis* indeed are rare in any case — and one would suppose that these two birds would be easily caught by Man. Present evidence suggests that few of them were present when Man arrived in New Zealand, accompanied by *Rattus exulans*. That the latter was capable of very sharp and intensive gnawing indeed is shown by many midden bones.

At present I know of no evidence that rats had reached New Zealand before Man arrived, and they therefore cannot have played a part in the destruction of the birds which seem to have vanished before the first Polynesians reached these shores.

However, the new evidence presented by Dr. Fleming cannot be ignored and must be considered as a possible factor in the lamentable disappearance of some of our birds.

— RON SCARLETT

Canterbury Museum
Christchurch

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References: If listed, these should be in the form of the following examples:

1. Atkinson, I. A. E., 1964: Feeding stations and food of the North Island Saddleback in August. Notornis 11, 2, 93-97.

2. Buller, W. L., 1888: A History of the Birds of New Zealand (2nd ed.) 2 vols., the author, London.

The references should be serially numbered, and in the text, should be shown thus: Atkinson 1964 (1), and Buller 1888 (2). If references are cited in the text, the following shortened form may be used: Atkinson 1964, Notornis 11, 2: 93-97.

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