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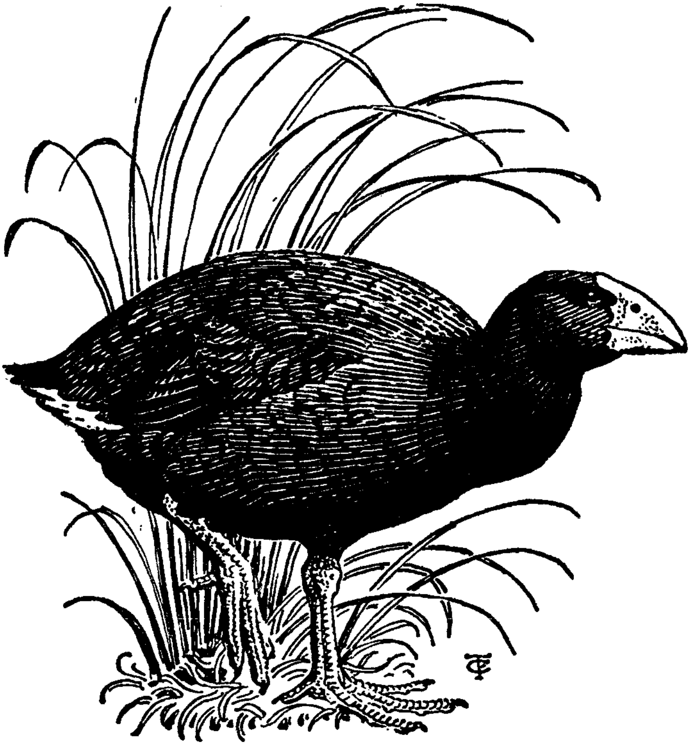
Journal of the Ornithological Society of New Zealand



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THE NEW CALEDONIAN PETREL

By M. J. IMBER and J. A. F. JENKINS

ABSTRACT

When *Pterodroma leucoptera* was first recorded from New Zealand in 1942, the 10 beach-cast specimens were recognised as being distinct from Gould's Petrel *(P. l. leucoptera)*, mainly because of their larger average dimensions. Their origin was unknown. Since then 10 more have been reported. Between 1971 and 1979, during studies of petrels in New Caledonia, R. de Naurois discovered populations of a form of Gould's Petrel breeding in the mountains and gave them the name *P. l. caledonica,* with a brief description. A New Caledonian specimen is identical with extant New Zealand specimens. Distinguishing features of the two subspecies are discussed: definite separation probably can be made in the hand only. Recent sightings of this species in the Tasman Sea are reported. Previous reports attributable to New Caledonian Petrels are assembled: these show it to be an east-west migrant like several other petrels of this region. Gould's Petrel should be replaced by New Caledonian Petrel in the New Zealand checklist.

INTRODUCTION

Gould's Petrel *(Pterodroma leucoptera leucoptera)* is known to breed only on Cabbage Tree Island, off New South Wales, Australia, where the population has been estimated as less than 2000 birds (Fullagar 1976). This is a very small population for a petrel and, considering the low mortality rate of petrels generally, not likely to yield more than occasional corpses on distant shores.

This may have been in P. C. Bull's mind when he examined and measured the remains of 10 petrels collected from Muriwai Beach, Auckland west coast, on 12 April 1942; the first of this species reported from New Zealand, over 2000 km from Cabbage Tree Island (Bull 1943). Bull found that these Muriwai Beach specimens had larger average dimensions than those of Cabbage Tree Island, that the leading edge of the underwing was less dark, that they had less of a tendency towards having a breast band, and that foot colour differed slightly from that reported for Australian birds. He did not give a name to the new subspecies because he considered this would be best done when its breeding grounds were discovered. Furthermore, he noted, taxonomy of the small *Pterodroma* petrels was at that time unstable, Murphy (1929), Fleming (1941) and Falla (1942) having recently published conflicting interpretations. From a study of weather conditions before this minor wreck, Bull deduced that the breeding grounds of the new subspecies probably lay north, rather than west, of New Zealand.

NEW ZEALAND SPECIMENS

Since the 10 were found in 1942, a further 10 specimens of *P. leucoptera* have been reported from New Zealand (Table 1). All but one have been beach cast, all but one are from the west coast, and their occurrence has been seasonal. The evidence shows that this petrel frequents the Tasman Sea, but apparently not seas immediately east of New Zealand, from November to June. (The only east coast specimen came from the Far North in spring and was probably migrating westwards.) It is, therefore, probably migratory.

TABLE 1 — Data concerning the 20 **Pterodroma leucoptera** recorded from New Zealand. BPS = Beach Patrol Scheme records. • Bones only. + Only 4 study skins extant.

Date	Locality	No.	Depository	Reference	Subspecies
12.4.42	Muriwai Beach	10	Auckland Museum+	Bull 1943	*caledonica*
27.1.46	" "	1	not kept	Bull 1946	?
25.6.61	Otaki Beach	1	National Museum	Falla 1962	*caledonica*
3.3.65	43° 28'S 163° 55'E	1	" "	Harper coll.	"
11.1.70	Muriwai Beach	1	not kept?	BPS	?
24.1.71	" "	1	Auckland Museum*	"	?
27.11.71	Waipu Beach	1	National Museum*	"	?
4.5.73	Titahi Bay	1	" "	Veitch 1975	*caledonica*
20.5.73	Muriwai Beach	1	Auckland Museum	" "	"
8.6.75	" "	1	not kept	Veitch 1977	?
11.5.80	Port Waikato	1	?	Sibson 1981	*caledonica*

TABLE 2 — Measurements (mm) of New Caledonian Petrels from various sources compared with those of Gould's Petrels from Cabbage Tree Island. * Includes one **P. l. leucoptera** from Cabbage Tree Island. † Possibly includes some **P. l. caledonica**. ‡ 3 in the National Museum plus 1 from Port Waikato. + claws worn down.

Source & Locality	Loomis 1918 Tropical E. Pacific	Murphy 1929* S-W Pacific	Bull 1943 Muriwai, NZ	This study: New Zealand‡	This study: N. Caledonia Tonga Pitcairn I.	Overall *P.l.caledonica*	(Serventy *et al.* 1971) *P.l.leucoptera*†
CULMEN No.	8	3	8	4	3	26	23-48
Mean	25.5	25.7	25.2	25.4	25.7-23.5-26.9	25.4	24.6
Range	24.3-27.0	25.0-27.0	24.0-27.5	24.8-25.9		23.5-27.5	23.0-26.5
WING No.	7	3	9	4	3	26	23-48
Mean	230	225	229	231	232-222-219	229	225
Range	225-234	224-226	225-235	229-232		219-235	213-238
TAIL No.	8	3	6	3	3	23	23-48
Mean	95	91	95.5	93	95-98 39	95	93
Range	93-97	89-93	93-97	91-96		89-98	82-105
TARSUS No.	(see text)	3	9	4	3	19	23-48
Mean		29.7	29.9	30.7	30.6-28.0-31.0	30.1	29.0
Range		29-30	28.5-30.5	30.4-31.3		28.0-31.3	25-33
MID-TOE & CLAW No.	8	3	5	4	3	23	23-48
Mean	37.9	37.3	38.7	38.3	37.5^{+}-36.0-35.2	37.9	37.0
Range	35.2-39.1	37-38	38-41	37.2-39.4		35.2-41.0	-

Measurements of New Zealand specimens are compared in Table 2 with those of Cabbage Tree Island birds from Serventy *et al.* (1971). The tendency towards larger size in New Zealand birds noted by Bull (1943), is confirmed in this larger series of measurements.

Additional plumage features have now been observed in these specimens. The back and upper tail-coverts are grey, thus contrasting with the rest of the upperparts, which are dark grey to sooty. State of plumage wear affects the back colour, as fresh feathers have a pale grey tip. In Gould's Petrel the upperparts are darker, the back in particular, and so there is much less contrast between the back and the rest of the upperparts than in New Caledonian Petrel.

However, the most reliable distinguishing feature seems to be found in the rectrices of the tail, and we are greatly indebted to F. C. Kinsky for pointing this out. In Gould's Petrel (two specimens in the National Museum were examined), the outermost tail feather has its inner web grey to brownish grey, except for the basal half, which is off-white. All eight New Zealand specimens that are available for examination (S. M. Reed and MJI checked those in the Auckland Museum; J. A. Bartle and MJI checked those in the National Museum) have the inner web of the outer tail feather white, or mainly white, but with a variable amount of grey freckling near the tip. At most this freckling extends from about the mid-point near the rachis gradually over the whole width near the tip. Falla's (1962) illustration of the Otaki specimen shows the inner web of its outer tail feather as entirely white.

Possibly the foot colour of live birds differs also since that of Gould's Petrel is described as " greyish blue " (Serventy *et al.* 1971) or " flesh-coloured " (Fullagar 1976), whereas that of New Zealand specimens was " pale Russian blue " (Bull 1943).

NEW CALEDONIAN SPECIMENS

Hitherto, study of the Procellariiformes of New Caledonia has been rather neglected. However, research carried out by R. de Naurois between 1971 and 1980 (Naurois 1978 and pers. comm.) has added greatly to our knowledge. In addition to locating many colonies of *Puffinus pacificus* and *Pterodroma rostrata,* he discovered two small *Pterodroma* nesting: first records for the region of Black-winged Petrels *(P. nigripennis)* nesting on islets in the lagoon, and *P. leucoptera* nesting in the mountains of the mainland.

At first, Naurois (pers. comm.) thought that these *leucoptera* would be a new subspecies but, when he came to publish his findings, he had only a few old specimens from Cabbage Tree Island for comparison and so was unsure of distinctions between the two populations. He recorded that New Caledonian birds were larger and had longer tarsi than Collared Petrels *P. (leucoptera) brevipes,* and, in comparison with Gould's Petrels, had larger bills and paler plumage on the back, wings and sides of the chest. He had intended withdrawing what he had written regarding a new subspecies (pers. comm.) but, owing to an oversight, the name " *P. leucoptera caledonica* nov. ssp." was published in the abstract of his paper (Naurois 1978). Thus we have a name, a locality, and a brief description without measurements. Additional diagnostic information comes from an American Museum of Natural History specimen collected at one of the colonies, which we have examined. It has white inner webs to the outer pair of tail feathers and its measurements are shown in Table 2. Thus, New Zealand and New Caledonian specimens are identical.

The New Caledonian Petrel breeds in heavily forested slopes of the mountains forming the backbone of New Caledonia. Naurois pers. comm.) found them in burrows on Mt Dzumac in the Humboldt Massif at an altitude of 450-500 m. They had fresh eggs on 30 December 1979. He collated reports of at least five other localities along the southern two-thirds of New Caledonia where petrel colonies, possibly of this species, were known locally.

The AMNH specimen was found dead near a burrow above a waterfall on the Kalouehola River at about 550 m below Mt Dzumac on 19 February 1978. Possibly this was the colony that Naurois studied.

MIGRATIONS

Apparently the earliest report attributable to New Caledonian petrels comes from R. H. Beck (Loomis 1918), who collected eight specimens identified as *P. leucoptera* at 4° 20′S, 93° 30′W (about 5 km south-west of the nearest island of the Galapagos) on 11 June 1906. He reported seeing " flocks " of the same birds in the vicinity at the time. The measurements of these birds, shown in Table 2, fit in well with those of *caledonica* obtained elsewhere, except for the shorter tarsus measurements. As we thought Loomis' method of measuring tarsi might have produced lower readings than those of other observers, we compared his data and Murphy's (1929) for Cook's Petrel *(Pterodroma cookii)* collected in the eastern Pacific Ocean. Wing measurements were too few for comparison but tail, culmen and middle toe and claw of Loomis' *P. cookii* were within 3% of Murphy's data. However, Loomis' tarsal measurements were 7.7% shorter than Murphy's. When Loomis' eight tarsal measurements of *P. leucoptera* are increased by 7.7% their mean is 29.9 mm (range 29.2-31.0), which is almost the overall mean for *caledonica* in Table 2.

It was probably the relatively short tarsus measurements given by Loomis that led Murphy (1936) to consider these birds to have been *P. brevipes*. However, all dimensions of Loomis' birds are greater than those recorded for *P. brevipes* by Murphy (1929).

Thus there is good evidence for a post-breeding migration to the eastern tropical Pacific. Using the available data on the breeding season of New Caledonian Petrel and extrapolating from this, using

FIGURE 1 — Dorsal view of New Caledonian Petrel captured near Tonga on 27 April 1979. Note colour pattern of outer tail feathers. Photo: J. Jenkins.

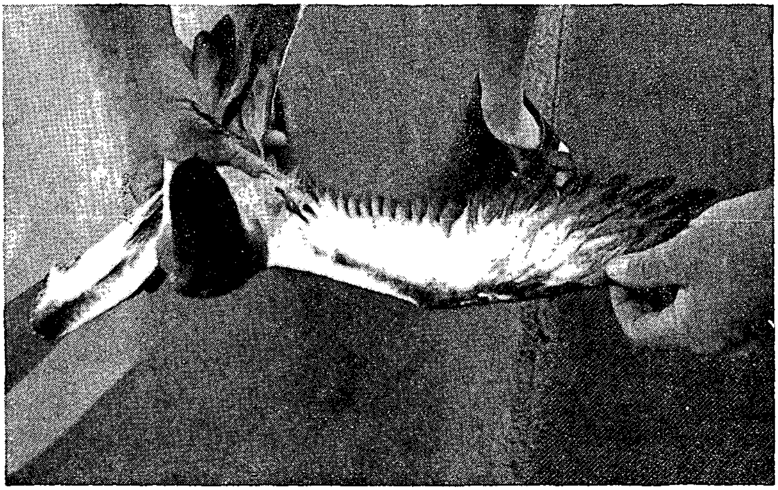

FIGURE 2 — Underwing pattern of same bird. Note similarity to that of Black-winged Petrel (see Notornis 27: 173). Photo: J. Jenkins.

much better knowledge of the breeding of Cook's Petrel as a guide (Imber, unpub. data), the following movements of New Caledonian Petrel may be expected. Breeders would return to the south-west Pacific in October-November and non-breeders from November probably to January. Return migration eastwards probably takes place from late March through April (non-breeders), May to June (breeders), and June to early July (fledglings).

Thus, migrating petrels might be observed in the subtropical/ tropical South Pacific between New Caledonia and Galapagos Islands from October-January and March-July. We mention this because of the records of petrels of this species in the vicinity of the Tonga Archipelago (Jenkins 1980 a, b). There seems little doubt now that most of these sightings were of migrating New Caledonian Petrels. We also suggest now that those considered to have been possibly *P. longirostris,* sighted in June-July, were fledglings of *P. l. caledonica,* showing pale backs because of their fresh plumage with prominent broad grey tips to the back feathers.

One of these *P. leucoptera* was caught aboard ship near northern Tonga on 27 April 1979 (Jenkins 1980a and Fig. 1 and 2). This bird we subsequently identified by photographs and notes taken at the time as *P. l. caledonica.* It had white inner webs to its outer tail feathers, although its dimensions (Table 2) are among the lowest recorded for this subspecies. Another record of a migrating New Caledonian Petrel was drawn to our attention by J. A. Bartle. This is now a skin in the Auckland Museum and was captured aboard MV *Africa Star* " before Pitcairn Island " on a voyage to New Zealand via Panama on 25 May 1955. It is a male with white inner webs to the outer tail feathers and dimensions shown in Table 2.

We interpret these records to indicate that the migration route follows a broad front in an east-west direction between the western and central South Pacific Ocean, turning almost north-south in the east. Thus the petrels remain over surface waters of similar temperature throughout migration, following a route that approximately parallels the Subtropical Convergence.

SIGHTINGS OF *Pterodroma leucoptera* IN THE TASMAN SEA

Regular logs by JAFJ of seabird sightings in the Tasman Sea on voyages between Australia and New Zealand, and around New Zealand, have been kept since 1970. Sight records of petrels identified as *Pterodroma leucoptera* made during the period 1970-1980 are shown by month in Figures 3 to 5. No sightings were made east of New Zealand. The area shown is that between 33°S and 47°S, and between 151°E (Sydney in the top left corner) and 175°E or the New Zealand coast. This area comprises 293 x 1° squares of ocean. It is approximately bounded by the Subtropical Convergence in the south. The Figures show only those months in which sightings were made; there were no sightings from May to November inclusive. The number of squares visited has ranged between 52 (April) and 109 (January) per month; the average number visited monthly during the positive period (December to April) was 77.6, which was only 4.3 per month more than that during the negative period. Thus no bias can be attached to relative effort in each period.

These sightings correspond well with the specimen records from the west coast of New Zealand. The latter undoubtedly arise from the frequent strong west to south-west winds over the southern Tasman Sea. The New Zealand specimens, and particularly the one collected independently at sea (Fig. 4) in an area of many sightings, indicate that most of these sightings have been of New Caledonian Petrels. Probably Gould's Petrels were encountered only in the western Tasman Sea. By being seasonal, these sightings provide further evidence that this species is migratory.

The extent of southward ranging of these petrels in the Tasman Sea is surprising. They range very near to Codfish Island, where another small *Pterodroma,* Cook's Petrel *(P. cookii),* breeds. However, during the voyages of the Antipodes Islands expedition in 1978, we observed Cook's Petrels far east of Codfish Island. Perhaps this is how these two petrels partition their food supply.

DISCUSSION

Gould's Petrel and New Caledonian Petrel are closely related, and clearly the latter must be considered a subspecies of *Pterodroma leucoptera.* The Collared Petrel seems more distinct, particularly since it breeds in the New Hebrides, within 1000 km of *caledonica.* Furthermore, this population of *brevipes* is polymorphic in plumage (Murphy 1929). Accordingly, the Collared Petrel is best treated as a full species. Distinguishing characteristics of New Caledonian Petrels compared with Gould's Petrels are their larger average dimensions, paler back, paler sides to the chest with less tendency towards a collar, mainly or entirely white rather than grey inner webs to the outer tail feathers, and less prominent underwing bar. Although Naurois (1978) did not formally describe the new subspecies, he provided an available name, a breeding locality and some valid characters. Since there can be little doubt about the petrel to which Naurois refers, we propose that his name be accepted. We understand that type specimens have been deposited in the Museum National d'Histoire Naturelle in Paris (J. A. Bartle, pers. comm.). Needed now are a good series of measurements from New Caledonia and further information on its breeding biology, its breeding distribution, and whether the colonies are endangered in any way.

Since all New Zealand skins of *P. leucoptera* still available (9 of the 20) show the characteristics of *P. l. caledonica,* and since none of the others has been confirmed as *P. l. leucoptera* nor seems to be that subspecies on available evidence, New Caledonian Petrel should replace Gould's Petrel in the *Checklist of New Zealand birds.*

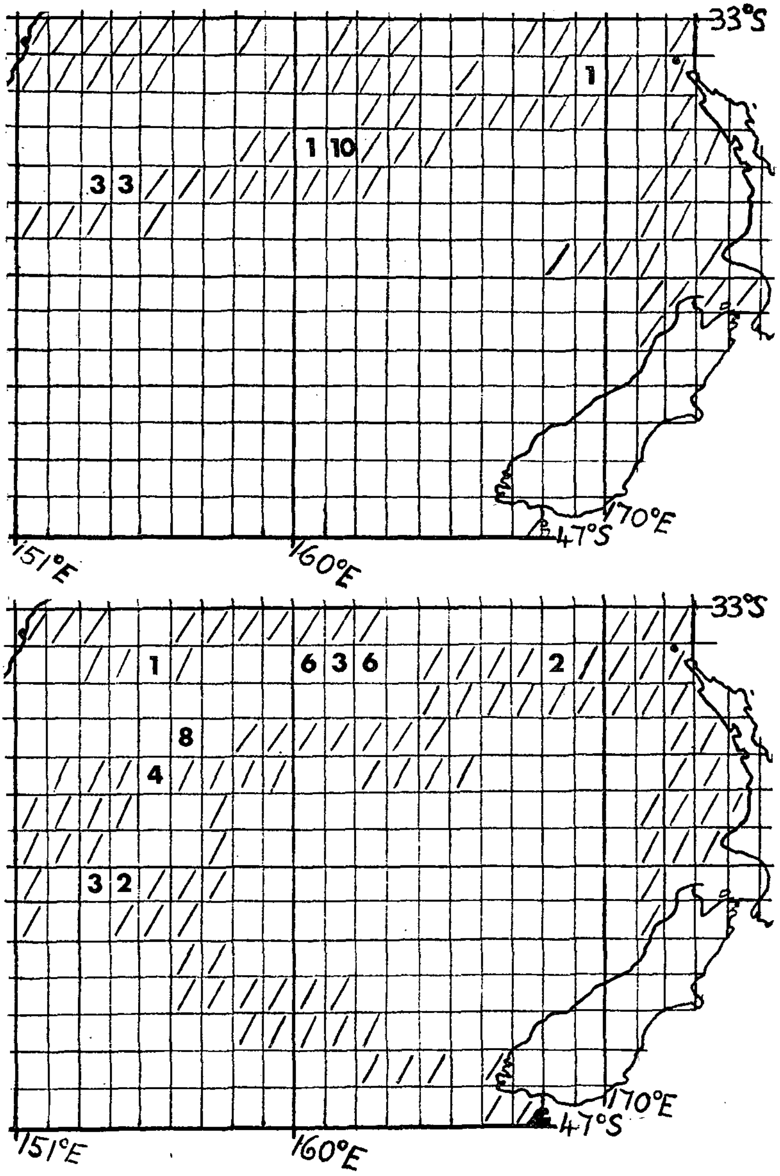

FIGURE 3 — Sightings of **P. leucoptera** in the Tasman Sea: above, in December; below, in January. **Key**: Blank squares = no observations made. Squares with diagonal line = observations made but no **P. leucoptera** seen. Squares with numbers = total sightings of **P. leucoptera** in that area of the grid.

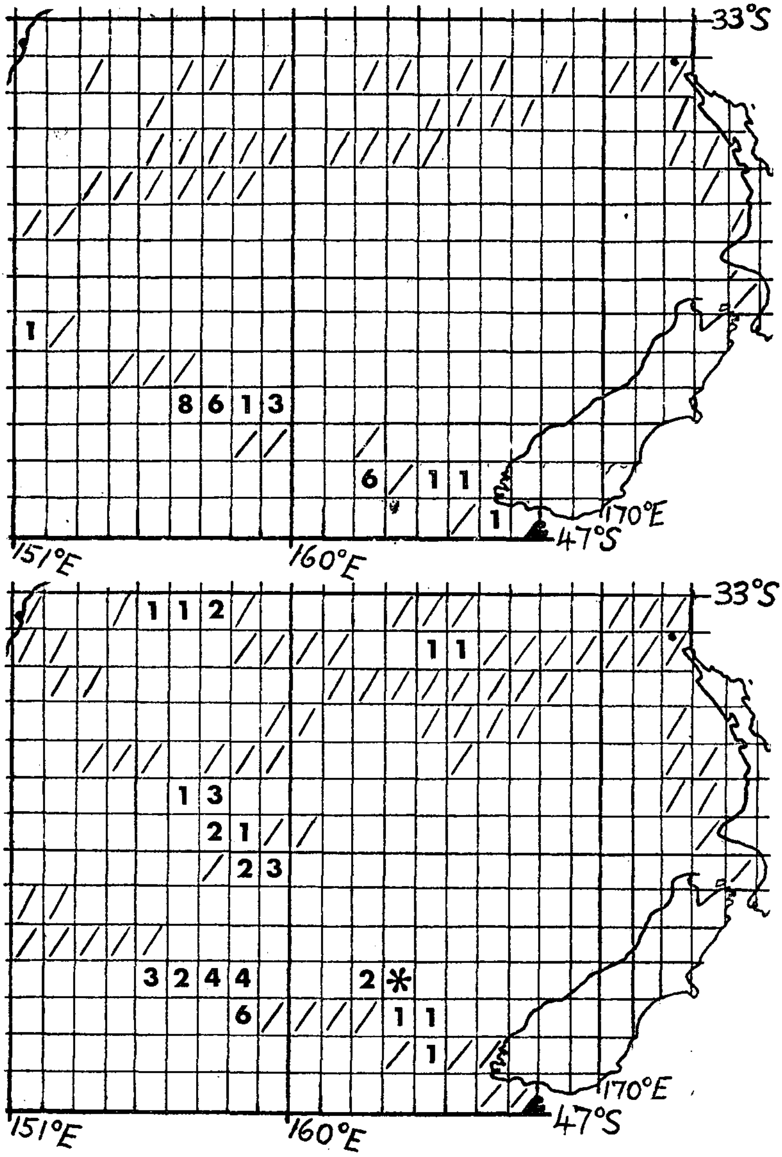

FIGURE 4 — **Above:** Sightings of **P. leucoptera** in the Tasman Sea in February. Details as in Fig. 3.
Below: Sightings of **P. leucoptera** in the Tasman Sea in March.
* Specimen of **P. l. caledonica** collected 3 March 1965 (see Table 1).

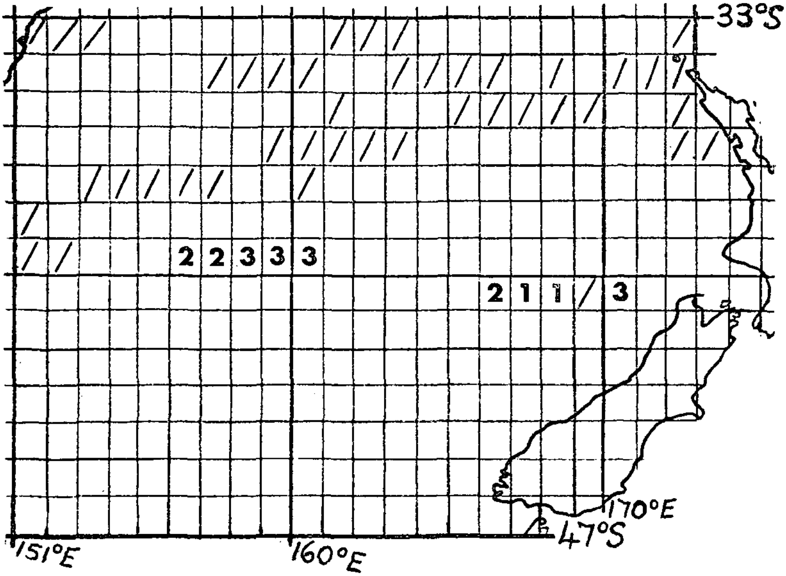

FIGURE 5 — Sightings of **P. leucoptera** in the Tasman Sea in April. Details as in Fig. 3.

Whether or not New Caledonian Petrels can be reliably distinguished from Gould's Petrels at sea has yet to be settled but, if they can, this will probably be by means of the contrast between generally very dark upperparts and the grey back in New Caledonian Petrels, and lack of this contrast in Gould's. Collections at sea indicate that New Caledonian Petrels are much more numerous than Gould's. Whether Gould's Petrels also migrate eastwards is not known as none seems to have been collected far from the breeding place.

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COMMON SANDPIPER IN SOUTH ISLAND

While carrying out *Spartina* control work on the Whanganui Inlet (North-west Nelson) on 12 March 1981, a Wildlife Service party of six returning down the Wairoa River flushed a small wader from the water's edge. It had an undulating jerky flight but was too distant for us to get any other details. The stream was a narrow channel with mudflat on each side but not more than 50 metres from bush edge to bush edge. We followed the bird downstream and saw it better. It was definitely a sandpiper with tilting pose but noticeably smaller than a tattler. It was smooth greyish brown above and white below. It flew off again but the only distinctive markings seen were two prominent white patches either side of the rump. The following day the bird was seen again and this time it circled against the bush background and exposed its prominent white wing bands confirming our initial identification of Common Sandpiper *(Tringa hypoleucos)*.

The bird's use of a confined habitat rather than the open mudflats is characteristic of the species. It went behind rocks on the bush edge and even walked under and through the branches of a stranded tree. This species has been recorded several times from the North Island but this seems to be the first record for the South Island.

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THE PHYLOGENETIC RELATIONSHIP WITHIN THE GALLIFORMES INDICATED BY THEIR LICE (INSECTA : PHTHIRAPTERA)

By P. R. KETTLE

ABSTRACT

A consideration of the distribution of the various genera of Phthiraptera occurring on Galliformes suggests that, while Megapodidae, Cracidae, Tetraonidae, Phasianidae, Numididae and Meleagrididae form a natural group of related hosts, Opisthocomidae, Tinamidae, Turnicidae and Pedionomidae do not fall within the same host group.

Evidence also suggests that Galliformes is more closely related to Columbiformes than is generally accepted.

The general lack of agreement in classifying Galliformes is evident from Table 1, which gives several recent classification schemes. The lice occurring within the order are considered here to help evaluate these schemes.

Hoatzin

All but one of the schemes listed include the hoatzin *(Opisthocomus hoazin)* in the order, but evidence is accumulating that it belongs within Cuculiformes, being close related to *Guira* and *Crotophaga* of the subfamily Crotophaginae of Cuculidae (Sibley & Ahlquist 1973). Sibley & Ahlquist based their conclusions on a study of electrophoretic patterns of egg-white proteins. Harrison (1966), in studying the distribution of pigment in the structure of egg shell, found that the hoatzin apparently does not integrate into Galliformes nor show a close affinity with Cuculiformes, although he did not specifically explore the second possibility.

Consider the Mallophagan genera that occur on Galliformes, shown in Table 2. The lice occurring on the hoatzin (*Hoazineus* Guimaraes, 1940, *Laemobothrion* Nitzsch, 1818, *Osculotes* Keler, 1939, *Wilsoniella* Eichler, 1940 and *Cuculiphilus (Carrikeria)* Hopkins, 1947) do not show a close affinity with those of any host order, and they are certainly not closely related to those of Galliformes. On the basis of one common derived character, a row of regular setae on the outer edge of tibia I-III, *Hoazineus* appears to have affinities with *Heleonomus* Ferris, 1916, which occurs on cranes (Gruiformes). *Laemobothrion* is a widespread genus occurring on aquatic birds from a number of orders as well as on Falconiformes and so cannot be used to indicate affinities. *Osculotes* and *Wilsoniella* show no clear associations with

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TABLE 1 — Classification of Galliformes

Order Galli		Mayr & Amadon (1951)
Family Megapodiidae		
" Cracidae		
" Phasianidae		
Subfamily Phasianinae		
Numidinae		
Tetraoninae		
" Meleagrididae		
" Opisthocomidae		
Order Galliformes		Sibley (1960)
Family Megapodidae		
" Phasianidae		
Subfamily Phasianinae		
Meleagrininae		
Numidinae		
Tetraoninae		
Cracinae		
" Opisthocomidae		
Order Galliformes		Wetmore (1960)
Suborder Galli		
Superfamily Cracoidea		
Family Megapodidae		
" Cracidae		
Superfamily Phasianoidea		
Family Tetraonidae		
" Phasianidae		
" Numididae		
" Meleagrididae		
Suborder Opisthocomi		
Family Opisthocomidae		
Order Galliformes		Verheyen (1961)
Suborder Tinami		
Family Tinamidae		
Suborder Opisthocomi		
Family Opisthocomidae		
Suborder Galli		
Family Cracidae		
" Megapodiidae		
" Phasianidae		
Suborder Turnices		
Family Turnicidae	Bustard Quail	
" Pedionomidae	Plains wanderers	
Order Galliformes		Storer (1971)
Superfamily Cracoidea		
Family Cracidae		
" Opisthocomidae		
" Megapodiidae		
Superfamily Phasianoidea		
Family Numididae		
" Phasianidae		
Order Galliformes		Olney (1974)
Family Megapodidae	Mound Builders	
" Cracidae	Guans, Curassows	
" Tetraonidae	Grouse	
" Phasianidae	Pheasants, Peafowls, Francolins	
" Numididae	Guinea Fowl	
" Meleagrididae	Turkeys	

TABLE 2 — Genera of mallophaga on the families of Galliformes

AMBLYCERA : Menoponidae	Megapoidiidae	Cracidae	Tetraonidae	Phasianidae	Numididae	Meleagridae
Cracimenopon Carriker, 1954		+				
Amyrsidea Ewing, 1927	+		+	+		
Desumenopon Carriker, 1954				+		
Menopon Nitzsch, 1918				+		
Numidicola Ewing, 1927					+	
Somaphantus Paine, 1914				+	+	
Menacanthus Neumann, 1912		+		+	+	+
Clayia Hopkins, 1941				+	+	
Kelerimenopon Conci, 1942	+					
Colpocephalum Nitzsch, 1818	+			+		
ISCHNOCERA : Philopteridae						
Goniodes Nitzsch, 1818	+		+	+	+	
Goniocotes Burmeister, 1838			+	+	+	
Pachyskelotes Kéler, 1939				+		
Passonomedea Carriker, 1944				+		
Labicotes Kéler, 1939		+				
Chelopistes Kéler, 1939		+		+		+
Oxylipeurus Mjöberg, 1910	+	+	+	+		+
Lipeurus Nitzsch, 1818	+			+	+	
Cuclotogaster Carriker, 1936				+		
Numidilipeurus Tendeiro, 1955					+	
Lagopoecus Waterson, 1922			+	+		
Megapodiella Emerson & Price, 1972	+					
Galliphilopterus Emerson & Elbel, 1957				+		

other ischnoceran genera, although Clay (1957) suggested that *Wilsoniella* may be related to *Rallicola* Johnston & Harrison, 1911. *Wilsoniella* does not appear to be closely allied to *Vernoniella* Guimaraes, 1942, which occurs on *Guira* and *Crotophaga.* According to Scharf & Price (1965), *Cuculiphilus (Carrikeria)* is a monotypic subgenus close to *C. (Cuculiphilus)* Uchida, 1926, from Cuculiformes, *C. (Falcophilus)* Guimaraes, 1942, from the family Cathartidae (Falconiformes) and *C. (Aegypiphilus)* Eichler, 1944 from the family Aegypiinae (Falconiformes: Accipitridae). *Cuculiphilus* has not been reported from either *Guira* or *Crotophaga* but is replaced by *Osborniella* Thompson, 1948. Its presence on *Opisthocomus* bears out the belief that the hoatzin is an aberrant cuckoo and substantiates the scheme of Olney (1974). In short, mallophagan affinities do not substantiate a relationship between the hoatzin and Galliformes but give some support for including the hoatzin in Cuculiformes.

Tinamous

Verheyen (1961) is alone among recent authorities in including tinamous within Galliformes. Tinamous are usually given ordinal status and placed either near the ratites (Storer 1971) or near Galliformes (Olney 1974). The mallophaga from tinamous are most distinctive and, with the exception of *Menacanthus,* which occurs on Galliformes, Piciformes and Passeriformes, are apparently not closely related to those of any other groups. Morphological studies by Ward (1957) and karyotype studies (Kettle, unpub.) suggest that the Hepatapsogasterinae (a group of louse genera found only on tinamous) are related to the *Goniodes* complex and that *Pseudolipeurus* and *Pseudophilopterus* are derived from typical philopterid stock. The distinctive nature of tinamou lice and the large number of species suggest that the tinamou separated from other birds a very long time ago. The evidence from mallophaga appears to support the belief that they should be placed in a separate order Tinamiformes, and adjacent to Galliformes.

Bustard Quail and plains wanderers

Verheyen (1961) also includes the Turnicidae (Bustard Quail) and Pedionomidae (plains wanderers) in Galliformes, although they are more usually placed with Gruiformes (Mayr & Amadon 1951, Wetmore 1960, Storer 1971, Olney 1974). *Turnicola* Clay & Meinertzhagen, 1938, from Turnicidae is the only genus recorded from these families and cannot be used to indicate affinities as it is a philopterid lacking distinctive features.

So far, then, the consideration of lice rejects Opisthocomidae, Tinamidae, Turnicidae and Pedionomidae from Galliformes and so agrees with the classification proposed by Olney (1974).

Affinities of remaining families

Gallinaceous birds are one of the primitive and basic orders

(Mayr & Amadon 1951). They are poorly represented in the fossil record but known as far back as the Palaeocene (Brodkorb 1971). Mayr & Amadon also stated that " certain resemblances between pigeons and game birds may eventually prove to be of significance." Current classifications usually do not place the two orders in adjacent positions but separate them by at least Gruiformes and Charadriiformes. Clay (1951) has drawn attention to apparent close morphological similarities between mallophaga of Galliformes and Columbiformes, and this relationship between lice is supported by karyotype studies (Kettle, unpub.).

Consider Table 2 again. *Colpocephalum* is widely distributed with species occurring on eleven orders, and so it is of little or no value in considering host relationships. *Amyrsidea, Cracimenopon, Desumenopon, Menopon, Menacanthus, Clayia, Numidicola* and *Somaphantus* appear to form a natural group with many characters in common (see Clay 1969). *Somaphantus,* being a quill dweller, however, is anomalous in its body form. This feature is paralleled by some species of *Actornithophilus* and *Longimenopon,* which also are quill dwellers. *Amyrsidea* is the most widespread genus within Galliformes, but the whole Amblyceran complex listed above emphasises the unity of the host order. *Numidicola* and *Menopon* appear to be closely related.

Kelerimenopon Conci, 1942, has been subdivided into two subgenera, *Kelerimenopon* and *Lorimenopon,* by Price & Emerson 1966. Species of *K. (Kelerimenopon)* occur on Passeriformes and Galliformes, and *K. (Lorimenopon)* is found on Psittaciformes. It is not possible to say which host order is the original one as the seven currently recognised species (Price & Emerson 1966) are almost evenly scattered throughout the above-mentioned orders. The feature in common is the geographical locations of the hosts — New Guinea, Indonesia, and the Philippines.

Ischnoceran mallophaga that are at present of little value to this study are *Megapodiella* and *Galliphilopterus,* both monotypic genera. While the former is considered by Clay (1958) to be related to *Lagopoecus,* the affinities of the latter are obscure.

The goniodiform genera *(Goniodes, Goniocotes, Pachyskelotes,* and *Passonomedea)* form a discrete group with related genera on Columbiformes (e.g. *Campanulotes* and *Coloceras*) and possibly on Tinamiformes (Heptapsogasterinae). Goniodes is the most widespread genus and is often found in the company of *Goniocotes.* On Megapodidae, two species of *Goniodes* frequently occur per host species, one species usually being large and typical of *Goniodes (sensu stricto)* and the other much smaller and included by Clay (1940) in a species group M, without taxonomic standing, and by Keler (1939) in *Homoceras.* This group appears to be taxonomically intermediate between *Goniodes* and *Goniocotes* and may represent the least differentiated lice of this group — being similar to the stock which gave rise to both *Goniodes* and *Goniocotes*. Their presence on Megapodidae supports the belief of avian taxonomists who consider Megapodidae the most primitive of galliform families.

Goniodes may represent the primitive stock which gave rise to *Goniocotes,* as mentioned above, in the Old World and to *Passonomedea* in the New World. *Pachyskelotes* is an aberrant elongate monotypic genus living on the Argus Pheasant *(Argusianus argus),* where it appears to have become adapted to occupy the niche normally filled by *Lipeurus,* or related genera of elongate mallophaga.

Chelopistes, Labicotes and *Oxylipeurus* are closely related genera with *Oxylipeurus,* on the basis of its present distribution, probably representing the more primitive form. *Chelopistes* and *Labicotes* are almost goniodiform in appearance and appear to occupy the niche which would have been occupied by *Goniodes* were it present on the host. *Chelopistes* occurs also on neotropical Phasianidae and Cracidae in a form that is somewhat different — *Trichomedea* Carriker, 1945 — but that is considered to be congeneric by Hopkins & Clay (1952). *Labicotes* lives on guans (Cracidae).

Related to *Oxylipeurus* and *Chelopistes* is the *Lipeurus* group — *Lipeurus, Numidilipeurus* and possibly *Cuclotogaster* and *Lagopoecus. Lagopoecus* may belong to the *Degeeriella* complex rather than to *Lipeurus* and its allies (Clay 1958). This point may be resolved when the karyotype of *Lagopoecus* is determined as it appears that the *Lipeurus* group have a male haploid number of 12, whereas the *Degeeriella* group have a male haploid number of 15 (Kettle, unpub.). *Lipeurus* and *Numidilipeurus* are apparently more closely related to each other than either is to *Cuclotogaster,* but they do appear to form a natural group with related genera occurring on Charadriiformes — *Rhynonirmus* Thompson, 1935, and *Otidoecus* Bedford, 1931. This link with Charadriiformes is in contrast to the relationship indicated by the *Goniodes* group.

In conclusion, the mallophaga of Galliformes show affinities in keeping with the classification of Olney (1974) within the order but suggest that perhaps Columbiformes are more closely related to them than is generally believed by avian taxonomists. Lice from Galliformes and Columbiformes appear much more closely related to each other than they do to lice from either Gruiformes or Charadriiformes. Similarities are most clearly seen between *Goniodes* and its allies from Galliformes and *Coloceras* and allies from Columbiformes. In addition, these genera appear to be related to the lice (Heptapsogasterinae) typical of tinamous. While convergent evolution in response to similar selection pressures (feather structure, etc.) cannot be excluded, the similarities are so striking that the possibility of a close relationship between Galliformes and Columbiformes should be given serious consideration by taxonomists.

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SHORT NOTE

PREDATION ON A SPARROW BY A POSSUM

While observing brush-tailed possum *(Trichosurus vulpecula)* behaviour in the captive colony maintained at Forest Research Institute in Rangiora, I saw the predation of a House Sparrow *(Passer domesticus)* by a possum. The event occurred in a pen holding five females and five males. Occasionally small birds become trapped in the pens, having been attracted by the food provided for the possums.

About 1 hour after dusk at 6.23 p.m., a roosting sparrow started to flutter around the pen, apparently being disturbed by a sudden south-westerly shower. Two minutes later, a male possum lept from a side fence of the pen, caught the sparrow in mid-air with its forepaws, landed on the ground about 1.5 m below, and transferred the bird to its mouth. The event attracted the attention of other possums, notably a dominant male and a dominant female, who briefly chased the captor. After about 20 seconds, he secured a safe position on a fence rail, where he proceeded to bite the dorsal surface of the bird's neck, probably to kill the bird, before eating parts of the head. Four minutes after the bird was seized, all that remained of the head was the beak and rejected pieces of bone tissue. The possum than started removing breast feathers with its teeth and proceeded to feed on the breast region. Subsequently, five other possums, including the dominant male and female of the group, investigated the carcase until observations ceased at 7.25 p.m. Two of these five other possums ate flesh from the carcase but the other three, whose position in the social hierarchy of the colony was ranked as 1st, 2nd, and 4th, seemed more concerned with asserting status over the carcase than eating it.

I inspected the carcase at 7.30, and noted that the soft tissues of the head, breast and legs had been eaten. In the morning, the carcase was no different.

The feeding habits of the brush-tailed possum have been well documented in several studies in which contents of a total of 1898 stomachs were analysed (Mason 1958, Gilmore 1967, Harvie 1973, Purchas 1975, Warburton 1978). Although the animal is mainly herbivorous, Warburton (1978) and Clout (1977) showed that insects may be eaten as chance occurs. I have watched captive possums catching moths (*Porina* sp.) during the summer months while fossicking in grass. In fact, a fluorescent lamp used as a moth attractant provides a cheap source of food for captive possums in summer.

Perham (1924) gave two separate instances in which remains of unfledged birds and feathers were found in stomach contents and concluded " but that the eating of such is generally a trait of the animal is not substantiated."

My observation above suggests that some possums may have the inclination to catch and eat birds, given the opportunity, just as they are attracted to fluttering insects. Certainly one of the possums was a predator and two others were flesh-eaters. Being semi-arboreal and nocturnal, possums may occasionally disturb birds from their nests, and fledglings particularly would be easy prey. If this is only an occasional habit of some possums, absence of bird remains in stomach contents is not surprising. The possum carefully manipulates its food while eating and rejects unwanted parts such as the peel of apples and carrots. Most bone fragments and feathers of the sparrow carcase were rejected. If the flesh of a bird was ingested, following mastication and partial digestion, it could well be ignored or recorded only as " unidentifiable " matter in stomach contents.

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SIZE VARIATION IN THE SNOW PETREL
(Pagodroma nivea)

By ALAN N. COWAN

ABSTRACT

During a year spent at Casey, Antarctica, in 1977-1978, I made a study of the local population of the Snow Petrel *(Pagodroma nivea)*. The breeding distribution of the species in the area is outlined, together with some of the problems encountered.

The Snow Petrel varies widely in size. The literature on the species is reviewed. Large birds (wing over 280 mm) are known chiefly from Dumont d'Urville, Adelie Land. Other published occurrences of large birds have often gone unnoticed or have been disregarded.

Large birds breed at the Windmill Islands, making up 35% of 178 birds measured. Most of these large birds are concentrated in one area and some show the same atypical choice of "open" nests as at Dumont d'Urville. Some large and small birds interbreed. These findings are discussed, and the hypothesis of separate "large" and "small" subspecies is critically examined.

It is concluded that the species has great individual variation in size, and that large birds form a varying proportion of the populations breeding at many localities.

INTRODUCTION

A circumpolar species, the Snow Petrel is not normally found north of the zone of pack ice. It breeds at many places on the coasts of the Antarctic Continent and in some mountain ranges up to 300 km inland (Lovenskiold 1960, Loy 1962, Ardus 1964, Bowra *et al.* 1966, Brown 1966, Brook & Beck 1972). It also breeds on many antarctic islands.

Most specimens are from those areas where exploration has been concentrated, e.g. Victoria Land, the Ross Sea and adjacent areas (see Fig. 1), whereas vast stretches of coast and expanses of ocean are almost unrepresented. Many specimens have been collected at sea, or on land in winter, and so their breeding places are unknown. Several authors have properly emphasised the need to measure birds at their colonies in the breeding season in order to clarify the taxonomy of the species.

It has long been known that Snow Petrels vary greatly in size. Prevost (1969) reviewed the literature from 1777 onwards and traced the development of the hypothesis of large and small forms. The

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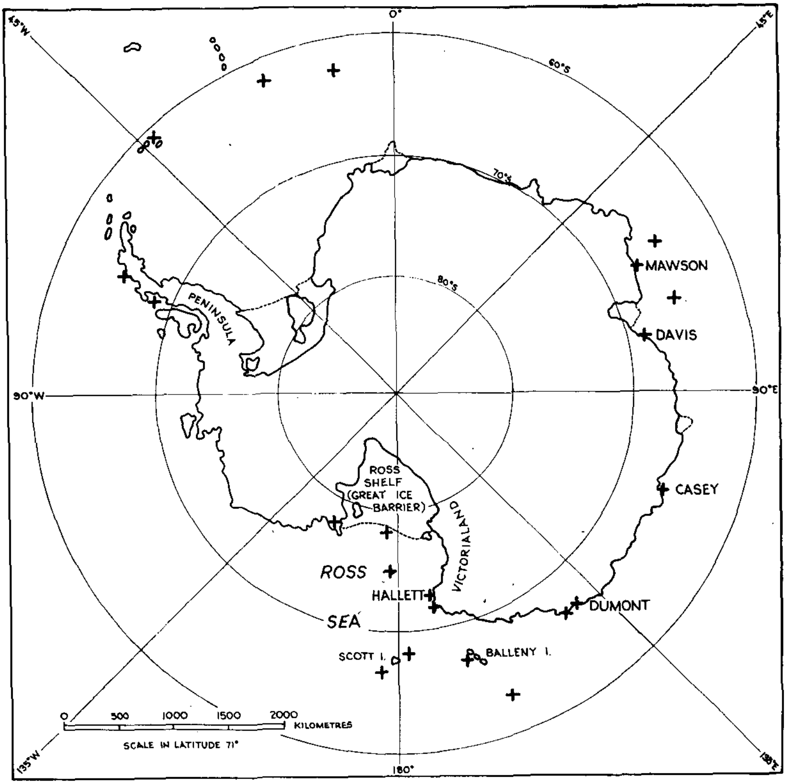

FIGURE 1 — Antarctica. Places of origin of major collections and records (marked +) of the Snow Petrel (schematic only).

best-known breeding areas of large birds, those with a wing measurement of 280 mm or more, are in the vicinity of Dumont d'Urville, in Adelie Land ("Dumont") and at the Balleny Islands.

There are no measurements of Snow Petrels in the sector 80°E to 140°E, some 3000 km of coastline, except for some eggs (Pryor 1968). Therefore it seemed that a project to measure breeding birds at Casey would be valuable, and it was included in the 1977 programme.

I served as medical officer to the Casey 1977 wintering party during the year February 1977 to February 1978, and the study was made in the summer of 1977-1978. A previous paper (Cowan 1979) described the area, its history, geography and climate, and previous ornithological work.

Casey is Australia's newest antarctic station and lies on the Budd Coast just north of the Antarctic Circle at 66°17'S, 110°32'E. The main geographical feature of this area is the Windmill Islands, a chain of islands varying in size from a few square metres to 10 square kilometres some of which, permanently connected by ice to the mainland, have been renamed peninsulas. In summer, extensive areas of rock are exposed, offering to several species of birds the only nesting place of any size in a stretch of coastline of some 800 km (see Fig. 2).

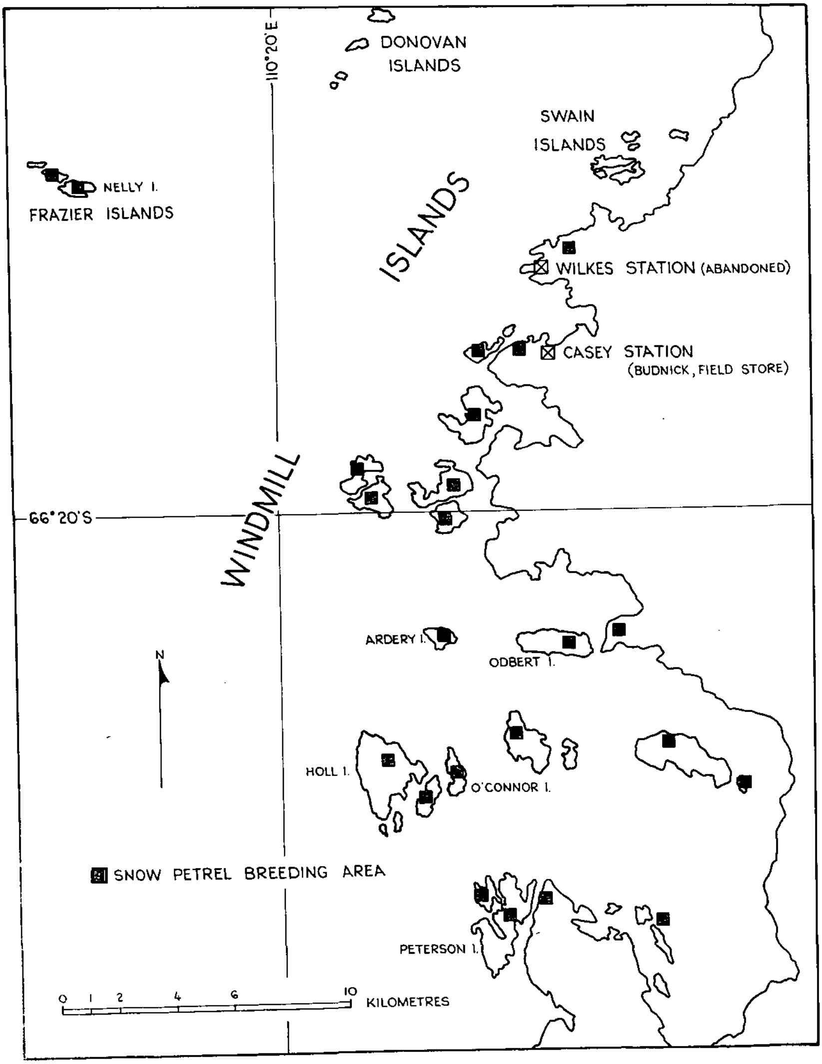

FIGURE 2— The Windmill Islands, Antarctica. Labelling is restricted to places mentioned in the text.

Inflatable boats were used to make 15 trips during the 1977-1978 breeding season. Ardery and Odbert Islands were the areas chiefly studied, but visits were also made to the Holl group and Peterson Island. One further trip was made by ship's boat in January 1978. Advantage was also taken of the helicopters carried by the relief ship to visit the Fraziers in February 1977 and January 1978, during the annual changeover operations.

The Snow Petrel breeds on most of the larger islands, some 20 in all, including the Fraziers but excluding the Swains and Donovans, as well as at several mainland localities. Nests are made in any rocky area with suitable crevices under or between the rocks. Because most nests are hidden and many places inaccessible, breeding numbers can only be roughly estimated. Two of the most populous areas are on Ardery and Odbert Islands. A previous estimate (Orton 1963) of 20 nests on Ardery contrasts with my own of 200-300 nests, with 105 birds caught and measured. On Odbert, I estimated 150 nests and measured 39 birds. See Fig. 3.

In general, the birds nested on cliffs and slopes facing north and east. Thus, the nests on Ardery Island were mostly scattered along the north cliffs and at the eastern end; those on Odbert Island were also along the north cliffs and at the eastern end, but a few were in the flat saddle area; those on O'Connor Island were mostly at the north-eastern end. Although some of these cliffs are inaccessible, birds can be seen flying about the nests, which can thus be mapped from a distance.

The orientation of most of the nests is towards the prevailing winds, which are off the land and easterly. A similar situation obtains at Dumont (66°40'S, 140°01'E), where the winds are mainly south-easterly (Mougin 1968) and at Haswell Island (66°33'S, 93°01'E), where they are easterly (Pryor 1968). Slopes exposed to the wind remain relatively drift-free and the scouring of snow that would otherwise fill nest entrances is clearly advantageous to the petrels. On the leeward side of the islands, snow remains accumulated in the summer, sometimes permanently. However, Brown (1966) found no such consistency in the orientation of nests at Davis (68°35'S, 77°58'E).

The breeding cycle is characterised by complex comings and goings at the colonies in early spring, followed, as in the other fulmarine petrels, by a pre-laying exodus which occupies the second half of November. Laying takes place in early December with hatching 6 to 7 weeks later. Detailed accounts of the breeding cycle have been given by Brown (1966) and Mougin (1968) and I have recorded some observations on the behaviour of the birds studied at the Windmill Islands (Cowan 1979).

MATERIALS AND METHODS

Two Hutchinson "Mapa 401" inflatable boats with Volvo "200" outboard motors were used for transport. The usual party consisted of

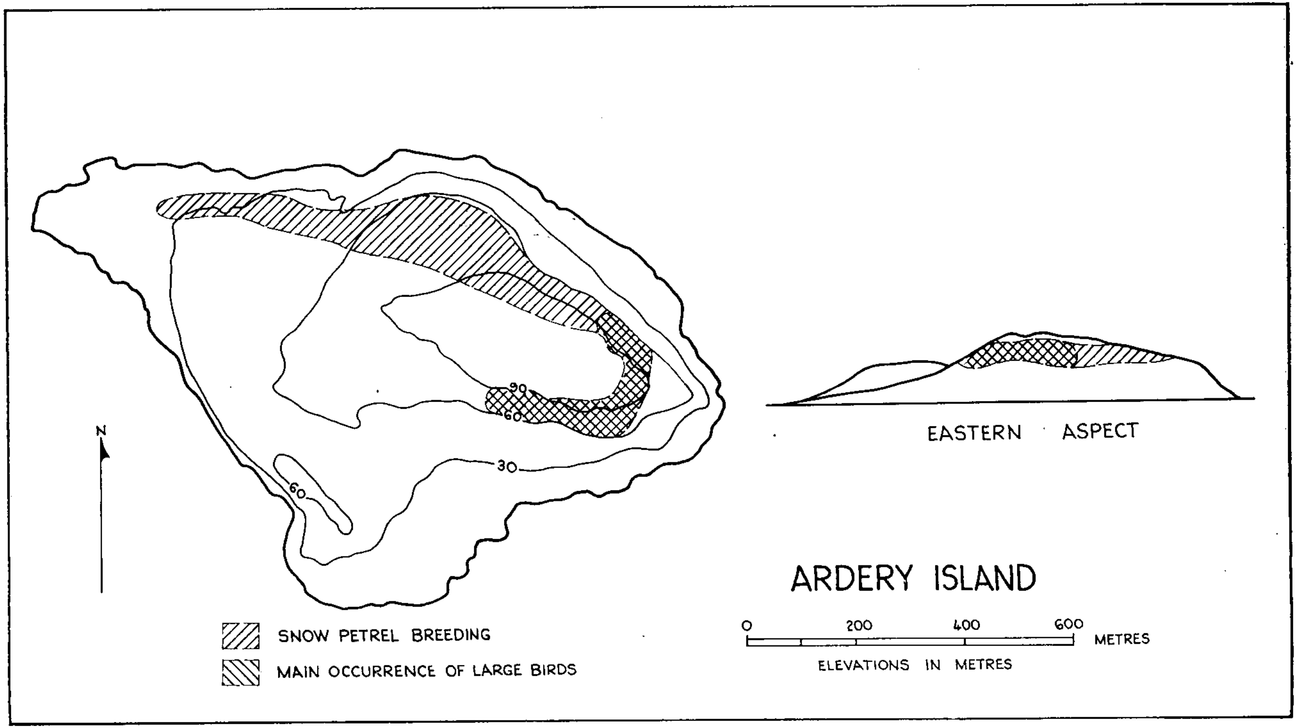

FIGURE 3 — Plan of Ardery Island; Snow Petrel breeding areas.

three men. Conditions were always potentially hazardous as the prevailing wind is off the land and high winds develop suddenly. The sea is very cold and is largely uncharted, abounding with shallow reefs. An enforced stay on an island was always possible, and much gear had to be carried, including tent, radio, food and fuel. The two boats never separated.

Measurements were taken of live birds captured at the nest site and then released, except for one severely injured bird which was measured immediately after being killed. Wing, culmen length and tarsus were measured as in the CSIRO Bander's Manual 1971. The wing was measured with a steel tape and to the nearest 5 mm. Where one wing was obviously shortened by wear, the other was measured, but this was rarely noted. The culmen (feathers to tip) and tarsus were measured with calipers to the nearest mm. All measurements were made by myself as sole observer. Birds were not weighed, and eggs were not weighed or measured.

The birds were not banded as this would have reduced the available time for making observations. However, there was little risk of duplicating measurements, since the nesting areas were extensive and dispersed. As no specimens were collected, the birds could not be sexed.

To measure the birds, most of which sat within one metre of an exit, I had to lie down, introduce an arm into the nest cavity, provoke the bird into setting the sharp hooked tip of its bill into the (gloved) finger, and extract the bird by gripping its bill with the free fingers. Birds not on an egg were more elusive and often an assistant had to block a second exit to prevent escape. The birds always regurgitated during capture and measurement. When released, they returned at once to the nest site.

RESULTS

Measurements

Altogether 178 birds were measured, located as follows.

Ardery Island (northern side)	39
,, (eastern end)	66
Odbert Island	39
Budnick cliffs near station	11
O'Connor Island	10
Peterson Island	10
Field store near station	2
Nelly Island	1
Total	178

Figure 4 shows the distribution of each of the three measurements. All show a roughly similar pattern. The wing length has historically

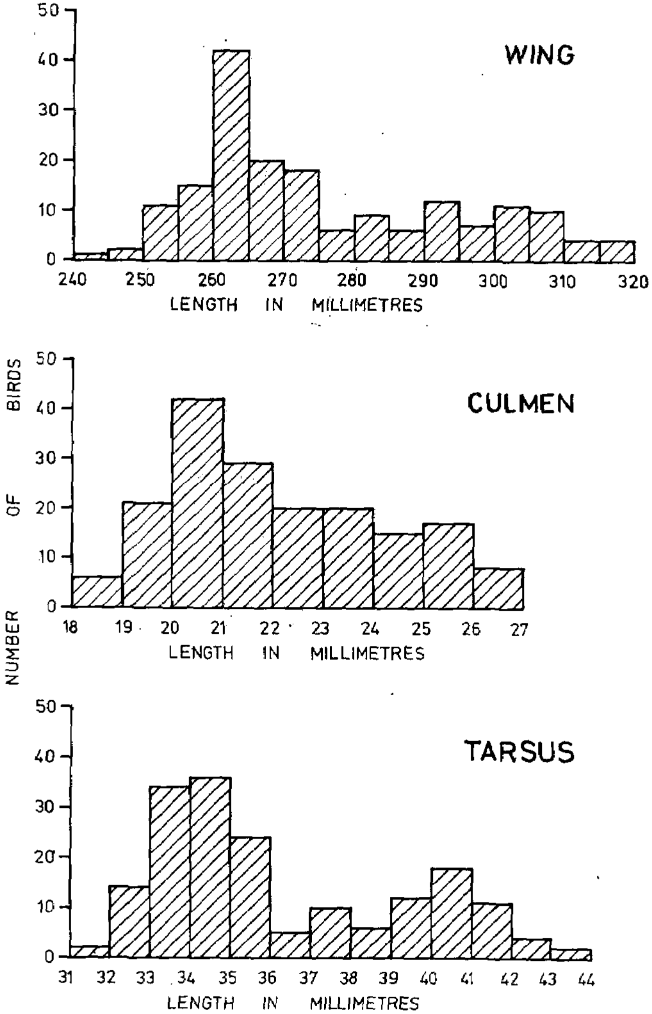

FIGURE 4 — Dimensions of 178 Snow Petrels

been the chief standard used and is probably subject to the least percentage error in the living bird.

Figure 5 shows the distribution of pairs of dimensions.

I use the terms "large" and "small" here simply for brevity of discussion, and the 280 mm wing length recognised by previous authors (Falla 1937, Prevost 1969) makes a convenient arbitrary division. Certainly, it distinguishes collections like those of Friedmann (1945), Maher (1962) and Brown (1966), none of whose specimens exceeds 269 mm, from the Dumont birds of Prevost, 82% of which exceed 280 mm. Applying this criterion to the Windmill Islands series, some interesting facts emerge. There are 63 large birds, that is, 35%. Of these 63, 54 are from Ardery Island, and 46 from around its eastern end. The rest are from Odbert (4), Peterson (3), O'Connor (1) and Nelly (1) Islands. Note that studies were made chiefly on Ardery and Odbert, and that many other known breeding islands were visited only once or not at all. Large birds probably breed at other places in the area.

The sizes of paired birds

Of particular interest are the nesting pairs, which are shown in Table 1. Although we made special efforts to capture such pairs for measurement, sometimes one or both escaped. However, 28 pairs were measured, only two of which were incubating. (The presence of old eggs from previous seasons is common and can easily lead to errors in recording "incubating pairs"). One other incubating pair was seen, but one of this pair escaped. Presumably the pairs found with an egg are changing over and the changeover periods are brief since, of the 98 eggs being incubated, 95 were attended by a single bird. This brief changeover period applies also to the Antarctic Fulmar *(Fulmarus glacialoides)*, the Antarctic Petrel *(Thalassoica antarctica)*, and the Cape Pigeon *(Daption capense)*. Pairs which have failed to breed or which have lost the egg may be found at the nest together late in the season; such pairs show little site tenacity and readily leave the nest if approached. Some of these may be young birds which are establishing territories but have not yet bred. Of 146 nests examined, no (new) egg was found in 46.

Note that of the nesting pairs measured, four were pairs of a large bird with a small bird.

Nest site in relation to size of birds

The literature had led me to expect that birds in the Casey area would be of the "small" size. The discovery of the concentration of large birds at the eastern end of Ardery caused some excitement, therefore, as did the apparent difference in many of the nest sites. Isenmann (1970) had discussed this difference in nest sites and incorporated it into his hypothesis of two subspecies. Not all but many of the large birds on Ardery had chosen exposed sites, some

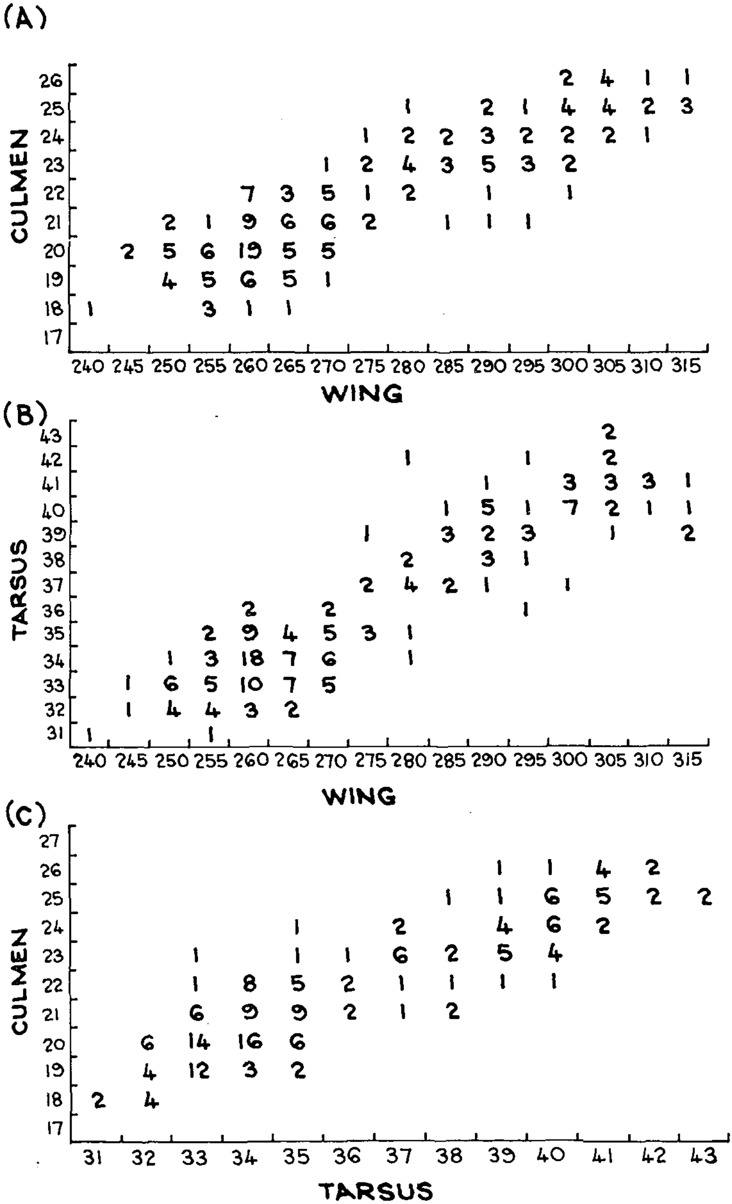

FIGURE 5 — Paired distribution of dimensions

TABLE 1 — Measured nesting pairs of Snow Petrels

Size of paired birds	Number of pairs	With egg	Without egg	Location	
Both small	16	1	15	Ardery north	5
				Ardery east	3
				Odbert	7
				Field store	1
Both large	8	0	8	Ardery east	7
				Odbert	1
Large with small	4	1	3	Ardery north	1
				Ardery east	1
				O'Connor	1
				Peterson	1

of them more appropriate to a Cape Pigeon, with an overhanging rock behind but nothing to provide any difficulty in extracting the bird. In one place towards the south-eastern face, long ledges with overhanging rock behind had rows of nests placed only one or two metres apart, where the birds sat in view of one another. Other large birds chose vertical clefts which were also rather different from the horizontal clefts typically chosen by the small birds. The terrain of the eastern end of Ardery showed no obvious differences from that along the northern cliffs such as might have attracted birds with particular nesting preferences.

The more exposed nests might seem vulnerable to predation by Antarctic Skuas *(Stercorarius skua maccormicki)*, but, like Isenmann (1970), we saw no evidence of this. The Skuas' behaviour in the colonies is rather skulking, and although they were seen to snatch deserted eggs, they were not seen to behave aggressively towards petrels of any species, adult or chick, in the mixed colonies of Snow Petrels, Antarctic Petrels, Antarctic Fulmars and Cape Pigeons. Only once was a Skua seen to bring down a Snow Petrel in flight.

Study is needed to show whether the use of exposed sites is associated with any modification in guarding behaviour. The length of the guard stage reported by Brown (1966) in uniformly small birds is rather shorter than that reported by Mougin (1968) for the predominantly large birds at Dumont. This may be associated with the more open nests chosen by some large birds. However, even the larger Snow Petrels, like the Wilson's Storm Petrel *(Oceanites oceanicus)*, a concealed nester, have a shorter guard stage than species which always make open nests (Brown 1966, Mougin 1968).

The concealed site protects the chick from predation and perhaps to some extent also from cold. In the Antarctic Petrel, which is an open nester, we found that the chicks had acquired the vomiting habit by the time they were left unguarded. However, we found several Snow Petrel chicks in concealed nests which although already left alone, did not appear capable of vomiting at us. The concealed nest may permit the parents to leave the chick unguarded before it has acquired this protective habit.

The large birds seemed to be less difficult to capture and less pugnacious in the hand. Their eggs were visibly larger.

REVIEW OF THE LITERATURE

(All measurements are in millimetres and are
of wing length unless otherwise stated.)

Ross (1847) visited a Snow Petrel breeding colony at Cockburn Island (64°12'S, 56°49'W) on the Antarctic Peninsula on 6 January 1843. He wrote: " The eggs of this bird, which have never before been seen, are 2.2 inches [56 mm] long, 1.6 inches [41 mm] broad . . ." These dimensions correspond with those of eggs of typical small Snow Petrels. (See Isenmann 1970.)

Sharpe (1902) studied specimens collected by the *Southern Cross* expedition. These fall into two groups. Firstly, there are seven birds collected during the first fortnight of January, corresponding with the late incubation period. All but one are exceptionally large with a mean wing of 292 (262-300). (I have converted Sharpe's figures from inches.) These birds were shot in the pack ice about 400-500 km north of the Balleny Islands (67°S, 164°E), not then known to be a breeding place and about as far again from the coast. Secondly, there are six birds shot at Cape Adare (71°18'S, 170°15'E). These are small, mean wing 261 (251-269). Only two were taken during the breeding season, in mid-December. Some eggs were also collected at Robertson Bay, near Cape Adare. These too are from small birds.

Wilson (1907) reviewed specimens in the *Discovery* and *Morning* collections and also earlier material in the British Museum. Like Sharpe, he commented on the great range in size and that it applied to both sexes. He did not give dimensions for every bird, only the largest, 290 (Ross Sea pack ice), and the smallest, 245 (off Cape

Adare), and remarked: ". . . and between these two extremes every gradation may be observed." Unfortunately, it is impossible to discover from Wilson's paper exactly where these birds were taken. Although Lowe & Kinnear (see below) did give exact locations, they also remeasured the specimens, and so one cannot match their specimens with Wilson's.

Always an outstanding observer, Wilson also commented on large flocks of Snow Petrels off the Balleny Islands on 2 March: " All were uniform in size and of the larger type; not one of the smaller type was seen, but as they seemed to be in flocks and on the move, one could not consider this to be characteristic of the locality." None of these was collected. At this date, most parents have abandoned the chick (Mougin 1968, Isenmann 1970).

Gain (1914) reported on specimens from Petermann Island (65°10'S, 64°08'W) on the Antarctic Peninsula, and also gave information on behaviour and seasonal movements. Of 22 birds, 7 were large (280-292), and one of these is described as " a juvenile male of 3-4 months " with grey dorsal feathering. Eight other birds were described as juveniles, and as a group they were smaller than the adults. Dates of collection for the whole series were between early April and mid-August.

Snow Petrels were not breeding in the immediate area, and the first appeared in April, when all birds were seen to be travelling northward. From that time until September they were seen regularly, and Gain noted that their numbers increased when the sea ice broke up and open water approached the wintering ship. They took advantage of food sources made available by the presence of the party, including seal carcases and galley scraps, and at times would remain in the area for many days. From early September their numbers began to fall off as they left for the south, and after 3 October only one bird was seen. It is now known that there are breeding colonies further south on the Peninsula (Watson *et al.* 1971).

Gain also recorded large numbers near Peter I Island (68°45'S, 90°40'W) in the following summer, but I can find no subsequent information on possible breeding there.

Lowe & Kinnear (1930) discussed the literature and taxonomy of the species and reviewed not only the *Terra Nova* collection but also other museum material from the expeditions of Ross, the *Southern Cross, Discovery, Morning* etc.; 69 specimens in all. Only one of these was taken at a colony in summer; this is one of the two above-mentioned *Southern Cross* birds taken at Cape Adare. They remeasured the specimens and so their measurements cannot be compared bird for bird with those in the original reports, especially as they apparently used a different technique. Thus, three of the birds studied by Wilson have a wing larger than Wilson's largest of 290, and the same applies to some of Gain's collection, part of which is included.

Two of the birds from Ross's expedition were also large, 290 and 290+. Both were taken in summer, the former in the Ross Sea, and the latter 400 km from the Balleny Islands and the same distance from Scott Island (67°25'S, 179°50'W); both these latter localities are now known to be breeding places (Kinsky, pers. comm.; Harper, pers. comm.).

One of the *Terra Nova* birds is large (297) and was shot in the pack ice in mid-December, less than 100 km from Scott Island and 500 km from the nearest coast. One of Wilson's large birds (300) was taken in late November, 200 km from Scott Island, 400 km from the coast and 500 km from the Balleny Islands. One of the *Scotia* expedition's birds from the South Orkney Islands (61°S, 46°W) in winter is also large (283).

Lowe & Kinnear refuted the claim of Mathews (1912) that large and small species *(sic)* can be separated on the basis of *discrete* size ranges; they believed that there is a gradation of intermediate sizes, although they conceded that the existence of two species was " highly probable."

Falla (1937) described 33 specimens, some of which were taken during the breeding season at two colonies. There was one large bird (295) shot in the pack ice at 66°S, 73°E, 300 km from the nearest land, on 22 December, that is in the middle of the incubation period. Two adults were taken at the colony at Proclamation Rock (65°51'S, 53°48'E) in mid-January; the male was large (283), the female, from an adjoining nest, was small (258). Falla commented on the range of sizes at this colony and noted that " *the larger form predominated in the neighbourhood.*" Falla used the criterion of wing 280 when speaking of large birds.

He also commented on the homogeneity in size of birds from Cape Denison (67°S, 142°40'E) which have a wing of 250-275, and suggested that the measurement of the wing may be more reliable than that of the length of bill. Like other writers, he found gradation of sizes, with " no marked gaps such as would justify specific distinctions."

Friedmann (1945) gave dimensions of 14 birds, including some taken during the breeding season at two colonies: Neny Island (68°12'S, 67°02'W) on the Antarctic Peninsula and the Rockefeller Mountains (78°S, 155°W) in Edward VII Land. All were small, less than 270.

Dupond (1946) published the ornithological results of the *Belgica* expedition of 1897-1899. Snow Petrels were seen throughout the winter while the ship was beset in the pack ice. Three specimens were measured; all were small, 270-273, and were collected at about 71°S, and between 83 and 90°W.

Bierman & Voous (1950) described birds taken at sea on whaling expeditions between 26°W and 9°E, and between 62 and

68°S. Of 19 birds, only one male and one female were classified as definitely breeding birds. Three other males are adult, of which one is a large bird (286) with a correspondingly large bill and tarsus and a weight easily the greatest of the 19. The authors speculated as to which colonies their breeding birds might have come from and suggested the South Sandwich Islands (58°S, 27°W at centre), about 1100 km from where the breeding male bird was taken and 500 km from where the breeding female and the large adult male were taken. All the non-breeders were collected after 1 March, within a very few days of the earliest departures of the juveniles.

Maher (1962), working at Hallett Station (72°19′S, 170°20′E), reported on the weights of 20 birds, and measurements of these were given by Prevost (1969); all were small, less than 260. All were collected at breeding colonies in November.

Brown (1966) reported on breeding colonies near the Australian stations at Davis (68°35′S, 77°58′E) and Mawson (67°36′S, 62°52′E). All the 31 adults collected were small birds.

Pryor (1968) at Haswell Island (66°33′S, 93°01′E) gave egg measurements only. These were clearly from small birds.

Prevost (1964) gave data on the breeding cycle at Dumont, which were expanded by Mougin (1968). Only the usual hidden type of nest of the species was described; no mention was made of nests in more open positions.

Mougin (1968) gave the first detailed account of the breeding of the Snow Petrel and other petrels at Dumont. The emphasis is on comparisons between the species. While the microclimate at ground level was more severe in the Snow Petrel breeding areas than among the Cape Pigeons, Mougin believed that the Snow Petrel, nesting in sheltered tunnels, must confront less severe conditions, and he correlated this with their weight, which was less than that of the Cape Pigeons. He did, however, mention that some Snow Petrel nests were in relatively open positions. He gave a series of measurements of juveniles just before their departure. The mean wing was 250, compared with the local adult mean of 295. The mean weight was 365 g (adults 450 g). The tarsus was the same size as in the adult, and the bill was rather smaller.

Isenmann et al. (1969) reported on birds collected at Cape Denison, and at Cape Hunter, 18 km to the north-west. This area is in King George V Land, about 100 km from Dumont. All are breeding birds; 11 are from Cape Denison and 8 from Cape Hunter. Later, Isenmann (1970) noted that there were " at the most 20 pairs " at each locality. The Cape Denison birds, like those of Falla (1937), are all small (mean wing 263). No mention is made of the large bird (wing 293) collected there in the breeding season by Sapin-

Jaloustre (1951). The Cape Hunter birds are less homogenous; the mean wing is 273 (239-295) and 4 of the 8 are large (281-295). The greater homogeneity of the Cape Denison birds is later cited by Isenmann (1970) as evidence for the lessening influence of the large form at Dumont as the distance increases, Cape Denison being a little farther away from Dumont than is Cape Hunter.

Prevost (1969), in reviewing previous literature, mentioned but did not discuss the large birds of Falla and of Bierman & Voous, while most of those of Lowe & Kinnear were not even mentioned. Turning to recent French collections, beginning with those of Isenmann *et al.* from Cape Denison and Cape Hunter, Prevost dismissed the large bird of Sapin-Jaloustre as being without doubt from another colony (" il provenait sans doute d'une zone de reproduction situee a l'Est ou a l'Ouest de Pointe Geologie ").

The collections made at Dumont numbered 90 birds in five collections. (There are actually 91, but a printing error deletes one set of measurements.) Most of these measurements were of birds killed at the colonies. Each of the five groups includes some small birds: in all 16 (18%) with a wing less than 280 of which 7 (8%) have a wing less than 270.

Prevost regarded the size of bill as also important and suggested that some large-billed birds may be of the " large form " even though short in the wing. He indicated two populations separated by a wing length of 275 and a culmen height of 11. The Dumont birds exceeded these dimensions, while by contrast those from Hallett, a typically " small " population, fall below them, as do the " rare aberrant birds " of Dumont. (Actually, the diagrams as printed plot the wing length against the cumen *length,* not height.) Prevost concluded by proposing two subspecies; a larger one, *Pagodroma nivea major,* of Terre Adelie and probably the Balleny Islands, and a smaller one, *Pagodroma nivea nivea,* breeding in all other known localities.

Isenmann (1970) followed the hypothesis of two forms of the Snow Petrel and developed the proposals of Prevost while trying to embody in the hypothesis the presence of small individuals among the breeding birds at Dumont.

Isenmann accepted seven groups of birds for comparison, all from breeding colonies in summer. These were: Dumont, 86 birds (see Prevost 1969), excluding some owing to lack of data; Cape Hunter, 8 birds (see Isenmann *et al.* 1969); Cape Denison, 13 and 11 birds (see Falla 1937, and Isenmann *et al.* 1969); Mawson, 10 birds, and Davis, 20 birds (see Brown 1966); and Hallett, 20 birds (see Maher 1962). Actually, Brown had 9 birds from Mawson and 22 from Davis, but this does not alter the facts in any way. Falla's (1937) birds from Proclamation Rock, one of which was large, were not included. Where available, weight, wing, culmen length and tarsus were compared for these seven populations. Weight, of course, varied greatly during the cycle, especially during shifts of incubation. The Dumont birds were significantly different in all four dimensions from the other six populations, with a security of 95%, and none of these six showed such differences from one another.

Isenmann drew attention to the *large spread of dimensions* in the Dumont birds, which is the key statement in understanding the hypothesis of two forms. The Dumont birds' wing lengths cover 87% of the total range of all seven groups, whereas those at Davis cover only 37%. That is, the typically " small " form, as at Davis, is not only small but homogenous, whereas the " large " form is very variable in size and includes some small birds, which Prevost (1969) dismissed as " aberrant." Comparing available breeding data from Dumont with those of small birds, the Dumont birds produced a larger egg, incubated a little longer but in shorter shifts, and hatched a larger chick.

About 10-15% of the birds at Dumont, mostly large birds, nested in relatively open and exposed sites such as had not been described elsewhere. Isenmann quoted Pryor (1968) (then *in litt.*) as suggesting population pressure as a possible reason for using such unfavourable sites, although Pryor as published does not say so. Isenmann in any case rejected this theory, believing that large birds would hardly be evicted by small ones, although he seemed to assert that the *small* birds in such sites *had* been so evicted. The absence of predation by skuas at Dumont was discussed as a possible factor permitting exposed nesting, although such predation seemed only to be seen at inland colonies (Lovenskiold 1960, Brown 1966), possibly because of the absence there of Adelie Penguin colonies as a preferred food source. Isenmann was unable to correlate climatic differences with differences in the size of birds. Nonetheless, he claimed that Dumont uniquely showed an example of climate affecting size, the " electicism " of some birds in their choice of nest site having tended to favour by natural selection the development of larger birds better able to withstand the more severe microclimate of the open nest site. Isenmann concluded by proposing that the Snow Petrel is a bitypic species whose two forms show imperfect geographical isolation and some genetic mixing, e.g. at Cape Hunter. The large form shows great variability in size; the small form shows little variability.

Kinsky (1970, and pers. comm.): In an addendum to the last-mentioned paper, Isenmann reported information from Kinsky on 26 specimens collected at the Balleny Islands, and F. C. Kinsky has kindly provided me with details of these birds. This is a unique collection of entirely large birds, the mean wing being 300 (291-311) and other dimensions correspondingly large, which corroborates Wilson's observation. Kinsky points out that because of the difficult terrain he did not actually *see* breeding, but the observations of large numbers of Snow Petrels landing on cliff faces in February seems conclusive !

Kinsky's data also include the dimensions of specimens from other localities. One of 38 birds taken in November at the breeding colony at Hallett Station, although too early to be on an egg, is a large bird (291), which makes Hallett another probable breeding place of large birds. Four other birds in this group have a wing of 275-280. This collection from Hallett is in fact more numerous than that of Maher, on the basis of whose collection the French authors have continued to regard Hallett as the seat of a typical population of homogeneously small birds with a wing not exceeding 258 (data from Maher quoted in Prevost, 1969).

Watson et al. (1971) and Watson (1975) are two recent publications, which include bibliographies. Both set forth the prevailing view of the French authors, that is, that " large " Snow Petrels breed at Dumont and the Balleny Islands, and typical " small " Snow Petrels breed elsewhere.

DISCUSSION

The vastness of Antarctica is difficult to grasp and has tended to vitiate thinking about the distribution of birds. If one studies distribution maps of known breeding localities of antarctic birds, most of these localities obviously correspond with the vicinity of manned stations or of well-visited areas. For example, the Southern Giant Petrel *(Macronectes giganteus)* is known to breed at only four places around the coast of the Antarctic Continent, that is, at Casey, Davis, Dumont and Mawson (Watson *et al.* 1971, Johnstone *et al.* 1973) ! If you discover the breeding place of unusually large Snow Petrels, you can easily assume that such birds may not occur elsewhere, forgetting the enormous stretches of coast and ocean from which no specimens at all are available (see Fig. 1). The literature contains very little information on the movements of Snow Petrels in winter, of non-breeding birds in summer, or even of the feeding range of breeding birds. The rule for species which breed around continental Antarctica is *not* to show regional differentiation, and the Snow Petrel has been the single " enigmatic exception " to this rule (Watson 1975). Isenmann (1970) suggested that differing local climates, especially wind conditions, might favour the development of distinct subspecies; and yet, if such an effect exists, why does it not seem to apply to other species ?

Records of large birds fall into the three categories shown in Fig. 6, as follows:

1. Those from breeding colonies. Large birds have been shown to breed at Dumont (Prevost 1969, Isenmann 1970), the Balleny Islands (Kinsky 1970), Cape Hunter (Isenmann *et al.* 1969), Cape Denison (Sapin-Jaloustre 1951), Proclamation Rock (Falla 1937), Hallett (Kinsky, pers. comm.) and the Windmill Islands (present paper).
2. Those collected at sea in summer and coming presumably from some colony within a few hundred kilometres. Localities where such birds have been collected or reliably reported include the

seas north and east of the Balleny Islands and around Scott Island (Ross 1847, Sharpe 1902, Lowe & Kinnear 1930), the Ross Sea and Great Ice Barrier (Ross 1847, Lowe & Kinnear 1930), the seas off the Amery Ice Shelf (Falla 1937) and near the South Sandwich Islands (Bierman & Voous 1950).

3. Those collected in autumn and winter in the vicinity of wintering ships near islands in the Antarctic Peninsula (Gain 1914) and the South Orkney Islands (*Scotia* collection in Lowe & Kinnear 1930).

While Snow Petrels are known to visit land throughout the year whenever weather conditions bring open water up to the shore (Gain 1914, Prevost 1964, ANARE Station Logs), such visits seem to be concentrated in April and May (Mougin 1968). Watson (1975) states that " in some areas birds are present all the year." At the South Orkney Islands Snow Petrels were " by far the most numerous of

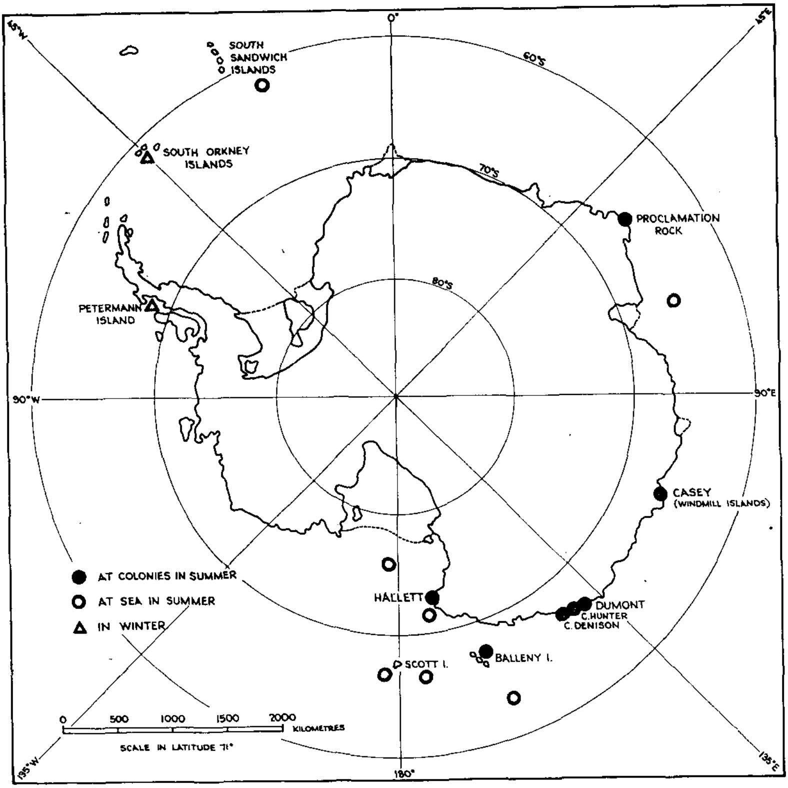

FIGURE 6 — Antarctica. Records of large (over 280 mm) Snow Petrels; when and where collected or recorded.

the few species which remained for the entire winter" (Clarke 1906), and at Petermann Island the birds spent extended periods about the wintering ship (Gain 1914).

The Snow Petrel is confined to the zone of pack ice. Complete circumpolar movements like those of the Wandering Albatross seem unlikely. The tireless glide of the Wanderer on the westerlies contrasts with the fast-beating erratic flight of this much smaller bird among the pack ice, where the winds are easterly but with irregularities in flow (Knox 1970), and where the frequent and violent local blizzards must also tend against consistent movement patterns. Any movements are more likely to be confined within a sector of longitude. Gain, too, believed that the Petermann birds bred at a colony further south, and that their seasonal movements were meridional.

The presence of small birds among the large ones at Dumont was described by Prevost (1969) as "aberrant," but was later incorporated into the hypothesis proposed by Isenmann (1970). Differences in bill size have received only cursory attention and do not seem to be regarded as a reliable sole criterion, varying with age, among other factors, though in general tending to correlate with wing length (Lowe & Kinnear 1930, Bierman & Voous 1950, Prevost 1969).

The paired distribution of dimensions shown in Fig. 4 suggests good correlation in the three dimensions, and, since wing length is easier and more accurate in the field on the live bird, I believe it should continue to be the main standard used.

Prevost (1969) suggested a separation around 275 mm wing length between two groups of birds, the "large" and "small" forms. However, I believe that my series shows a rather continuous size range in all dimensions, that is, that birds of all intermediate sizes occur between the largest and the smallest. As I have also shown, large birds do breed with small birds.

Finally, I have shown that the proportion of large birds (280 mm wing length or above) is widely variable, examples being 100% at the Balleny Islands, 82% at Dumont, 50% (4 of 8) at Cape Hunter, 35% at the Windmill Islands, single birds at Hallett and at Proclamation Rock and 0% at Davis and at Mawson. The evidence indicates a very strong individual size variation in many breeding populations of the Snow Petrel. However, since variability in size cannot be correlated with geographical distribution, the existence of two subspecies is, in my opinion, questionable.

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A STUDY OF THE GENTOO PENGUIN
Pygoscelis papua

By PAULINE N. REILLY and J. ANNE KERLE

ABSTRACT

Gentoo Penguins were studied for 3 months at four separate colonies on Macquarie Island. No external characters were found for sexing and ageing adult birds, but first-year birds could be distinguished by plumage. Breeding success varied between colonies from an estimated 0.36 to 1.14 chicks per pair. Chicks joined creches by 5 weeks of age, and they were fully feathered by 11 weeks, when the mean weight was 5.4 kg. An unusual temporary partial retention of body feathers by moulting adults was observed, and a weight loss of 3.3% per day during moult was similar to that of other penguin species.

INTRODUCTION

The Gentoo Penguin *(Pygoscelis papua)* has been studied little in comparison with its congeners, the Adelie *(P. adeliae)* and the Chinstrap *(P. antarctica)*.

On Macquarie Island the Gentoo nests all round the coast to 70 m above sea level, on gentle slopes or flattened areas covered with tussock grass *(Poa foliosa)* and Macquarie Island cabbage *(Stilbocarpa polaris)*, or occasionally on rocky open areas. It builds well-formed widely spaced grass nests. Nesting areas are well separated from three other penguin species breeding on the island. The Gentoo does not use exactly the same site in successive seasons. It is present all year, and breeding usually begins in September but is not tightly synchronised (Falla 1937, Gwynn 1953).

This study was stimulated by a 6-day visit to Macquarie Island by PNR with the Australian National Antarctic Research Expedition (ANARE) in November 1977. Between 20 November 1978 and 14 February 1979 we established a marked population, looked for external characters suitable for sexing and ageing live birds, estimated breeding success, recorded the growth rate of chicks, described moult in both chicks and adults, and tried to get information on diet. When we arrived, larger chicks had already formed creches near the nesting areas. Some eggs were still being incubated but few if any were laid after that time.

METHODS

Four study areas where Gentoos were known to have bred for at least 10 years were chosen close to the Antarctic Division station. Birds were handled at two of them but in the other two we restricted

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ourselves to regular observations only. The stage of breeding was noted at other colonies round the island.

At the study areas, preliminary counts of nests and eggs by members of the ANARE wintering party showed that breeding began in September. After our arrival we continued the counts but in greater detail. Because of the timid nature of the Gentoo and the risk of predation, considerable care was necessary in the nesting areas. Nestlings could be taken from and returned to the nest without the parent leaving, but if nests were left exposed, we covered the contents with nesting material.

All birds were caught for measuring and marking with a long-handled net or by a running tackle when in the creches or on the beach. No attempt was made to handle adults at the nest. A portable corral of stakes and string held up to 100 birds, but wire netting proved unsatisfactory because the birds could scramble over it.

Funnel-shaped bags of heavy-weight cloth-backed vinyl were most satisfactory for restraining the birds. The open narrow end allowed the bill to protrude and avoided breathing stress, noticeable with closed vinyl bags.

Bills were measured as shown by Warham (1975), and details were recorded of weight, flipper and tail length, colour of bill, feet, and underflipper, length of the strip of orange on the culmen, distension of cloaca and development of brood patch. Spotting on the head was photographed. Flipper length was measured with the rule pressed firmly into the axilla and the flipper flattened but not stretched. Chicks were weighed and plumage development noted throughout, and their bills were measured after they joined the creche. Four marked chicks were measured twice weekly.

Chicks with feathered flippers and birds of unknown age were banded on the flipper with bands supplied by the Australian Bird-banding Scheme, Division of Wildlife Research, CSIRO. Birds were dye marked with Rhodamine B in alcohol or Bendix purple meteorological ink, and this enabled us to follow four nestlings through to fledging.

To determine the rate of weight loss and progress of adult moult, 25 birds were kept penned, and their moult and weight were recorded on capture and thereafter on every third day.

A stomach pump (Emison 1968), a gastrotomy operation and freshly dead specimens were all tried for the collection of stomach contents.

RESULTS

Banding and morphology of adult Gentoos

In total 413 Gentoos were banded, of which 161 were chicks. This includes 62 banded by G. W. Johnstone in February 1978. Breeding birds were regularly found resting or later moulting with colonies away from their nesting area.

Adult measurements are listed in Table 1. There was a tendency towards a bimodal distribution of bill depths but not of bill lengths (Fig. 1). The sample of weights included both breeding and non-breeding birds but few, if any, approached the heavier weights recorded during moult. The inclusion of 56 birds weighed on 2 January 1979, when moult was first recorded, increased the mean weight by only 100 g.

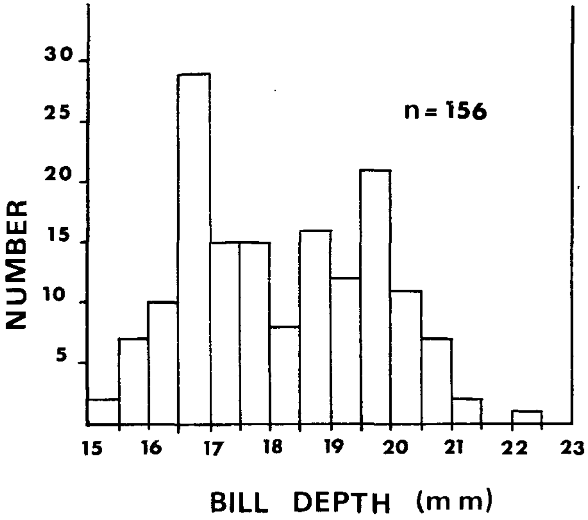
We found a gradation of bill colour from orange to salmon pink, not sexual dimorphism in bill colour, as suggested by Despin (1972). Variation in colour was also apparent on the feet and under-flipper. In addition, two specimens with salmon-pink bills were examined: one had active testes and the other had active ovaries.

A strip of orange on the black culmen was first noted on some birds by G. W. Johnstone (pers. comm.). We found the mean bill depth of birds with this orange strip significantly greater than that for all birds ($p < 0.01$). On some retrapped birds the length of the strip had either increased or decreased, perhaps because the ends were often indistinct. A spot of colour was also noted on a newly feathered chick but this had disappeared after 10 days.

Gentoos showed variable amounts of head spotting but, apart from identifying one-year-old birds, which had few spots and lacked the white orbital ring of the adult, this character was not useful for sexing or ageing. Because most incubation had finished, sex or breeding status could not be determined by distension of the female cloaca (Serventy 1956) or by the presence of a brood patch.

TABLE 1 — Measurements of live Gentoo Penguins of unknown age and sex. Measurements in mm

	Mean	s.d.	Range	n
Weight (kg) 22/11 - 19/12/78	5.7	0.61	4.2 - 7.2	97
Bill depth	18.3	1.6	15.3 - 22.2	156
Bill length	56.3	3.3	48.3 - 63.8	136
Bill width	10.0	0.8	8.6 - 11.3	16
Tail length	143	6.2	130 - 153	12
Flipper length	230	0.8	210 - 240	19
Length of orange on culmen	17.3	9.7	3 - 38	43



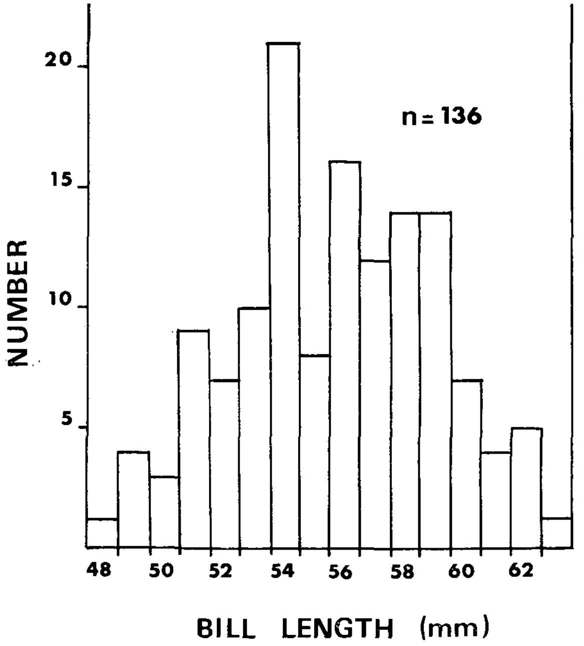


FIGURE 1 — Histograms of Gentoo bill depths and bill lengths measured in this study.

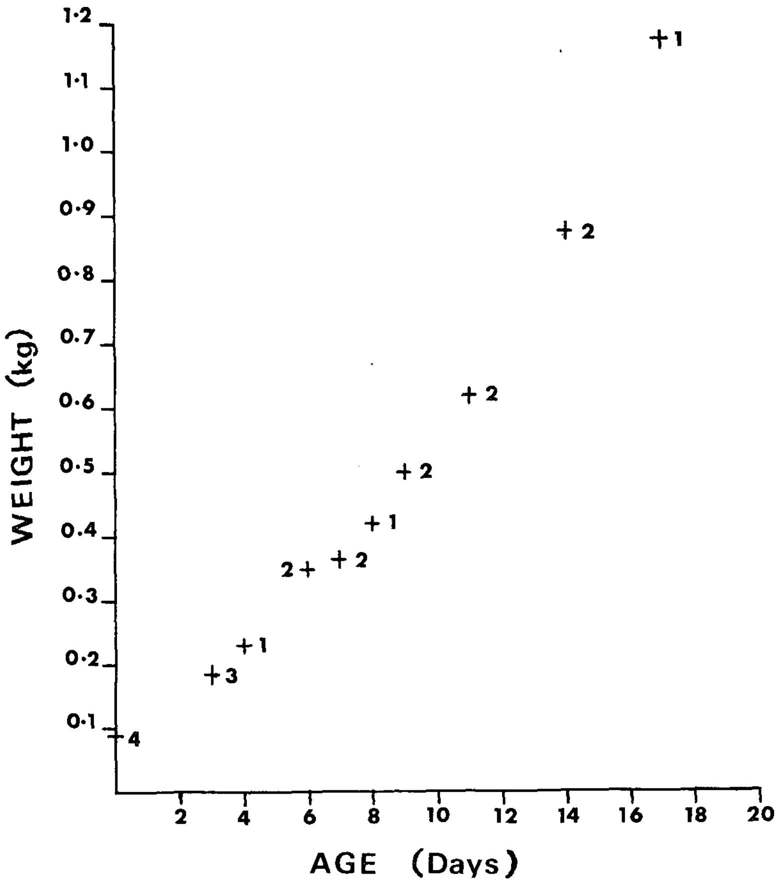


FIGURE 2 — The early growth of Gentoo chicks from hatching to 17 days (sample size is indicated by figures).

Breeding success

Breeding was well advanced when we arrived and we were unable to obtain an accurate estimate of breeding success but some indication was possible using earlier counts of nests and eggs and our subsequent counts.

The two study areas where birds were handled produced 0.90 and 0.93 chicks per pair; and the other two areas, 0.36 and 1.14 chicks per pair. Normal clutch size was assumed to have been two eggs per nest (Gwynn 1953). All eggs or nestlings still present when we arrived were unsuccessful, apart from the four largest nestlings, which were almost to creching stage.

Chick growth and plumage development

Because most late nests failed, our information on chick growth is based on the weights of only 20 nestlings. Nine were weighed once, three twice, four 3 times and four through to fledging. Only five were of known age. Figure 2 shows the early weight increases of these chicks and their estimated ages. The growth of four chicks through to fledging is shown in Figure 3.

The mean weight of 145 fully fledged chicks was 5.4 kg (s.d. 0.54, range 3.7 - 6.7 kg). The bill size of 65 fully feathered chicks lay within the range of adult measurements but most were below mean adult size.

The protoptyle down was replaced by the mesoptyle down at the end of the first week. The following plumage development of chicks and the ages and mean weights at which the various stages

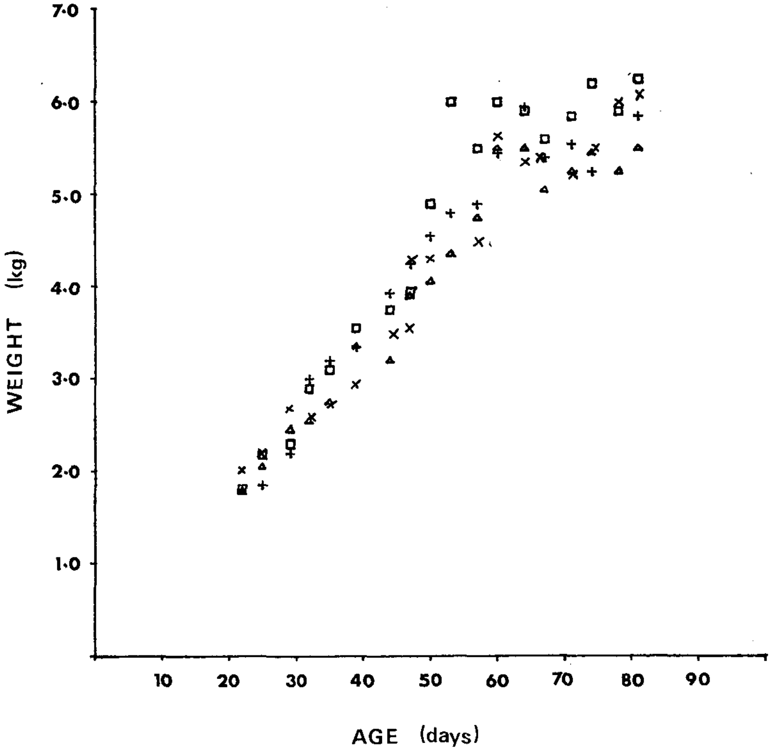


FIGURE 3 — Growth of four Gentoo Penguin chicks from 20 to 80 days, each chick represented by a different symbol.

occurred was determined from the four marked chicks and other observations. The stages of feathering, estimated age at the start of each stage, and the mean weight were as follows:

1. 18-29 days: Start of growth of rectrices
   32-35 days: Appearance of white head-spotting
   39 days: Feathering of tail coverts

   During this period the mean weight was 3.3 kg (range 2.8 - 4.2, n = 11).
2. 47 days: Feathering of underflipper and thinning of down over supraorbital band. Mean weight 3.9 kg (range 3.4 - 4.9, n = 8.)
3. 47-53 days: Feathering of frons and thighs. Mean weight 4.4 kg (range 4.0 - 5.1, n = 8)
4. 53-57 days: Feathering of upperflipper; head mostly clear; underflipper mostly fully feathered. Mean weight 4.7 kg (range 4.3 - 5.5, n = 8)
5. 50-60 days: Head, throat and chin clear; start of feathering on centre of back; upperflipper half-feathered. Mean weight 5.1 kg (range 4.0 - 6.1, n = 12)
6. 60-67 days: Start of feathering on breast or abdomen; back half to fully feathered; upperflipper one half to two-thirds feathered. Mean weight 5.5 kg (range 4.7 - 6.3, n = 13)
7. 63-71 days: Feathering round neck; some patches of down remaining on breast and/or abdomen and upperflipper. Mean weight 5.4 kg (range 4.7 - 6.5, n = 7)
8. 71-74 days: Fully feathered

First-year plumage was distinguishable from the adult by the grey rather than black throat, few or no white orbital feathers and few spots on the head.

The four marked chicks spent less and less time at the nest, until they joined the creches when about 32 days old (the youngest was 25 days). Initially, small creches were scattered throughout the breeding area but these merged, and eventually all chicks migrated to the beach. At this time the four marked chicks, the youngest in the creche, were between 44 and 53 days old. Chicks from one study area with two nesting sites 300 m apart joined to form one creche when they moved to the beach.

Two chicks still downy on the breast entered the water when escaping from us but they were not proficient swimmers. Normally chicks began swimming within a week after becoming fully feathered, and by the first week in January many went to sea during the day and returned to their natal creche during the afternoon. Dye-marked chicks were first observed with other creches at the beginning of

February. From the middle of January the four marked chicks were hard to find, and the youngest was seen at another creche 2 km south when it was about 100 days old.

Moult

Birds nearing moult were heavy, clumsy, and tobogganed rather than ran. The first moulting bird was seen on 2 January 1979. On 10 January we caught, marked and released three beginning to moult, hoping to observe them without further handling. All soon disappeared and two were seen 4 days later, 0.5 and 1.5 km distant. Other birds in full moult swam away when disturbed though most stayed ashore.

There was some variation in the sequence and duration of moult of the 25 captive Gentoos. We defined the beginning of moult as the time when feathers started to lift and stand out from the body before being shed. Birds were released before they had completely lost all old feathers and when the rectrices were about 0.5 cm long. Eleven were released after 15 days of moult, 12 after 18 days, one after 21 days and one when only half moulted. All were in good condition.

The sequence of adult moult was as follows:

Pre-moult:	6 days:	Up to 40% weight increase; feathers dull and brown
	3 days:	Loss of some tail feathers; flippers swollen and bleeding readily
Moult:	0 days:	Body feathers lifting; tail lost
	0-3 days:	New feathers on thighs, upper and under tail-coverts
	3-9 days:	Partial loss of feathers from the breast, abdomen and from below the mantle to the tail; remaining old feathers concealing the new ones underneath. Feathers lost in complete patches from head, chin and flippers and re- Narrow band of new feathers encircling body at upper breast and mantle.
	9-14 days:	New plumage increasing, leaving only partial layer of old body feathers (see Fig. 4)
	15-21 days:	Sheathed tail growing approx. 1 cm every 3 days. Final gradual loss of remaining old feathers, giving a mottled appearance on dorsal surface.
Post-moult:		All birds, including one-year-olds, in typical adult plumage with black throat, white band across crown, white orbital ring and variable amounts of head spotting.

FIGURE 4 — Gentoo Penguins showing different stages of moult. The bird second from left is beginning to moult and losing some of its body feathers. The bird on the right is further advanced, having some of the old feathers still on its back.

The 24 birds that almost completed moult lost, on average, 3.3% of body weight per day (s.d. 0.33). For a weight loss of X to Y in n days, the " compound interest " % weight loss per day is (100/n) ln (X/Y). Peak weights of the birds ranged from 6 to 9 kg. so although weight loss in grams per day was variable it was very nearly constant when compared as a percentage of body weight. Figure 5 shows mean weight loss of birds during moult. One bird, 4.2 kg when released, had gained 1 kg when recaptured 3 days later.

Moulting birds stood pecking distance apart in the pen, and also in the wild, where they gathered on the lee side of rocks and hummocks on beaches or in fringing tussock grass. They did not maintain this distance at other times. They drank from a natural pool in the pen. Allopreening was not seen.

When released, some birds joined groups of creching chicks and pre-moulting and moulting birds. Others, including the one half-way through moult, immediately entered the water. All appeared to swim normally. Five of the released birds were later seen on other beaches, one 24 days later, 3 km from where it had been released, with moult complete but still without visible tail feathers.

Diet

Our attempts to obtain stomach contents produced little result. No recognisable items were collected by stomach pump. Palpation of the stomach after laparotomy indicated it to be empty except for pebbles, and gastrotomy was not proceeded with. Pebbles were also found in stomachs of dead birds, but little else. Squid beaks were collected when regurgitated by one adult and one chick.

DISCUSSION

Sexing and ageing

Bill depth and length have been successfully used to sex other penguin species (Downes *et al.* 1959, Kinsky 1960, Reilly & Balmford 1975, Boswell & McIvor 1975, Warham 1975) and may be useful for the Gentoo with further data from birds sexed during egg-laying. No other character such as body size (Falla 1937, Stonehouse 1970) or bill colour (Despin 1972) was of use in sexing Gentoos.

Apart from distinguishing first-year birds, we were unable to determine the age or breeding status of others. The strip of orange on the culmen may be a sign of maturity because it occurred only over the higher range of bill depths. We have not found any other reference to this character.

A faint orange colour on the underflipper of both adults and chicks appeared to be caused by deposits of orange fat showing through the skin. Towards the end of moult, when fat deposits dwindled, this colour became very faint. It does not seem to be a breeding character, as suggested by Murphy (1936), nor is it equivalent to the pink flushing displayed by some penguins when cooling after exercise.

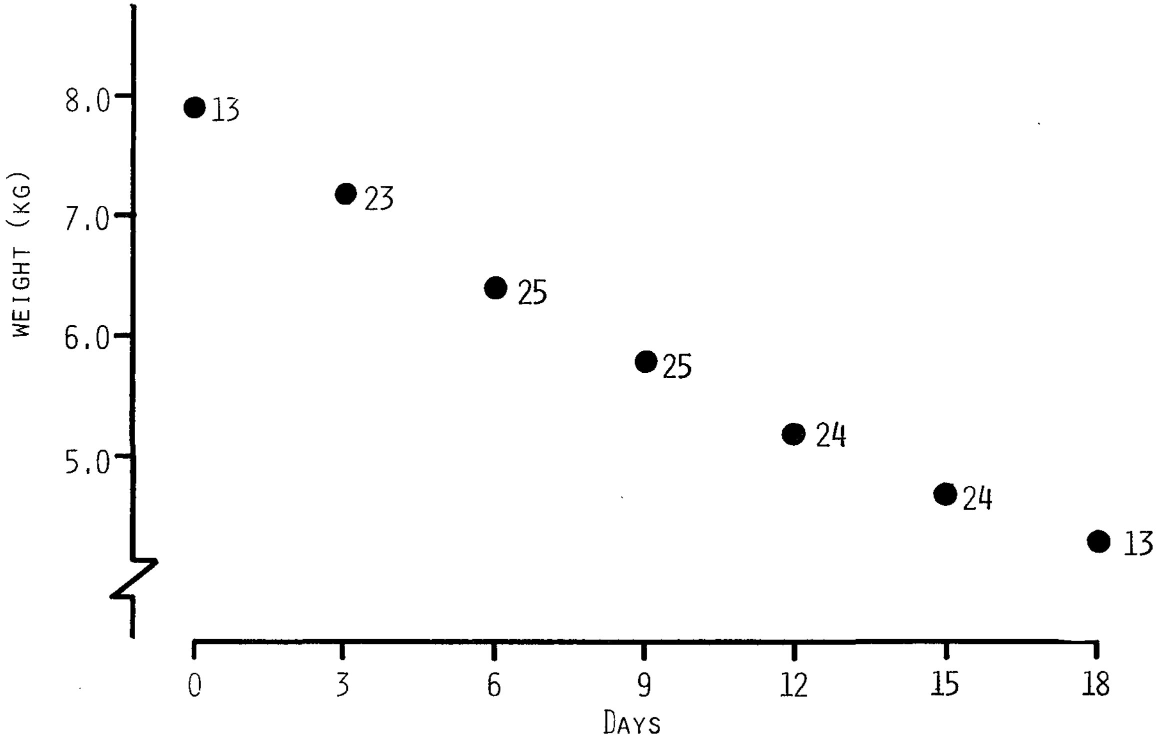


FIGURE 5 — Mean weight loss of adult Gentoos during moult. (Sample size is indicated by figures).

Chick growth and development

Weights of the four marked chicks increased steadily until they were about 55 days old. From that time the weights fluctuated, perhaps because the time of weighing varied from the time of feeding. Despite this, the mean weight of fully fledged chicks of 5.4 kg was significantly greater than that found by Bagshawe (1938) ($p < 0.05$). The average weight in Bagshawe's sample of 34 birds was 4.5 kg (s.d. 0.5, range 2.9 - 5.4).

We found less variation in the degree of whiteness on the throat and round the eye of immature birds than Bagshawe (1938), and the eye fillets extended from eye to eye rather than having an intervening band of " pepper and salt " like the Heard Island birds (Downes *et al.* 1959).

The four marked chicks began creching at about 4 weeks (25 - 32 days) compared with 35 days on Marion Island (Van Zinderen Bakker 1971) and up to 42 days on Heard Island (Downes *et al.* 1959). From the time they joined the creches chicks could defend themselves from skuas.

Moult

We have found no detailed description of moult of the Gentoo in the literature. Murphy (1936) claimed the tail was moulted last but mentioned that others disagreed. We always found the loss of the tail to indicate impending moult, and post-moult adults could be distinguished from newly fledged young because they had no tail. The rectrices were last to grow. Van Zinderen Bakker (1971) stated that the head and neck were the last parts to moult and made no mention of the temporary partial retention of feathers which we

TABLE 2 — Comparative weight loss by six species of penguin during moult

Species	Per cent loss/day	Sample size	Initial weight (kg)	Number of days	Reference
Emperor	2.80	4	ca 34	12?	LeMaho *et al*. (1976) p. 917
Gentoo	3.34	24	6-9	15-18	This study
Macaroni	2.73	10?	5.9	35	Williams *et al.* (1977) Fig. 1
Blackfooted	3.03	1	3.11	20	Cooper (1978) Fig. 2
Rockhopper	3.24	9?	3.6	25	Williams *et al.* (1977) Fig. 1
Little	3.78-3.19	Many	1.5-1.8	7-20	Hodgson (1975) 4.3, Table 4.31, 4.32

observed. Indeed, partial moult such as this does not appear to have been previously recorded for any penguins. Roberts (1940) claimed that the mandibular plates were shed during moult but we did not see any evidence of this either in the pen or on the beaches.

Stonehouse (1968) stated that moulting penguins rode high like ducks if they accidentally entered the water and Bagshawe (1938) noted three swimming in shallow water close to the shore. On a number of occasions we observed moulting Gentoos swimming. They swam underwater and were observed " porpoising " but most were quickly lost to sight. Usually they retreated to the water to escape. The temporary partial retention of body feathers may provide some insulation until the new feathers grow, allowing at least short periods in the water.

Comparative figures for the weight loss by six species of penguin during moult are shown in Table 2. The % weight loss per day for each of these species is surprisingly similar despite the differences in size and duration of moult.

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Members of the 1979 ANARE wintering party on Macquarie Island assisted by making our stay enjoyable and field assistance was provided by N. Brothers, G. Copson, M. Durre, B. Harvey, R. Hutchinson, R. Millard, L. Olsen and A. Winter. We also thank E. Borschmann and W. Plant of the 1978 ANARE wintering party for their nest counts.

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THE NEW ZEALAND DABCHICK ON LAKE ROTOITI

By C. H. and J. R. LUSK

ABSTRACT

During December 1980, 121 adult New Zealand Dabchick *(Podiceps rufopectus)* and 14 young were counted on Rotoiti. Their distribution on the lake is discussed in relation to habitat and resources. Nesting habits and the effects of weather and recent habitat changes are also discussed. In spite of high nest failure, the population on Rotoiti appears to be stable.

THE CENSUS

Rotoiti, one of the larger lakes of the Rotorua district, has an area of 37 km^2 (McColl 1974) and a shoreline length of 57 km (F. A. Tercel, Lands and Survey Dept, pers. comm.). It is a mesotrophic (moderately productive) lake with a maximum depth of 93.5 metres (Irwin 1969).

The lake was circumnavigated by canoe, and the counts were made without optical aids. The counts were made during only 4 days (28-31 December 1980) to reduce error resulting from movements of Dabchick around the lake. Each bird was listed as " adult " or " young," the latter category including chicks and juveniles. The distribution of adults only is shown in Fig. 1. 121 adults and 14 young were counted, but these are probably slight underestimates because on about six occasions the behaviour of a solitary adult suggested a mate was hidden nearby on a nest, and we may have missed a few young chicks riding on parents' backs or hidden among vegetation.

DISTRIBUTION IN RELATION TO HABITAT

The distribution of Dabchicks on the lake during the breeding season seems to be explicable in terms of just two major factors — food, and nesting cover and shelter.

1. *Food:* Dabchicks obtain most of their food by diving and so require suitable shallow-water feeding habitat.
2. *Nest sites and shelter:* Potential nesting cover may seem to be available on most of the shoreline of Rotoiti, but, as noted by Buddle (1939), nesting sites that are likely to be successful are not plentiful. Shelter from waves is clearly important for a good nesting site.

The highest numbers of Dabchicks were found in the Motumauri region, where the indented rocky coastline provides sheltered nest sites in caves and crevices. Many birds were found in the shallow narrow

NOTORNIS 28: 203-208 (1981)

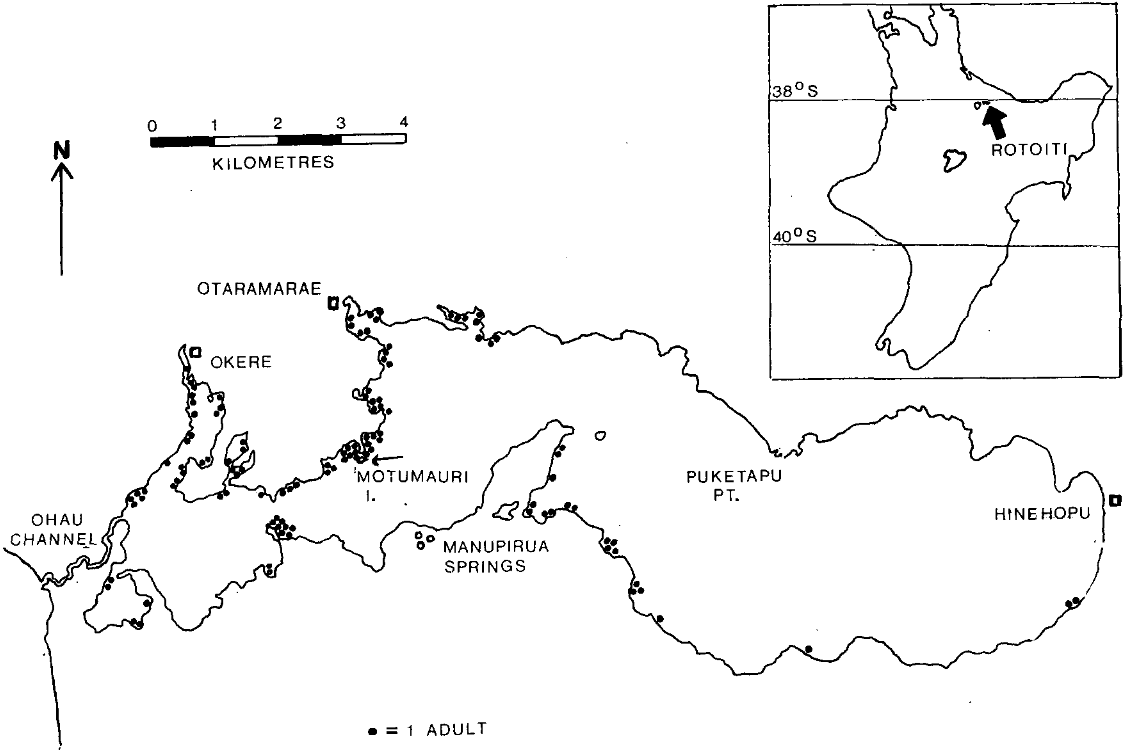

FIGURE 1 — *Lake Rotoiti, showing distribution of adult Dabchicks, December 1980. Not shown, 8 birds (4 pairs) in Ohau Channel.*

arms and sheltered bays of the western end, where willow trees provide nesting cover and beds of the emergents *Typha orientalis* (raupo) and *Scirpus lacustris* (a large leafless sedge) at least partly buffer the shore against waves and powerboat washes. But even the best-sheltered nest is vulnerable to a rise in lake level.

The eastern end of Rotoiti had very few Dabchicks, and from our experience we know of only one successful nesting place in the whole eastern half of the lake — in Korokitewao Bay, near Hinehopu. Here we observed successful nesting in rock crevices twice in 1978, but this bay was not occupied by Dabchicks at the time of the December 1980 census. Some areas clearly lacked nesting sites and/or shallow-water feeding habitat, e.g. from Puketapu Point to Hinehopu, where the forested rocky shore plummets steeply into deep water. But considerable lengths of open shoreline, mainly in the eastern half of the lake, despite the presence of shallows and seemingly suitable nest sites, had few or no Dabchick. This shows the Dabchick's need for shelter and its avoidance of open shores exposed to a large body of water.

Several hot springs feed the lake on the south side of the western half. These thermal areas seem to have no marked effect on the distribution of Dabchicks, at least during the breeding season.

In addition to the main settlements at Hinehopu, Otaramarae, Okere and Mourea (at the Ohau Channel), smaller pockets of settlement are scattered around the lakeshore. Many of the dwellings are holiday cottages rather than permanent residences, and the level of human usage of the lake varies throughout the year. During summer, Rotoiti is very popular for fishing, water-skiing and other recreation. Dabchicks apparently show no strong tendency to avoid settled areas or water-ski lanes, unless these areas lack food, nesting cover or shelter.

NESTING HABITS ON ROTOITI

The following information is extracted from notes and records accumulated since December 1976.

Nest sites and materials: 24 nests were sited as follows.

Seven supported by or anchored to branches (usually willow) trailing in water
Six in caves or rock crevices
Three resting on lake bed, sheltered among emergent vegetation in shallow water
Two resting on lake bed in shallow water, attached to trailing willow branches
Two on land, among herbage at water's edge
Two resting on lake bed in " wet " boatshed
One on concrete wharf pile, just above later level
One attached to the stern of a boat in " wet " boatshed

The last-mentioned nest was curious indeed. It was a large pile of material jammed between the stern board and a small boarding ladder outside the boat, with the egg bowl about 20 cm above the water. By a " wet " boatshed we mean a shed where the boat floats in the water instead of being raised above the water on a ramp.

In our experience, Dabchick nests seldom are truly floating in the manner of many nests of the Australian Coot *(Fulica atra australis)*. Dabchick nests at Rotoiti are composed mainly of waterlogged and decomposed plant matter and so have very little buoyancy. In addition, the materials have little or no binding, and so the nest may need continual attention from the birds to prevent its disintegrating.

By comparison, Coot nests seem much better suited to surviving bad weather, Coots having a very different nest-building " technology " from Dabchicks. Coot nests at Rotoiti are built mainly of strong buoyant materials (fresh stems of the emergent plants raupo and *Scirpus*), which are woven together to form a robust structure. We noted several occupied nests of Coot and Pukeko *(Porphyrio porphyrio melanotus)* surviving a very destructive storm on 20 January 1981. These nests, loosely moored to the surrounding emergent vegetation, floated with the rising waters and rode the waves, whereas all six Dabchick nests under observation at the time were destroyed.

Eggs: From a sample of ten full clutches, the mean clutch size was 2.2 (range 2-3, S = 0.79). The laying interval appears to be 2 days but may be irregular. Whether or not the bird covers the eggs with weed, as many grebes do, seems to depend on the disposition of the individual bird and the circumstances of its departure from the nest. It seems that the bird covers the eggs more often when it leaves the nest of its own accord than when it is flushed at close range.

During the 1980-81 breeding season, we recorded a likely case of two females laying in the same nest. The nest was in a cave near Motumauri Island. On 28 and 31 December 1980 it contained two eggs, but on 7 January 1981 there were four eggs. On each occasion a bird was sitting, but although the bird leaving the nest always joined another Dabchick outside the nesting cave, we could not be certain of the number of birds attending the nest. Many Dabchicks were in this area, and so several birds were always close to the nest. Although one bird may perhaps have laid all the eggs at irregular intervals, it seems far more likely that two females had each laid two eggs in the nest. Brood parasitism and polygamy have been recorded for a few North American grebe species (Bent 1963), but these are not known as normal grebe habits.

Hatching success: Out of 13 nests followed through to a conclusion (i.e. proven hatching or failure), only 3 (23%) produced chicks. From a total of 29 eggs laid in the 13 nests, 5 (17%) were hatched. Buddle (1939) believed that a pair of Dabchicks on Rotoiti would probably rear one, or rarely two clutches out of five or six laid during each breeding season. Our results confirm his estimate of low productivity.

Nest failures: Of the nine nests followed through to a conclusion during summer 1980-81, none was successful.

Two nests in the Ohau Channel were apparently swamped by boat washes. Unfortunately, the speed restriction sign at the Rotoiti end of the channel is overgrown and not conspicuous to boat users. Natural waves of any size do not develop in this channel, and so before the advent of power boats, this must have been one of the safer parts of the lake for Dabchick nesting.

Six nests (not in the channel) were washed out in a north-easterly storm on 20 January 1981. During this storm the lake level rose at least 10 cm, and the combination of waves, heavy rain and rising waters may have destroyed all the Dabchick nests on the lake at that time.

One nest was apparently deserted shortly before the storm.

DISCUSSION

In 1938, Buddle estimated that about 50 pairs of Dabchick were breeding on Rotoiti. As he had the use of a boat (implied *in* Wilson 1959), his estimate was probably reasonable. Therefore, the species seems to be at least holding its own on this lake (121+ adults in December 1980).

Weather seems to be a major factor controlling the size of the Dabchick population on Rotoiti, mainly by destroying nests. However, intensive human settlement has brought new pressures into the Dabchick's environment; notably motor boats and the water-loving Norway rat *(Rattus norvegicus)*. Indeed, rats were cited by Buddle as a major nest predator. The persistence and perhaps even modest increase of the Dabchick on this lake in spite of these new pressures might suggest that some other modification of the lake environment by European man has actually favoured the Dabchicks. For example:

1. The establishment of willows around much of the lake shore may have improved conditions for nesting, and
2. Enrichment of the lake due to catchment modification may have resulted in an improved food supply for Dabchicks.

Alternatively, European settlement may have had no greater impact on the Rotoiti Dabchick population than the Maori and the Polynesian rat or kiore *(Rattus exulans)*, which had been present for hundreds of years previously. However, this explanation seems unlikely because

1. The Dabchick is not likely to have been of interest to the Maori as food, and indeed is never prominent in middens (P. Milliner, pers. comm.); and
2. *Rattus exulans* is much less aquatic than the more recently introduced *R. norvegicus* (Atkinson 1976) and therefore probably had less influence on Dabchick mortality.

A third possibility is that the population on Rotoiti (and on other similar lakes) is not actually self-sustaining but is supplemented by post-breeding immigration from small ponds and farm dams, where perhaps nesting is safer (no boats or large waves) but food is limited. The Dabchick is known to be rather mobile after the breeding season, at least in the southern North Island (Stidolph & Heather 1978), but very little is known about its breeding success on smaller bodies of water.

In summary, despite heavy nesting losses, the Dabchick appears to be maintaining its population on Rotoiti. The persistence of breeding Dabchicks around settled areas of the lake shore shows some ability to adapt to a man-modified environment and to tolerate moderate levels of human activity.

ACKNOWLEDGEMENTS

Thanks are due to R. A. Fordham, B. D. Heather and R. B. Sibson, who read drafts of this manuscript and offered guidance and helpful comment.

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SHORT NOTES

SEABIRDS NESTING AT NORFOLK ISLAND

The following is a summary of the breeding and status of seabirds on Norfolk, Nepean and Philip Islands as observed in December 1978 and December 1979. The first visit was 3-8 December, when seabird censusing was part of my activities at the RAOU field outing. The second visit, 9-23 December, allowed more time to concentrate on banding, measuring and censusing seabirds.

As Moore (1981) points out, little has been published on Norfolk Island birds, despite the considerable amount of information that has been collected. In that these notes include Nepean and Philip Islands and were made during a month not included in Moore's summary, they add usefully to that summary. All measurements are in millimetres.

BLACK-WINGED PETREL *Pterodroma nigripennis*

Local information suggests that numbers on Norfolk have decreased. Cat-killed remains of two were found at Ross Point and Collins Head. Live birds were seen at Ross Point during the day and heard there at night. One was seen at Anson Point during the day.

On Philip, some were seen flying over and landing at their burrows on the slopes above and to the east of the north coast landing. Between dusk and 2300 hours, 12 were caught outside or entering their burrows. The population is estimated to be 50-100 pairs. Not one was seen on Nepean.

Measurements of nine live birds were: wing 226.9 (221-231), SD 3.8; culmen 23.7 (21.8-24.5), SD 1.2. Two wing spans were 744 and 748. One had tarsus 29.3, toe 35, length 290, and tail 105.

WEDGE-TAILED SHEARWATER *Puffinus pacificus pacificus*

The vast majority nest on Norfolk itself where, in some places, the large numbers burrowing under the kikuyu-grass pasture at the cliff edges are causing erosion.

On both visits the birds were incubating, and 16 were taken from their burrows during the day. This was about a third of the burrows sampled and the birds were presumed to be beyond reach in most of the rest. At night the surface was covered by thousands of birds. In five nights 800 were banded, and I estimate that several hundred thousand are using the island. Hundreds of cat-killed carcases litter the breeding colonies. About eight surface eggs were found. One bird handled had a white tail feather. Owen Evans, the local bird bander, finds from one to four with similar white tail feathers each season.

The whole surface of Nepean is honeycombed with their burrows, but they are less common on Philip.

NOTORNIS 28: 209-219 (1981)

Measurements of eight live birds and 27 incomplete carcases on Norfolk were: wing 310 (300-324), n = 35, SD 7.0; culmen 40.4 (38.4-43.2), n = 17, SD 1.3; tarsus 51.3 (48.1-53.6), n = 31, SD 1.6; toe 62.1 (55.6-67), n = 29, SD 2.0; length 462 (442-471), n = 8, SD 9.5; tail 141 (133-149), n = 22, SD 4.7; wing span 1061 (1032-1100), n = 10, SD 22.3.

Five surface eggs measured 43 (41.4-44.4) x 67.4 (65.7-68.7) mm.

LITTLE SHEARWATER *Puffinus assimilis assimilis*

No live birds were seen as they breed in winter. Dead nestlings and adults of 2 or 3 months' decay were found on Nepean and Philip.

Measurements of two adults from Nepean were: wing 172, 176; culmen 23.1, 23.6; tarsus 37.2, 37.0; toe 43.7, 40.2; tail —, 65.

AUSTRALASIAN GANNET *Sula bassana serrator*

In both years four pairs were seen incubating on the south clifftop of Philip. Breeding was first recorded on Nepean in November 1961 (McKean *et al.*). One bird was seen circling low over the north end of Nepean.

MASKED BOOBY *Sula dactylatra*

Two hundred pairs breed on Nepean and 100 pairs on Philip. Breeding was more advanced on Philip, where fledglings were common and eggs few. On Nepean more eggs and young chicks than fledglings were present. The last adults at the remnant of the 100-acres colony on Norfolk were killed during the 1977-78 season.

RED-TAILED TROPICBIRD *Phaethon rubricauda*

At least 200 pairs were breeding on Norfolk. Most were incubating, although no chicks had hatched. Some eggs were laid during our stay and some prenesters were active in selecting sites. Some eggs were found broken.

Some 10-20 pairs were nesting on the north side of Philip with more on the south side (see Tarburton 1979). No nesting was observed on Nepean.

Measurements of 30 birds were: wing 353 (335-375), SD 9; culmen length 67 (61.8-70.5), SD 2.1; culmen width 26.8 (24.8-29.7) SD 1.2.

Twenty eggs measured 67.2 (62.7-73.9) x 47.5 (42.2-49.2).

SOOTY TERN *Sterna fuscata*

Probably 40 000 - 70 000 pairs nest on Philip and several hundred pairs under the low shrubby patches of white oak *(Lagunaria patersonia)* on Nepean. A few half-grown chicks indicated that the annual egg-collecting (October-November) had not been completely destructive. Most birds were still incubating their replacement clutches or guarding very young chicks. Some also nest on Bird Rock and adjacent stacks off the north coast of Norfolk.

Two birds from Norfolk measured: wing 294, 305; culmen 42.9, 45.3; tarsus 25.2, —; toe 28.9, —; tail 163, 192.

COMMON NODDY *Anous stolidus*

The few hundred that nest on the ledges of Philip had either eggs or chicks up to about 3 weeks old. Some were nesting on the stacks on the north side of Norfolk. No pairs were observed on Nepean.

BLACK NODDY *Anous minutus*

About 30 pairs were found nesting on two remaining white oaks on Philip. Two colonies were found on Norfolk in Norfolk pines *(Araucaria heterophylla)*. About 100-150 pairs were in each. One was in a gully between Bloody Bridge and Collins Head, the other just east of Rocky Point. Some birds were incubating and some shell fragments were found on the ground.

Measurements made on Norfolk were: wing 222, 234; culmen 37.2; tarsus 25.

GREY TERNLET *Procelsterna cerulea*

On Philip, 15-20 nests were found. They were in cavities around the landing and on the ground under trees towards the summit. There were numbers of birds on the stacks off the north coast of Norfolk and two carcases were found in a cat's cache near the Captain Cook Memorial, indicating nesting nearby. One leg was found at Rocky Point. No nests were seen on Nepean.

Measurements of two wings were 203 and 205. One egg measured 41.3 x 28 mm.

WHITE TERN *Gygis alba*

Eggs and chicks at all stages of development were found on Norfolk pines and white oaks over a wide area of Norfolk. Cat killed remains were common. None nests on Nepean or Philip.

Measurements made on dead material were: wing 252 (244-262), n = 23; culmen 32; tarsus 14.4; toe 28.9, 27; tail 104, 120.

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HEAD PLUMAGE VARIATION AND WINTER PLUMAGE OF THE SOUTHERN CRESTED GREBE

Descriptions of the Southern Crested Grebe *(Podiceps cristatus australis)* either do not mention any physical differences between the sexes (Oliver 1955, Slater 1979) or describe the sexes as "alike" (Falla *et al.* 1979).

While working on the ecology of this species, I noted that males and females differ in head plumage and in stature (Figure 1; also Plate 4 in Soper 1965). In the field, the major difference was the presence of white plumage above and in front of the eye in the female. This was distinct in 93% of females (n = 28) in my study area, the Ashburton Lakes. Of 29 males, 86% had black crown plumage extending down to the eye. Male grebes also had markedly thicker necks, a longer bill and larger tippets on the cheeks. Overall, males appeared slightly larger with brighter plumage. Differences were particularly obvious when a pair was together. Examination of museum skins did not completely support this observation. Some females are dark in front of and above the eye, and one male is light in the same area (J. A. Bartle, National Museum). Two out of the three sexed skins in the Canterbury Museum support my observations.

It has been stated that Crested Grebes in Europe (Cramp & Simmons 1977), Australia (Slater 1979) and New Zealand (Falla *et al.* 1979) lose their conspicuous breeding plumage during the winter. Of 35 grebes observed in March 1980, 21 in July 1980, 42 in July 1981 (Ashburton Lakes, pers. obs.), 13 in May 1981 (West Coast, pers. obs.) and 8 in July 1981 (Pearson Lakes, P. M. Sagar, pers. comm.),

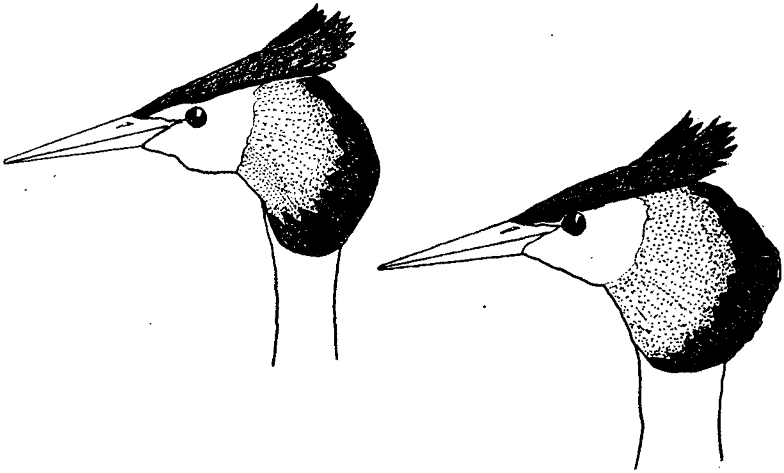

FIGURE 1 — Head plumage variation in the adult Southern Crested Grebe. Left: female. Right: male.

all but one were in full breeding plumage. Tentative conclusions drawn from my breeding data suggest that in New Zealand classical " winter plumage " is really that of the first-year immature. The head crest is smaller and browner than in the adult, tippets are marked by an indistinct ruff and the bill is yellow-ivory. Immatures lose the remains of their striped head plumage by 4-5 months.

Finally, Cramp & Simmons (1977) state that the subspecies *australis* lacks a white line over the eye. While not as distinct as in the nominate form of *cristatus,* white plumage above the eye was present in many of the grebes I studied and in some museum specimens.

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ANOTHER ARCTIC TERN AT THE TARAWERA RIVER MOUTH

On 17 May 1981, I noticed an Arctic Tern *(Sterna paradisaea)* roosting at the edge of a mixed flock of White-fronted Terns *(S. striata)* and Black-fronted Terns *(S. albostriata)* at the Tarawera River mouth. This is the second that I have seen there; the first being on the 10 June 1978 (*Notornis* 26: 63-67).

When compared with the 1978 bird, this one showed a fainter carpal bar, a totally black bill and tail streamers slightly shorter than the tips of the folded wings; otherwise it appeared identical.

On this occasion I made a more critical comparison with the White-fronted Tern; the very short red legs, resulting in the bird's belly almost touching the ground, again being the most obvious distinguishing mark. The darker grey mantle and upper wing surface, the longer dark-grey-edged tail streamers and smaller body size were seen as before. However, some further differences were noted.

1. Steeper forehead.
2. Greater extent of white on the crown.
3. Bill more dagger shaped; having a straighter, less bow-shaped top edge to upper mandible; also noticeably shorter and proportionately deeper at the base; no horn-coloured tip.
4. The forward edges of the dark cap, where the white encroached on the black on the crown, and about the eyes, was sooty brown. This was in marked contrast to the shiny black of the remainder of the cap from hind-crown to lower nape. It was this that first drew my attention to the bird as at that stage all I could see was its head and neck.

This bird, like that of 1978, was part of the flock, though at the edge of it, but unlike that of 1978 it was aggressive, jabbing at any White-fronted Tern that came too close.

P. C. M. LATHAM, *c/o Papamoa Beach P.O., via Te Puke, Bay of Plenty.*

FURTHER SIGHTINGS OF NORTHWARD MIGRATING SHORT-TAILED SHEARWATERS

The note by Neil Cheshire (1980, *Notornis* 27: 234) and recent discussions with both him and John Jenkins prompt me to record similar observations which I made in May 1978. This was on a voyage from Ile des Pins, New Caledonia, to Whangarei between 2 and 11 May 1978 on the Whangarei sloop *Derwent.*

The prevailing wind throughout the voyage was a light to moderate south-easterly. Thus the course to New Zealand was to windward, and we had to tack several times. One of these tacks took us to a point about 100 nautical miles west of Norfolk Island and about 300 n. miles westward of the rhumbline.

The first northward-migrating Short-tailed Shearwaters *(Puffinus tenuirostris)* were encountered about 100 n. miles south-west of Norfolk.

My observations are as follows:

8/5/78 1350. A tight bunch of c.15 flying low to the water heading NNE
1430. c.12 heading NNE, flying swiftly
1505. Two ” ” ” ”
1630. Five ” ” ” ”
Our fix at 1530 was 31°21′S, 168°19′E, the course 107°, and the sea temperature 21.7°C.

9/5/78 0730. Four heading on a similar course to those seen on 8/5/78
0900. Six ” ”
1035. Ten ” ”
1100. Twelve ” ”
Our noon fix was 32°52′S, 169°48′E, the course 128°, and the sea temperature 19.4°C.

I saw very few birds compared with the thousands recorded by Cheshire on 25/4/80. Also they were 500-600 n. miles ENE of the area of Cheshire's observations.

Jenkins (1980, *Notornis* 27: 220) commented that the northward migration of *P. tenuirostris* seems to pass west of Fiji. Cheshire (1980) projected his observations northward and commented that the birds that he saw were probably going to pass close to the south-eastern tip of New Caledonia. Figure 1 shows the possible tracks of the shearwaters seen by NCC and TGL.

Young birds leave their burrows and head northward on migration ". . . in the latter part of April or early May . . ." (Serventy *et al.,* 1971, *The handbook of Australian sea-birds,* p. 130). Adults apparently leave earlier.

No Short-tailed Shearwaters were seen from *Derwent* anywhere between Ile des Pins and the area west of Norfolk in the first week of May. Perhaps most of the migrants had gone through and the birds seen on 8 and 9 May were stragglers, on the very eastern edge of their normal migration track. The weather had been settled with

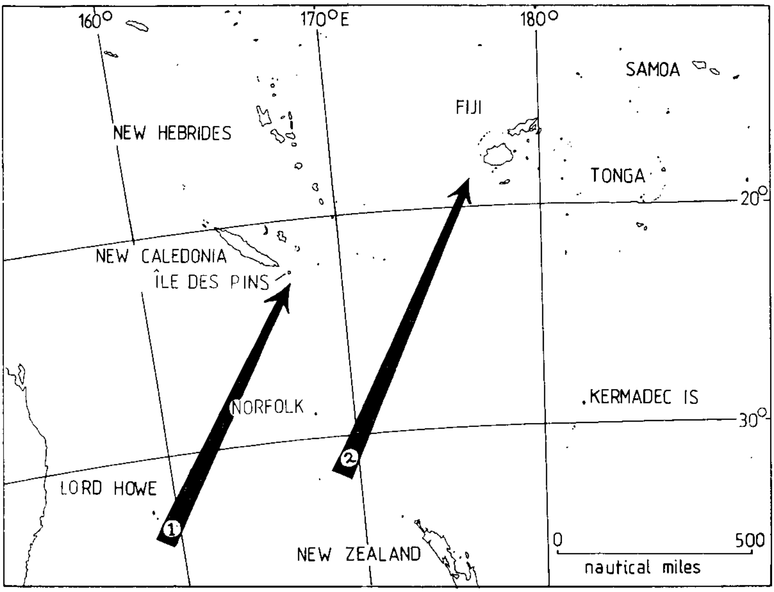

FIGURE 1 — Possible migration paths of Short-tailed Shearwaters.
1. Possible track of birds seen by Cheshire on 25 April 1980.
2. Possible track of birds seen by TGL on 8 & 9 May 1978.

light to moderate south-easterlies for the previous fortnight. Had there been strong south-westerlies, we may have logged more Short-tailed Shearwaters in this part of the Tasman. They certainly occur further south-eastward, along the west coast of the North Island of New Zealand during May, as shown by beach patrol records over the years.

Our average course at the time was about 118° and our speed only about 5 knots. I estimated that most of the shearwaters were heading on a course of about 030°. They were flying directly and quickly at c.40 knots. Their speed and heading were much the same as Cheshire noted, but they were over 500 n. miles further eastward. If these birds maintained their course and we allow for some slip to the north-west caused by the south-east trades, they would probably have passed through the western part of the Fiji Islands.

TIM LOVEGROVE, *R.D. 2, Waiotira, Northland*

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WHY IS THE KIWI SO CALLED?

It has been widely accepted that the kiwi was named because of its cry, *kiwi*. The cry is in two syllables, but there the similarity ends. Anyone listening to the hoarse cry of the female, *ah-eh*, or the shrill high-pitched *aarh* or *ah-el* of the male would find both calls difficult to turn into anything resembling *kiwi.*

While reading Peter Child's article (1981, *Notornis* 28: 32), I noticed that the Cook Islanders' name for the Bristle-thighed Curlew *(Numenius tahitiensis)* is *kivi.* It is now commonly accepted that Hawaiki, the ancestral homeland of the Maori race, was a group of islands in Eastern Polynesia, including Tahiti and the Cook Islands. Physical and linguistic similarities bear this out, with Rarotongan being the closest language to Maori (B. Biggs, 1971, *in* New Zealand's Heritage 1 (6): 160). However, resulting from isolation, the Polynesian letter *v* corresponds to a *w* in Maori. For example, Cook Island numerals, *tai, rua, toru, a, rima, ono, itu, varu, iva* became *tahi, rua, toru, wha, rima, ono, whitu, waru, iwa* in Maori.

From a long association, the ancient Cook Islanders had developed an awareness of the common birds around them. On islands and atolls, the wildlife consisted mainly of seabirds and migratory waders. The rather large *kivi,* a summer migrant, was especially well known. When the Maoris arrived in New Zealand they promptly gave names to all the new things they encountered. Often these names were derived from known objects ' back home.' Therefore, it is reasonable to assume that a strange hen-sized land bird with a characteristic long, slightly downcurved, beak was called *kivi,* or *kiwi,* after the curlews with their long curved beaks. Not only did the first Maoris notice this similarity, W. R. B. Oliver (1930, *New Zealand birds,* p. 14), when describing the kiwi, stated that " The bill is very long, similar in this respect to the bill of wading birds, especially the Curlew . . ." G. R. Gray (1844, *The zoology of the voyage of HMS Erebus and Terror,* p. 11) gives one of the earliest accounts of the kiwi, mentioning that it was called the *kiwikiwi* or *kivi.*

Since New Zealanders take such pride in calling themselves Kiwis, this note may perhaps provoke discussion as to why our kiwis were so named.

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IMMATURE NIGHT HERON IN OTAGO

The immature Nankeen Night Heron *(Nycticorax caledonicus)* shown in Figure 1 was present on the property of Mr W. B. Miller at Tarara, near Owaka, in the Catlins district of Otago, from mid-June 1980 to mid-September 1980.

It was first noticed by the Millers because of the droppings containing remains of freshwater crayfish *(Paranephrops zealandicus)* under its roosting tree. It spent its daylight hours roosting in a macrocarpa tree close to the house, and every evening it flew heavily away to feed, sometimes at least in the farm creek nearby. It roosted regularly in the same place, fairly well hidden by the foliage. Several times, it stayed away for two or three days, and once after a topdressing plane had been working close by all day. When I saw it on 21 June, after a morning of very severe frost, it was perched on a limb of the tree in direct sunlight but not disturbed by my presence or by talking.

The bird had the spotted and streaked plumage of an immature. The facial skin between bill and eyes was yellowish green, the bill was heavy and black, and the iris yellow.

FIGURE 1 — Immature Nankeen Night Heron, Owaka, 1980.
Photo: R. Bayley

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SWALLOWS SEEN AT SEA

I recently received reports from Mr T. King and Mr C. Rhodes of swallows seen at sea to the north of New Zealand. At the time, these men were taking part, in different boats, in the 1980 Auckland to Vila yacht race.

Three birds were seen from Mr King's boat when in position 173°E 30°S, on 7 May 1980 and one was seen the following day from Mr Rhodes' boat, at that stage about 80 km ahead of Mr King's. All the birds seen were apparently heading north.

A colour photograph taken by Mr Rhodes of one bird resting on his boat's rail enabled me to identify it as a Welcome Swallow *(Hirundo tahitica neoxena)*. In Mr King's opinion the birds seen by him were the same species.

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NOTICE

We regret that, through no fault of either editor, the short note by Teppen, Muse & Muse on a probable Common Sandpiper in Western Samoa was published in both *Notornis* (1981, 28 (1): 34) and *Elepaio* (1981, 41 (11): 115), the journal of the Hawaiian Audubon Society. During quite a correspondence with both editors, the authors made no mention of the article's having been submitted to both journals; they have since apologised for doing so. The original article was considerably condensed and rewritten by the editor of *Notornis*, and we have since found that this revised form was resubmitted to *Elepaio* without either editor being told, and published therein in the *Notornis* form, apart from a revamped final paragraph and two extra short paragraphs.

We would gladly accept the author's statement in explanation that they " held a misconception of the *Elepaio* readership " had not a second article, by Muse & Muse, about a possible Laughing Gull in Western Samoa, been submitted to *Notornis, Elepaio,* and also *American Birds* in New York. This article has now appeared in *Elepaio* (41 (12): 130-131) and in *American Birds* (34 (6): 848-849), and it would also have appeared in *Notornis* but for a chance meeting of the Hawaiian and New Zealand editors.

REVIEW

The complete birds of the world by M. Walters. 1980. A. H. & A. W. Reed. 340 p. $NZ35.00. *A complete checklist of the birds of the world* by R. Howard & A. Moore. 1980. 701 p. Oxford University Press. $NZ62.25.

These two books are the latest in a small spate of one-volume world bird lists to have appeared in recent years.

The information given in each is rather different. Walters includes brief descriptions of all the families, lists the scientific and one vernacular name for each species, including extinct ones, and attempts to give information on habitat, distribution, type of nest, clutch size, incubation and nestling periods, even food. Subspecies are not covered. He has a 3-page bibliography (neither the OSNZ nor RAOU checklists feature here) with a few general references scattered through the text. There are indexes to scientific and English family names.

Howard & Moore devote 39 pages to key references for each family (both OSNZ and RAOU checklists included) and the rest of their book is, as titled, a checklist giving the scientific and one vernacular name for each species and the scientific names of the most generally accepted subspecies, together with a maximum of five words on distribution. There is a 58-page index to the scientific names of species.

I examined entries for penguins and petrels in both works. Walters' nomenclature and attempts to give information are very poor and patchy and often ignore work available 20 years ago, let alone up to 1977 when the MS was completed. Howard & Moore are usually more up-to-date, although their references virtually cease after 1975.

Not surprisingly, in attempting to cover some 8500 species, both works have plenty of errors. Walters gets the two giant petrels confused, *Pterodroma axillaris* is omitted, and his information on distribution is often faulty. For instance he gives that for the Wandering Albatross as 'Southern Ocean 30°-60°S,' for the Royal Albatross 'Southern Oceans b. Auckland Islands,' yet lists four breeding places for the Yellow-nosed Albatross. Some references in Howard & Moore are inaccurately cited and distributions are also often incomplete. They too list no New Zealand localities for the Wandering Albatross, and The Snares are stated to be where both the Snares Island Penguin *(Eudyptes robustus)* and a subspecies of the Victoria Penguin, *E. pachyrhynchus atratus,* occur! And what do you think of Howard & Moore's name for our Grey Warbler — 'The New Zealand Grey Flyeater'?

Of the two books, that of Howard & Moore seems likely to be the more useful, particularly as it has a good index and so the entry for any species is readily found — quite difficult with Walters. But few readers will think it worth $62.

John Warham