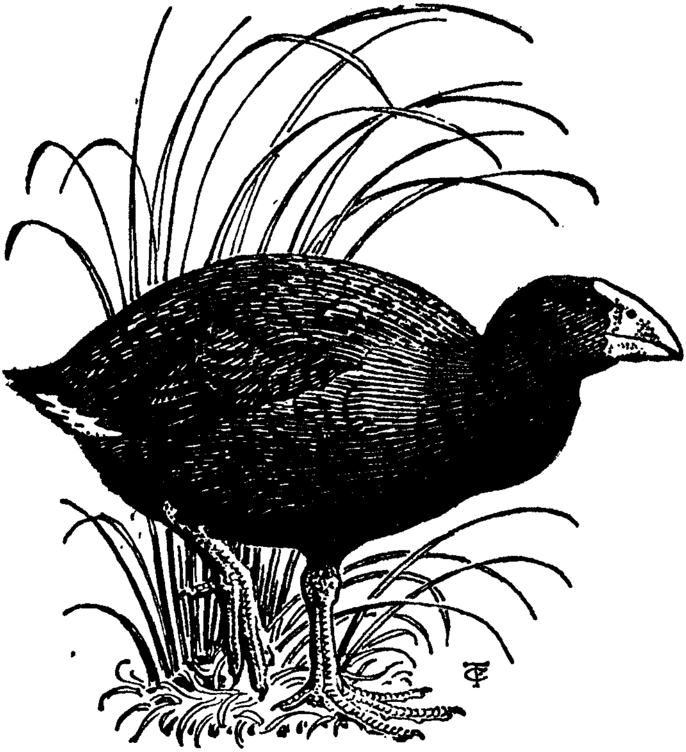
NOTORNIS

Journal of the Ornithological Society
of New Zealand



Volume 32 Part 1 March 1985

OFFICERS 1984 - 85

President — B. BROWN, 20 Redmount Place, Red Hill, Papakura
Vice-President — R. B. SIBSON, 580 Remuera Road, Auckland 5
Editor — B. D. HEATHER, 10 Jocelyn Crescent, Silverstream
Treasurer — D. F. BOOTH, P.O. Box 35337, Browns Bay, Auckland 10
Secretary — R. S. SLACK, c/o P.O., Pauatahanui, Wellington

Council Members:

BEN D. BELL, Zoology Dept, Victoria University, Private Bag, Wellington
BRIAN D. BELL, 9 Ferry Road, Seatoun, Wellington
P. C. BULL, 131A Waterloo Road, Lower Hutt
D. E. CROCKETT, 21 McMillan Avenue, Kamo, Whangarei
P. D. GAZE, Ecology Division, DSIR, Private Bag, Nelson
J. HAWKINS, 772 Atawhai Drive, Nelson
P. M. SAGAR, 38A Yardley Street, Christchurch 4

Conveners and Organisers:

Rare Birds Committee: Secretary, J. F. M. FENNELL, 224 Horndon Street, Darfield, Canterbury

Beach Patrol: R. G. POWLESLAND, Wildlife Service, Dept. of Internal Affairs, Private Bag, Wellington

Librarian: A. J. GOODWIN, R.D. 1, Clevedon

Nest Records: D. E. CROCKETT

Classified Summarised Notes —
North Island: L. HOWELL, P.O. Box 57, Kaitaia
South Island: P. D. GAZE, Ecology Division, DSIR, Private Bag, Nelson

S.W. Pacific Islands Records: J. L. MOORE, 32 Brook St, Lower Hutt

Reviews Editor: D. H. BRATHWAITE, P.O. Box 31022 Ilam, Christchurch 4

Editor of *OSNZ news:* P. SAGAR, 38A Yardley St, Christchurch 4

SUBSCRIPTIONS AND MEMBERSHIP

Annual Subscription: Ordinary member $20; Husband & wife members $30; Junior member (under 20) $15; Life Member $400; Family member (one Notornis per household) being other family of a member in the same household as a member $10; Institution $40; Overseas member and overseas institution $5.00 extra (postage).

Subscriptions are for the calendar year of first joining and are renewed by invoice each January. Please pay promptly to ensure receiving *Notornis* and *OSNZ News.*

Applications for membership, changes of address and resignations should be sent to the Treasurer.

Exchanges and library subscriptions should be sent to the Treasurer.

Editorial matters ONLY should be sent to the Editor.

[Registered with the GPO Gisborne as a publication]

ISSN 0029-4470

CONTENTS

Short Notes

Letter

Printed by TE RAU PRESS LTD., Peel Street, Gisborne, New Zealand

REGIONAL REPRESENTATIVES

FAR NORTH: L. Howell, P.O. Box 57, Kaitaia.
NORTHLAND: D. E. Crockett, 21 McMillan Ave., Kamo, Whangarei. Ph. 50954.
AUCKLAND: M. J. Taylor, 28 Awarua Crescent, Orakei, Auckland 5. Ph. 549234.
SOUTH AUCKLAND: Beth Brown, 20 Redmount Place, Red Hill, Papakura. Ph. 2988157.
WAIKATO: F. Nieuwland, 38 Berkley Ave., Hamilton. Ph. 62045.
BAY OF PLENTY: P. C. M. Latham, c/o Papamoa Beach P.O., via Te Puke. Ph. 420406.
VOLCANIC PLATEAU: J. G. Innes, Loop Road, Okareka. Ph. 28107, Rotorua.
GISBORNE/WAIROA: J. C. Henley, 9 Mason St., Gisborne. Ph. 81581.
TARANAKI: D. G. Medway, 25A Norman Street, New Plymouth
MANAWATU: } L. J. Davies, 71 Jickell Street, Palmerston North.
WANGANUI: } Ph. 70159.
HAWKES BAY: K. V. Todd, 2/416 E. Heretaunga Street, Hastings. Ph. 82172.
WAIRARAPA: C. Scadden, 15 Madden Place, Masterton. Ph. 86423.
WELLINGTON: R. N. Thomas, 6 Satara Crescent, Khandallah, Wellington 4. Ph. 791-165.
NELSON: J. Hawkins, 772 Atawhai Drive, Nelson. Ph. 520151.
MARLBOROUGH: P. Jenkins, 234 Howick Rd., Blenheim. Ph. 83775.
CANTERBURY: P. M. Sagar, 38A Yardley Street, Christchurch 4. Phone 429720.
WEST COAST: C. S. Lauder, 9 Winnie Street, Greymouth. Ph. 6349.
OTAGO: P. Schweigman, 121 Maryhill Terrace, Maryhill, Dunedin. Ph. 52790.
SOUTHLAND: W. J. Cooper, 218 Chelmsford Street, Invercargill. Ph. 75281.

LITERATURE AVAILABLE

From all bookshops:

A field guide to the birds of New Zealand, by R. A. Falla, R. B. Sibson and E. G. Turbott, new ed.	$19.95

From M. Bishop, Maungakura Road, R.D. 3, Helensville:

Back numbers of 'Notornis': Parts of Vol. 1, 50c each; Vols. 2-13, $1.00 per part; Vols. 14-21, $1.50 per part; Vols. 22-25, $2.00 per part; Vols. 26-29, $3.00 per part; Vols. 30-, $5.00 per part; all plus postage (10% in NZ).	
Reports and bulletins (1939-1942)	**$2.00**
OSNZ Library catalogue (1976 ed) 17 pp.	**$0.55**
Banding reports, Nos 8-14, 55c each.	
Kermadec Expedition, 1964, by A. T. Edgar.	**$0.50**
Guide to Identification of Shearwaters and Petrels in New Zealand waters (Auckland Museum), J. P. Croxall	**$0.55**
Amendments & Additions to 1970 Checklist	**$2.00**

NOTORNIS

is the journal of the Ornithological Society of New Zealand (Inc.)

Editor: B. D. Heather,
10 Jocelyn Crescent
SILVERSTREAM

VOLUME 32 PART 1 MARCH, 1985

RECORDS OF CHINSTRAP PENGUINS IN THE ROSS SEA REGION, ANTARCTICA

By E. B. SPURR

This paper reports two new sightings of the Chinstrap Penguin (*Pygoscelis antarctica*) on Ross Island, Antarctica, and reviews the records of the species from the Ross Sea region.

The first new record is a Chinstrap Penguin that I observed and photographed (Fig. 1) at Cape Bird (77°13'S, 166°19'E) on 19 January 1970, in the southernmost of the three breeding grounds of Adelie Penguin (*P. adeliae*). When first seen, the Chinstrap, of unknown sex and in good physical condition, was standing between colonies of breeding Adelie Penguins; later it moved to the shore. Interaction between the Chinstrap and Adelies was not observed although the Chinstrap mingled with small flocks of Adelies moving to and from the colonies. This is the only known record of a Chinstrap Penguin at Cape Bird. I saw no others in four summers at Cape Bird (10 November 1967 to 15 January 1968; 23 October 1968 to 28 January 1969; 1 November 1969 to 21 January 1970; and 11 November 1970 to 25 January 1971) and I know of no other sightings at Cape Bird, which has been visited each summer since 1965-66.

The second new record is a Chinstrap Penguin that I observed at Cape Royds (77°33'S 166°07'E) on 27 January 1971, in the world's southernmost Adelie Penguin breeding ground. As at Cape Bird, the Chinstrap was standing between breeding colonies of Adelies. It appeared to be in good condition and was not seen to interact with other penguins. This is the second known record from Cape Royds, the first being in 1908 (probably mid-February) by Murray (1909). I saw no other Chinstraps at Cape Royds during two visits (23 January 1970 and 25 January to 30 January 1971) and know of no other records from there despite frequent vists by biologists since 1959-60.

Chinstrap Penguins have seldom been reported from the Ross Sea region. This is not surprising because their main breeding grounds are on the islands

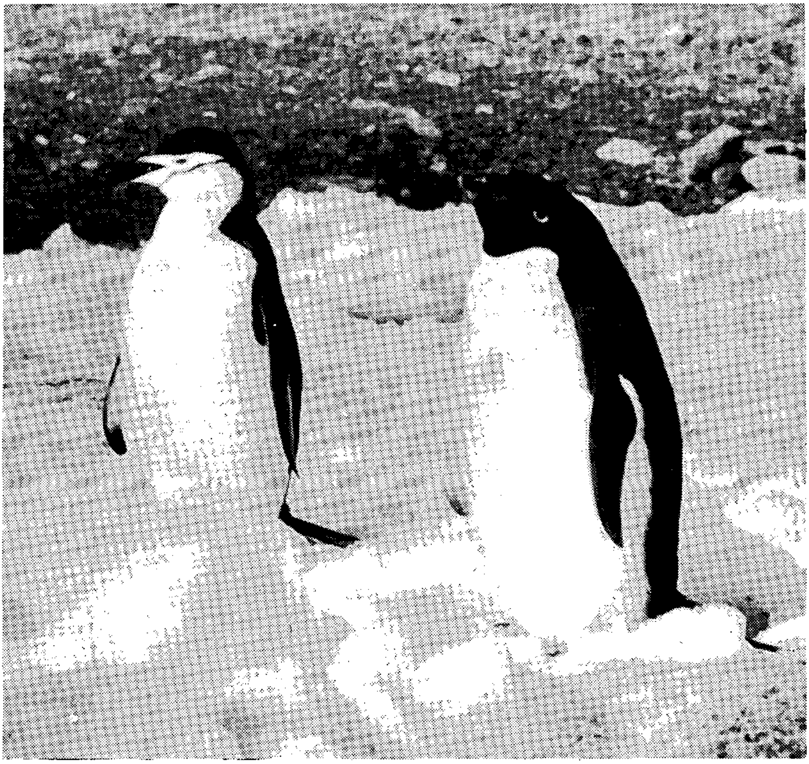


FIGURE 1 — Chinstrap Penguin (on left) standing beside an Adelie Penguin on shore, southern breeding ground, Cape Bird, Ross Island, 19 January 1970

of the Scotia Arc and the northern part of the Antarctic Peninsula in western Antarctica (Conroy 1975, Watson 1975).

The first reported sighting of a Chinstrap Penguin in the Ross Sea region was the 1908 observation at Cape Royds by Murray (1909). The next reported sighting was not until 55 years later at Cape Crozier (77°27'S, 169° 13'E), where one was banded in 1963 (Sladen *et al.* 1968, Ainley *et al.* 1978). Since then a further 13 Chinstrap Penguins have been reported, making a total of 15 reported in the Ross Sea region (Table 1). Eight of these have been at Cape Crozier, not nine as reported by Ainley *et al.* 1978 (Ainley, pers. comm.) The most southerly and most recent, observed in 1974 by Raymond (1975), was a bird standing on the sea ice about 3 km north of McMurdo Station, near the southern tip of Ross Island.

The recent increase in reports of Chinstrap Penguins in the Ross Sea region may reflect the increased number of observers since the beginning of the International Geophysical Year in 1956-57. However, it is more likely to reflect the relatively recent establishment of Chinstrap Penguins breeding on

Chinstrap Islet (66°57'S, 163°17'E) in the Balleny Islands group about 1200 km north of Ross Island (Sladen 1964, Robertson *et al.* 1980). Sladen noted that, apart from the record at Cape Royds by Murray (1909), none of the many early expeditions in eastern Antarctica had reported Chinstrap Penguins on land or at sea, whereas the early expeditions in western Antarctica had often reported them (see references in Sladen 1964). Chinstrap Penguins have also not been reported from more recent cruises in the Ross Sea (Dell 1960, Ozawa 1967, Darby 1970, Fowler 1973, Hicks 1973, Harper & Wilson pers. comm. 1982), whereas they have been reported from other sectors of Antarctica (e.g., Ozawa 1967). The lack of sightings of Chinstrap Penguins on recent cruises in the Ross Sea is not surprising because the breeding site in the Balleny Islands is only a very small and isolated one.

Most of the sightings of Chinstrap Penguins in the Ross Sea region have been in January and February toward the end of the breeding season. Ainley *et al.* (1978) actually stated that, at Cape Crozier, Chinstraps were usually seen in late February, but this is not supported by their data. More than half the birds at Cape Crozier were first seen before 14 February and nearly half the birds in Table 1 were seen in January. The only observation of breeding behaviour is by Crawford (1974), who reported a Chinstrap

TABLE 1 — Reports of Chinstrap Penguins in the Ross Sea and McMurdo Sound, eastern Antarctica

Location	Latitude	Number of Penguins	Date of First Observation	References
Cape Hallett, Victoria Land Coast	72°19'S	1	10.1.65	Muller-Schwarze 1967
		1	?.2.68	Baker 1973, Crawford 1974
		1	30.12.72*	
Cape Bird, Ross Island	77°13'S	1	19.1.70	Spurr, this paper
Cape Crozier, Ross Island	77°27'S	1	24.2.63	Sladen *et al*. 1968, Ainley *et al*. 1978
		1	22.2.64	
		2	15.1.65	
		1	2.2.65	
		2	13.2.66	
		1	20.2.66	
Cape Royds, Ross Island	77°33'S	1	? .2.08	Murray 1909
		1	27.1.71	Spurr, this paper
McMurdo Sound, Ross Island (on sea ice)	77°50'S (approx.)	1	26.1.74	Raymond 1975

* Remained until 13.1.73

occupying nest scrapes of Adelie Penguins at Cape Hallett (72°19'S, 170°13'E) from 30 December 1972 to 13 January 1973. The Chinstraps at Cape Crozier had apparently come ashore to moult (Ainley *et al.* 1978).

Since the early 1970s, few birds have been seen probably because few people have visited penguin breeding areas toward the end of the season, when Chinstrap Penguins are most likely to be there.

My new records are further evidence of the reported extensions of the range and numbers of Chinstrap Penguins in the last few decades (Sladen 1964, Conroy 1975, Watson 1975).

ACKNOWLEDGEMENTS

My observations were made while I was a member of the University of Canterbury Antarctic Research Unit. They are reported for the benefit of the International Survey of Antarctic Seabirds (ISAS), which is part of the BIOMASS programme of the Scientific Committee on Antarctic Research (SCAR).

I am grateful to P. C. Harper, R. H. Taylor, G. J. Wilson and E. C. Young for helpful comments on the manuscript.

LITERATURE CITED

AINLEY, D. G.; WOOD, R. C.; SLADEN, W. J. L. 1978. Bird life at Cape Crozier, Ross Island. Wilson Bull. 90(4): 492-510.

BAKER, J. R. 1973. Penguin and skua studies at Hallett Station. Ant. J. US 8: 200-201.

CONROY, J. W. H. 1975. Recent increases in penguin populations in Antarctica and the Subantarctic. *In* B. Stonehouse (ed.) "The Biology of Penguins", pp. 321-336. London: Macmillan.

CRAWFORD, R. D. 1974. Chinstrap Penguin at Cape Hallett. Notornis 21(3): 264-265.

DARBY, M. M. 1970. Summer seabirds between New Zealand and McMurdo Sound. Notornis 17(1): 28-55.

DELL, R. K. 1960. Sea-bird logs between New Zealand and the Ross Sea. Rec. Dom. Mus. 3(4): 293-305.

FOWLER, J. A. 1973. A transect diagram for oceanic birds recorded between McMurdo Sound, Antarctica, and New Zealand, February-March 1973. Notornis 20(4): 314-317.

HICKS, G. R. F. 1973. Latitudinal distribution of seabirds between New Zealand and the Ross Sea, December 1970. Notornis 20(3): 231-250.

MULLER-SCHWARZE, D. 1967. Tierstrassen in der Antarktis. *In* H. Hediger (ed.) "Die Strassen der Tiere", pp. 120-133. Vieweg: Braunschweig.

MURRAY, J. 1909. Biology *In* E. H. Shackleton (ed.) "The Heart of the Antarctic", Appendix I, Vol. 2, pp. 233-267. London: Heinemann.

OZAWA, K. 1967. Summer distribution of Chinstrap Penguin in the Antarctic. La Mer 5(2): 95-99.

RAYMOND, J. A. 1975. Chinstrap Penguin at McMurdo Sound. Ant. J. US 10(5): 275.

ROBERTSON, C. J. R.; GILBERT, J. R.; ERICKSON, A. W. 1980. Birds and seals of the Balleny Islands, Antarctica. Rec. Nat. Mus. NZ 1(6): 271-279.

SLADEN, W. J. L. 1964. The distribution of the Adelie and Chinstrap Penguins. *In* R. Carrick, M. W. Holdgate and J. Prevost (eds) "Biologie Antarctique", pp. 359-365. Paris: Hermann.

SLADEN, W. J. L.; WOOD, R. C.; MONAGHAN, E. P. 1968. The USARP bird banding program, 1958-1965. *In* O.L. Austin, Jr (ed.) "Antarctic Bird Studies", Antarctic Research Series, Vol. 12, pp. 213-262. Washington DC: American Geophysical Union.

WATSON, G. E. 1975. "Birds of the Antarctic and Sub-Antarctic". Washington DC: American Geophysical Union (Antarctic Research Series), 350 pp.

E. B. SPURR, *Zoology Department, University of Canterbury, Christchurch. Present address: Forest Research Institute, P.O. Box 31-011, Christchurch.*

PYCROFT'S PETREL IN THE BREEDING SEASON AT HEN AND CHICKENS ISLANDS

By G. M. DUNNET

ABSTRACT

We studied Pycroft's Petrel, *Pterodroma pycrofti*, at a breeding colony in the Hen and Chickens Islands, New Zealand, during the prebreeding and breeding seasons of 1982/83. Breeding birds attended their burrows singly and in pairs, often for several days at a time, from at least 38 days before laying, and up to 19 days before laying. No parents were in their burrows during the fortnight before laying, except a day or so before laying.

In October/November the weights of breeders arriving at their burrows averaged about 150 g, but females arriving to lay weighed on average about 188 g, and males arriving to begin their first incubation stint averaged about 190 g — about 25% more than in October/November. The egg averaged 32 g. Daily weight loss over consecutive days in the burrow averaged 3.5-5 g/day, 2-3% of body weight.

Laying took place from the second week in November to the end of the first week in December. Egg dimensions are given. Incubation lasted about 45 days and the fledging period was 77-84 days. Weights of fledglings ranged 156-188 g. From small samples, hatching success was 72% and fledging success 50%. Losses were caused by infertility, desertion and breakage resulting from fighting, probably with tuataras.

One male failed breeder was at its burrow six weeks after its egg was broken.

Non-breeders are defined as adults not known to breed in the current breeding season but may include some failed breeders. Some occurred in burrows in each observation period, and one was recorded throughout the study period, but more were at the colony in January than earlier. Non-breeders and breeders did not differ significantly in weight in October/November, but non-breeders did not usually achieve the higher weights of breeders arriving to lay or incubate. Weight loss of non-breeders in burrows was similar to that of breeders.

The state of the brood patch, egg formation and the history of previously ringed birds are briefly discussed.

INTRODUCTION

Little has been published on the breeding biology of the small species of the genus *Pterodroma*. Hindwood & Serventy (1941) described the history, breeding and behaviour of *Pterodroma leucoptera leucoptera* at Cabbage Tree Island off the New South Wales coast near Newscastle, and Falla (1934) gave brief accounts of *P. cookii* and *P. pycrofti*. Fleming (1941) examined the relationships of four species of *Pterodroma* in the New Zealand area — *cookii, pycrofti, nigripennis* and *axillaris*. Although mainly concerned with the

NOTORNIS 32: 5-21 (1985)

taxonomic relationships of these species, Fleming included some field observations on the biology of Pycroft's Petrel. Some observations on Cook's Petrel in the field were reported by Reischek (1885) and Stead (1936). Bartle (1968) gave data on the laying and incubation of Pycrofts Petrel and the composition of the population on Aorangi Island in the Poor Knights Group in November/December 1964. Jenkins & Cheshire (1982) described the distribution and breeding biology of the Black-winged Petrel (*nigripennis*), which is rapidly increasing in the South-west Pacific. Grant *et al.* (1983) described the breeding of the Bonin Petrel (*P. hypoleuca*) from December to March 1979/80 and from December to May 1980/81 — the most complete of the studies on breeding behaviour and ecology of any of the small *Pterodroma* species.

The present study, on Lady Alice Island in the Hen and Chickens group, New Zealand, was designed to investigate the breeding biology of Pycroft's Petrel from the prelaying phase through to hatching. A colleague made a later visit to determine fledging success in the study burrows. My main objectives were to study attendance of breeding and non-breeding birds at nesting burrows from the prelaying period onwards, to record the spread of laying, to study the incubation behaviour and weight characteristics of the species, and to measure hatching and fledging success.

STUDY AREA AND METHODS

The study area was on Lady Alice Island in the Hen and Chickens group (35.5°S 174.4°E). Its 138 ha, rising to 150 metres a.s.l., are covered in open woodland dominated by kanuka (*Leptospermum ericoides*). It was briefly described by Percy (1956) under the name of Marotiri Island and by Skegg (1964) under the name Big Chicken. Maoris had occupied it for many years up to 1821. By the end of last century the vegetation was regenerating into a mixture of coastal scrub and woodland communities with the drier ridges largely covered with kanuka. Now the island has populations of tuatara (*Sphenodon punctatus*) and the introduced Polynesian rat or kiore (*Rattus exulans*) and for some years the New Zealand Wildlife Service had been studying the interaction between these two species. During these investigations the burrows of nesting seabirds were regularly inspected because the tuataras spend much of the day in them. As a result breeding colonies of Flesh-footed Shearwater (*Puffinus carneipes*) and Pycroft's Petrel, which are summer breeders, and of the Grey-faced Petrel (*Pterodroma macroptera*) and Little Shearwater (*Puffinus assimilis*), which are winter breeders, were known and some had been mapped.

In 1980, 1981 and 1982, D. G. Newman and M. J. Imber had banded some breeding adults and fledglings of Pycroft's Petrel. Pycroft's Petrel was thus known to breed in a scattered 'colony' on the low slopes surrounding Grave Bay at the western end of the island, mainly in coastal scrub including flax (*Phormium tenax*), kanuka and kawakawa (*Macropiper excelsum*), and also in a scattered 'colony' on the main ridge of the island at about 150 metres a.s.l. in dry kanuka scrub. I studied both colonies.

My wife and I made four visits to the island totalling 35 days of field observations, the first on 23-29 September 1982, the second from 25 October to 5 November, the third from 23 November to 3 December and the fourth on 11-15 January 1983. In later visits made on 21-29 March and 11-15 April, Ian MacFadden of the NZ Wildlife Service recorded nestling weights and fledging success in the study burrows.

We inspected 48 burrows regularly, 32 of which were used by Pycroft's Petrels during this study. The remaining 16 were always empty by day. An egg was laid in at least 28. We banded 74 adults, most of which were caught in burrows, and handled them on 224 occasions.

The main set of observations is derived from daily visits to each of the study burrows. During September, when Pycroft's Petrels were still not spending time on land during the day, we marked previously known and newly found burrows with numbered labels and put lids over most of the nest chambers. Additional burrows were found on later visits.

On each daytime visit we inspected the burrows and noted the contents. Any bird present we weighed, examined for bare or downy brood patch and for tail or wing moult, and measured. Bill length was taken from the feather line on the forehead to the tip of the bill, and bill depth vertically at the gonys.

The bird was returned to its burrow, and we erected a fence of twigs across the entrance. Apart from occasional checks, we examined the burrows again only if the fence had been disturbed.

We hoped that bill, wing and other measurements might enable us to sex the birds, but this proved not to be so. However, at and just after laying, the cloaca of females was conspicuously enlarged and discoloured, whereas males had no such enlargement. Therefore, immediately before and for rather longer after laying, we could tell the sex of each bird without doubt (cf. Serventy 1956). With some females we palpated the egg in the abdomen.

In the October-November visit during the prelaying stage we found six pairs of birds together in burrows. We administered gelatin capsules of Sudan Black Dye to all 12 birds (which we could not sex at the time) in the hope that a dark ring in the yolk would show when yolk was laid down (Grau 1976). Later, we collected their eggs when laid (replacing them with dummies which the birds incubated until January) and processed them in the laboratory by the method described by Grau (1976).

We also visited the study area every night but did not open the burrows then. These visits were rather unproductive owing to the scattered pattern of burrows and the fact that Pycroft's Petrels seem to spend very little time on the surface. However, some birds which were active in the burrows at night were not there on the following or previous day. This was especially true in the prelaying stage and the birds may have been non-breeders: cf. Grey-faced Petrels (Imber 1976) and Sooty Shearwaters (*Puffinus griseus*) (Richdale 1963).

BREEDERS

Attendance at burrows

Figure 1 shows the pattern of attendance of the adults at the 21 burrows in which we knew that an egg was laid and could estimate the date of laying.

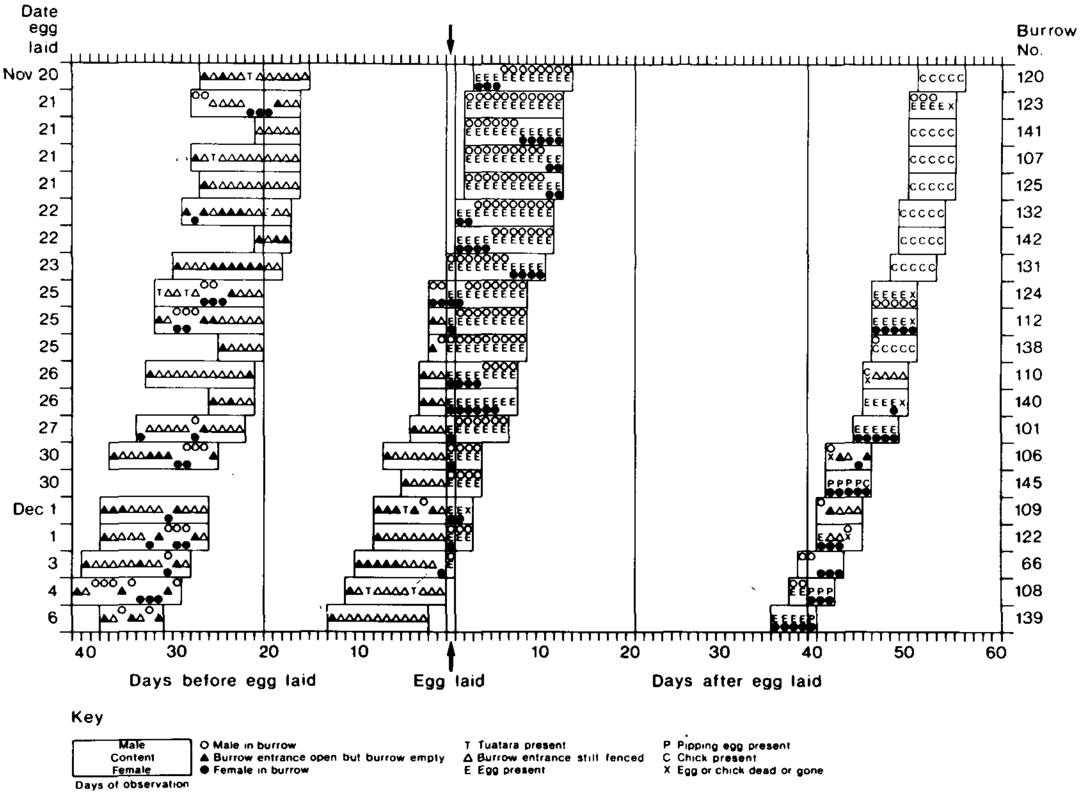


FIGURE 1 — Pattern of attendance of Pycroft's Petrels at each of 21 burrows in which an egg was laid

We had most of these burrows under observation off and on over several weeks before the egg was laid. In addition, we have quite good records of attendance at two other burrows, and we found five more late in the study when the eggs had already hatched. Only the adults from these 28 nests are considered as positive breeders. We sexed them by the state of the cloaca, by palpating the egg in the abdomen, or by incubating behaviour at the time of laying.

On our first visit in September we found no Pycroft's Petrels in burrows by day and saw or heard none at night. On the second visit in October-November, between 15 and 40 days before laying, birds were in burrows by day. Our third coincided with laying in most of the study burrows, but some eggs had been laid before we arrived and some were laid after we left. On our last visit, 35-55 days after laying, several eggs had hatched, some were hatching and some were still to hatch.

From Fig. 1 it is clear that, during periods between 20 and 40 days before the egg is laid, breeding Pycroft's Petrels can be found in their burrows by day. During our daily inspections at that time, on 14 occasions the male was alone in the burrow, on 12 occasions the female was alone, on 9 the pair was present, and on 181 occasions the burrow was empty. Among the 181 records were 23 when the fence at the burrow entrance was down, but the burrows were also used by tuataras, which we found in the burrows three times during this period, and probably by rats. The data show that the petrels were present for 1-3 consecutive days and there is little evidence that the pairs come and go together.

The birds are absent from the burrow in the days immediately before laying. The data suggest that the female arrives back at the burrow on the night that she lays and that the male is with her at that time or arrives in the following day or two. Having laid, the female incubates for a short time before being replaced by the male. From Fig. 1 we can get the following times for the first incubation stint of 19 females: 4 less than 1 day; 4 = 1; 2 = 2; 4 < 3; 1 = 3; 1 < 4; 1 = 4; 1 < 5; 1 = 6 days. At one site (140) the female laid on 26 November and stayed 5 days before abandoning the egg. The abandoned egg was still intact in the nest in January.

The first incubation stint of the male is much longer, but our visits were too short to get complete data. We know that one male had incubated for 11 consecutive days, one for 10 and three for 9 days, but all these males were still incubating when we left.

At hatching only one adult was present in the burrow and, in the four cases where we found pipping/hatching eggs, the female was incubating. However, in at least two of these the male had been incubating until the beginning of the hatching process. From a few days after hatching, the chick is left alone in the burrow during the day.

We can also estimate the first incubation stint of males by relating the beginning of the females' second incubation stint to the estimated time of laying: for one this was on the eighth day after laying, for two the eleventh day, and for one the seventh day

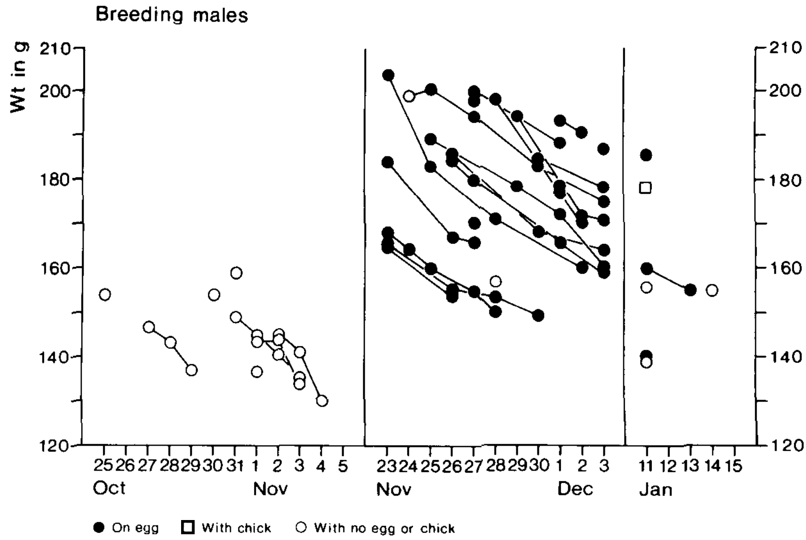


FIGURE 2 — Weights of breeding male Pycroft's Petrels caught in their burrows. Lines join weights on consecutive weighings, not necessarily on consecutive days for incubating birds

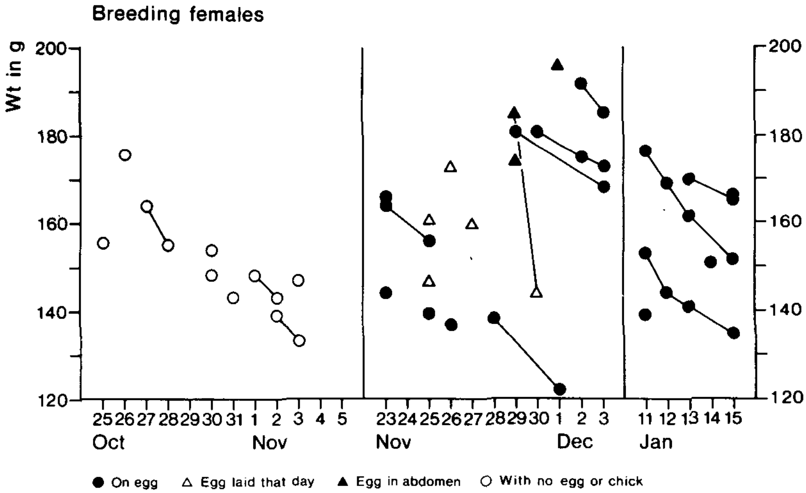


FIGURE 3 — Weights of breeding female Pycroft's Petrels caught in their burrows. Lines join weights on consecutive weighings, not necessarily on consecutive days for incubating birds

Weight

Weight is known to be highly variable in *Pterodroma* species (Bartle 1968, Imber 1976), mainly associated with periods of fasting when the birds come to land. The data can be considered under two headings: the weights of birds when first found in the burrow ("initial weights"); and the rate of weight loss while birds remain in their burrows.

Initial weights: Particularly in our November-December visit, the birds we weighed on the first day of our visit may have been in the burrows for several days before we arrived. As these measurements may be underestimates of the weights of returning birds we have excluded them from the analysis in Fig. 2 & 3.

In the October-November visit we recorded seven male and seven female breeders in the burrows. One bird of each sex was present on the day we arrived, and so they have been excluded. The mean weight of eight males is 150.33 g, SD 5.20 g, and of eight females 156.0 g, SD 11.80 g, and there is no significant difference between the sexes.

On arrival to begin incubation, nine breeding males averaged 192.3 g, SD 6.69 g. This was 41.97 g greater than the mean weight of adult males arriving during the prelaying period, an increase of about 28%.

The three females found in the burrows soon after dark with an egg in their abdomen weighed 196, 185 and 174 g. The one weighing 185 g was next day incubating an egg weighing 34.5 g and itself had a body weight of 144 g. The weights of five other females, their newly laid egg, and the total weight respectively were 161, 33.5 = 195 g; 160, 32.0 = 192 g; 147, 31.5 = 170 g; 173, 30.5 = 204 g; and 140, 32.5 = 173 g. Note that the bird weighing 185 g the day before laying weighed, together with her egg, only 178.5 g the following day. The average weight loss per day for incubating females is about 3.5 g (see below), and so some weight may be lost while the egg is laid.

Nevertheless, we can take the weights of female plus newly laid egg as the best indicator of weights of females at the time of their return to lay. For these eight birds the mean weight is 187.50 g, SD 11.50 g. This represents an increase of 20.2% (31.5 g) over the average weight of breeding females in the prelaying season (156 g). The initial weights of females plus egg and that of males returning to incubate are not statistically different.

We encountered no adults in March and April.

Weight loss: The weights of birds occupying burrows on successive days can be used as information on the rates of weight loss of birds on land. In the prelaying period, although the birds could go to sea and feed at night and still be in the burrows in consecutive days, we have only one record of a bird showing no weight loss on two consecutive days. All others lost weight.

Frequently we found birds in burrows on several consecutive days. To calculate the rate of a bird's weight loss, we took the weight of the bird when first found in the burrow and the last of the series of weights obtained when it was continuously in the burrow (based on no disturbance of the fence at the burrow entrance) and divided the weight loss by the number of days to produce an estimate of mean daily weight loss.

We have data for 10 birds during prebreeding attendance in October-November. Eight of these proved to be breeders. All showed similar weight losses ranging between 2 and 11 g per day, with a mean of 5.6 g (3.8% of the average initial weight, 148.0 g).

The daily weight loss in early incubation in November-December for 14 males (79 bird days) ranged from 2 to 7 g, with a mean of 3.58 g, being 1.91% of the initial weight (182.0 g) or 2.15% of the final weight (166.8 g). For seven females (17 bird days) the mean daily weight loss was 3.65 g, being 2.18% of the initial weight or 2.30% of the final weight. There are no statistically significant differences between the mean rate of weight loss for males and females in early incubation, or between all birds in early incubation and in the prebreeding period. Figure 2 shows that the slopes of weight loss do not show any regular pattern of change in rate in relation to initial weight.

The mean weights of males and females at the end of their incubation stints, allowing the mean daily weight losses for the days between last weighing and their departure, respectively were 151 g, SD 10.32, n = 8 and 142.25 g, SD 15.59, n = 4. These weights are 83% and 76% of the initial weights. The lowest weight recorded for an adult was for one female that weighed 122 g (approximately 65% of the mean initial weight) less than a day before she deserted her egg five days after laying.

Several adults were captured in attendance on egg or chick in January, and some of these were incubating on consecutive days. For both sexes together, the average weight loss of seven birds for 19 bird days was 4.89 g per day, which is c. 2.99% of initial weight and 3.17 % of final weight.

Laying dates

Figure 4 gives the laying dates known precisely or approximately for 22 burrows. Four more eggs were laid after 3 December. By their behaviour the adults at two other sites may have been failed breeders. At one of these, one member of the pair (? the female) arrived on 29 November weighing 201 g and remained in the burrow over 3 consecutive days. Its mate had been recorded on 24, 25 and 27 November weighing 166, 163 and 162 g, and both birds were in the burrow on 29 and 30 November. If this was a female returning to take over incubation the egg may have been laid not less that 12-15 days previously, i.e. 14-17 November. At the other site, two birds were recorded, one of them weighing 169 g on 26 November and 180 g on 1 December. If this bird also was the female returning to incubate, the egg may have been laid around 10-12 November. All these four birds had a bare brood patch, none had an enlarged cloaca, and none had an egg in the abdomen.

Laying is therefore more protracted than previous authors have indicated, extending perhaps from the second week in November to the end of the first week in December.

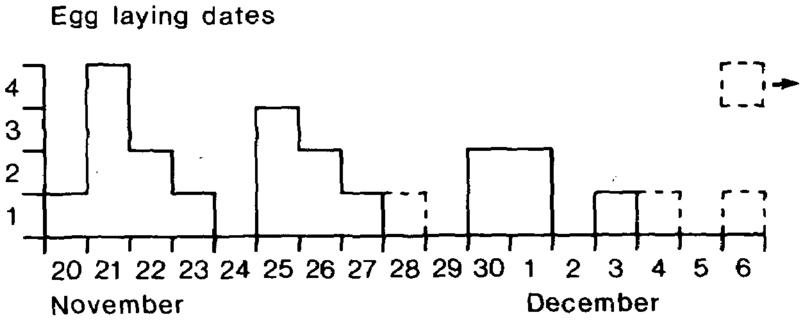


FIGURE 4 — Laying dates of Pycroft's Petrel. Broken lines indicate estimated dates

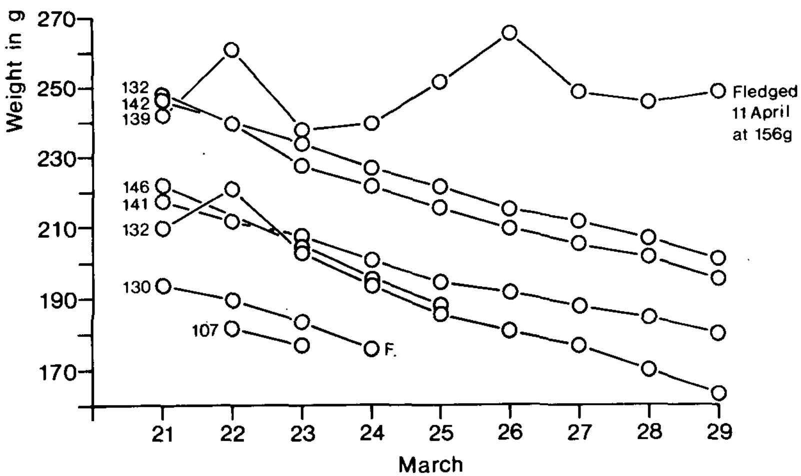


FIGURE 5 — Weights of eight nestling Pycroft's Petrels towards the end of their nestling period. The numbers refer to the burrow; F = fledged

Egg dimensions

We have the length and breadth of 22 eggs and the weights of 19 of them at or close to the date of laying. The dimensions (mm) are as follows:

Length: mean 48.90, SD 1.45, range 45.4-50.4
Breadth: mean 34.78, SD 1.67, range 32.0-36.3
Weight: mean 31.89 g, SD 2.46, range 25.5-35.5g

Three eggs, still intact on 11 January, were weighed and their reduced weights were compared with their weights at the time of laying. The data are as follows: (1) 31.5 g to 27.5 g, — 4.0 g; (2) 28.5 g to 23.0 g, — 5.5 g; (3) 32.0 g to 28.5 g, — 3.4 g. Overall this represents a 14.1% average loss of weight between laying and hatching.

Incubation

We have little information on the incubation period. From seven burrows the evidence is that incubation takes less than 48 days. At two others incubation was < 46 and < 45 days. Eggs may be pipped for at least four days before hatching. The only firm evidence is for one egg which hatched on the 46th day after laying, but an average incubation period might be 45 days.

Hatching success

From 18 sites with an egg, 13 eggs (72%) hatched successfully. Of the five failures, one was infertile, one was abandoned, two were broken and one contained a dead embryo.

Fledging

Ian MacFadden checked several Pycroft's Petrel burrows each day during visits in March and April for information on the weights of nestlings and the dates of fledging.

Weights: Figure 5 shows the weights of eight nestlings, four of which fledged during the observation period; their weights on the day before fledging being 156 g, 176 g, 177 g, and 188 g. Three of these birds fledged during the March visit, and based on their declining daily weights, two of them had not been fed for at least three and five nights before they fledged. The weights of four other nestlings declined each day, with declines of 248 to 196, 218 to 180, and 247 to 201 g over eight days, and 221 to 163 g over seven days. It is clear that nestlings are not fed for at a week before they fledge, and so one factor that determines the time of fledging may be the body weight of the nestlings. From the known weights of fledging birds (156-188 g) it would seem that the last four birds above must have been on the point of fledging at the end of the period of observation.

The heaviest nestling we recorded was a bird that fledged on 11 April. On 22 March it weighed 261 g, on 26 March 266 g and on 29 March 249 g. The bird had certainly been fed on the night 28/29 March. In March 1981, M. J. Imber (pers. comm.) weighed seven chicks, of which one weighed 278 g and another 261 g.

Fledging period: We obtained sets of hatching and fledging dates, and hence accurate fledging periods, for only two nestlings. These were 77 and 82 days. However the four birds above, which must have been on the point of fledging when the observations ceased, were then 83, 82, 82 and 79 days old. Fledging thus normally occurs between 77 and 84 days of age, although at two other sites fledging may have occurred (the burrows being empty when first examined in March) at less than 76 and less than 73 days old. The observed fledging dates were 23, 25 and 26 March and 12 April. It is possible that two birds might have fledged before 21 March.

Fledging success: The records from many burrows are incomplete but of 12 burrows with complete records six (50%) successfully fledged a chick. Our activities during the study did not cause any known losses of eggs or chicks, apart from the three eggs collected experimentally.

NON-BREEDERS

During the study we caught, in burrows or on the surface, 32 Pycroft's Petrels which were not known to be breeding. None of these birds could be sexed. Some might have been failed breeders but this cannot be confirmed: for example, the pairs of birds at two burrows may have lost their egg very soon after it was laid because both burrows had no egg on 23 November. Of the 32 non-breeders, all but three were found in burrows by day.

Table 1. Records of non-breeding Pycroft's Petrels in the breeding colony: (a) number of individuals and captures in each observation period, and (b) the distribution of individuals according to the observation periods in which they were recorded.

(a)	Observation Periods	1 (Oct/Nov) 12 days	2 (Nov/Dec) 11 days	3 (Jan) 5 days
	No. of individuals caught	8	13	21
	No. of individuals first recorded	8	10	14
	No. of captures	13	33	27

(b)	Observation periods recorded	1	2	3	12	13	23	123
	No. of individuals	5	4	14	2	0	6	1

Attendance

Non-breeding birds were found on the island during each of the three main observation periods (Table 1): 8 were recorded in October-November, 13 in November-December and 21 in January. Even allowing for the number of days in each period, we found many more in January than in November-December, and more then than in October-November. Only one bird was recorded in all three observation periods, two in the first and second only, and six in the second and third only. The increase in January may be due to new arrivals or, conceivably, to failed breeders moving into different burrows.

In October-November, five birds were recorded a total of nine times singly in burrows. One "pair" was found on two consecutive days in a burrow but was not seen again. During the same period, six pairs of birds subsequently proved to breed were found together in burrows, but although pairs of proven breeders were together more often than "pairs" of non-breeders, the difference was not significant.

During October-November, all the non-breeding birds, except the one "pair", were in the burrow for only one day at a time. This is a lower frequency of presence in consecutive days than we found for the breeders, especially the breeding males, four of which were recorded on three consecutive days.

During November-December there was a stronger tendency for non-breeding birds to stay in the burrows over consecutive days (Fig. 6). Compared with October-November, when eight records were for one day only and only two for more than one day, the corresponding figures are five records for only one day and 11 for more than one day. Of the 11, four birds were present for three consecutive days. This difference in behaviour between October-November and November-December is significant ($X^2 = 4.06$, $p < .05$).

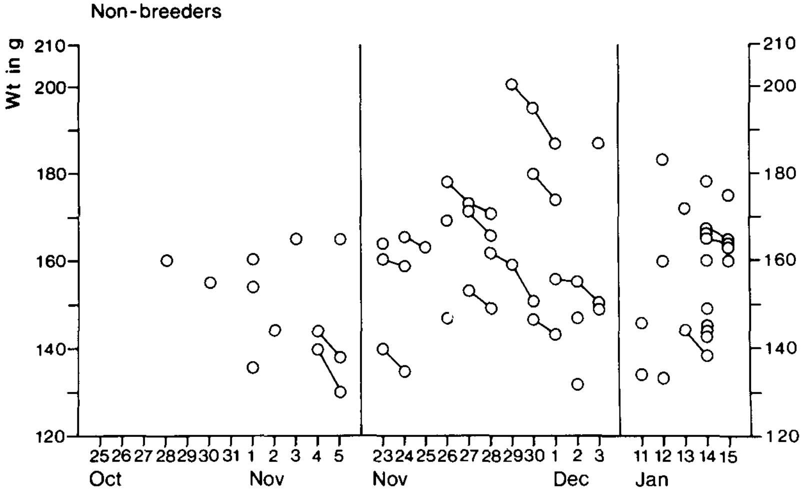


FIGURE 6 — Weights of non-breeding Pycroft's Petrels caught in burrows. Lines join weights on consecutive weighings.

The data for January are hard to interpret owing to the very short observation period and the difficulty of using data from the first and last days. However, 10 of the observations were of a single day only and only one was of two days only. Two records were for a minimum of two days and may have continued (Fig. 6). These data are too few to analyse but the visits of non-breeders in January do seem shorter. Table 1 shows that many non-breeders were recorded for the first time in January, and so more non-breeding birds may visit breeding colonies then.

Because breeders are committed to incubation and caring for the young, their behaviour contrasts markedly with that of non-breeders in November-December and January.

Constancy of burrows

Non-breeders were always recorded in the same burrows: none was found in more than one burrow throughout the study. In general the burrows occupied by non-breeding birds were not attended by other birds, but there were exceptions such as the following example.

In one burrow ♂95 and ♀96 were together from 30 October to 1 November, when ♂96 was present alone. When we arrived again on 23 November, birds 08 and 09 were together in the burrow, as they were on the following day. On 25 November, ♀96 was in the burrow with an egg. On 27 November, ♂95 was incubating the egg, and it continued until the end of our visit on 3 December. Birds 08 and 09, presumably a non-breeding "pair", were not recorded again in the study. Imber (1976) recorded similar cases for the Grey-faced Petrel.

In another burrow, bird 03 was present on the evening of 1 December and was alone there the following day. Its brood patch bare, it weighed 155 g. On 3 December it was still in the burrow, together with bird 79. No egg was recorded in November-December. In January the burrow was empty when we arrived but on 14 and 15 January a new unringed petrel, 45, was in the burrow. It had a bare brood patch with a little regrowth of down, and no sign of wing or tail moult.

By contrast one breeder, ♂75, which we found alone in one burrow on 31 October-2 November, was alone in another burrow on 3 November. This bird went on to breed with ♀80 in the latter burrow.

Non-breeders may turn up at colonies throughout the breeding season. For example, on 1 November bird 01 was alone in a burrow and on 26 November it was there again, alone. The burrow was empty on 29 November, but on 30 November and 1 December 01 and 23 were there together. In January the burrow was empty when we arrived, but on 14 January 01 and 23 were together in the burrow and on 15 January 01 was there alone. We do not know of an egg being laid in this burrow.

Weights

The mean weight of eight birds present on 10 occasions in October-November was 152.30 g, SD 10.57 g. This value is not significantly different from those of breeding males and females in October-November. Weight loss, which was measured over only two bird days, averaged 8.0 g per day, which was consistent with the rates of loss of breeders at this time.

In the November-December visit, excluding the weights on the first day of our visit, the mean initial weight for 15 non-breeders was 162.93 g, SD 18.28 g. The range of weights (132-201 g) accounts for the rather large standard deviation, but most were between 145 and 170 g. It is interesting to speculate whether those birds coming in with weights greater than 170 g could have been failed breeders. The mean weights of males and females returning to begin incubation in November-December were 192.3 and 187.5 g respectively. Only five of the non-breeding birds weighed more than 170 g on their return in November-December: the weights were 172, 178, 180, 201 and 187 g. On evidence derived from their attendance pattern, the first three of these birds may have been failed breeders, and the fourth may have lost its egg.

We can conclude that, although a few of the "non-breeding" birds may have been failed breeders, most seem to have been genuine non-breeders and to have maintained throughout November-December body weights very like those in October-November. The same was true in January*, when for 16 initial weights (excluding the first day of our visit), the mean was 158.69 g, SD 14.65 g. Again the range is very wide, 133-183 g, and four non-breeders caught in January weighed 172, 176, 178 and 183 g.

The rates of weight loss also are similar to those of breeding adults. For 15 bird days in November-December the average rate of loss was 4.53 g per day.

OTHER OBSERVATIONS

Brood patch

In petrels a conspicuous abdominal brood patch develops by losing its thick covering of down and becoming vascular. When 'bare' the brood patch of Pycroft's Petrel retains a narrow mesial band of down but is otherwise bare vascular skin. In our records we described brood patches as either 'bare' or 'downy'.

In October-November, we handled five breeders, of both sexes, and two non-breeders. All had brood patches completely covered with down.

In November-December, we examined the brood patches of 11 non-breeders, of which seven were bare and four were completely downy. In one burrow where two birds were present, possibly a pair, one bird's brood patch was downy and the other's was bare. In two other "pairs" of non-breeders, both had bare brood patches. We examined 13 male, 11 female and one unsexed breeders at this time. Of the five females found with their newly laid egg, or just before laying, three had downy and two had bare brood patches.

Two females were sitting alongside their egg, which was cold, and were not incubating. One of these, 02, was sitting beside a new egg, which was cold, on 30 November, and its brood patch was recorded as "rather downy; not vascular". It had been recorded in the burrow with ♂78 on 1 November,

---

*In these analyses we have regarded one bird, found on 13 January with the remains of an unhatched egg in its burrow, as a non-breeding bird because we have no evidence that this was indeed one of the parents of the egg.

and ♂78 was incubating the egg from the evening on 30 November to 3 December. When we returned in January the burrow had collapsed and contained broken egg shells. On the evening of 11 January, ♂78 was digging in the burrow (which we had repaired), and on 14 January ♀02 was caught digging in the burrow. Almost certainly, therefore, ♀02 had laid the egg. It is easier to understand why the female in another burrow was not incubating and the egg was cold when first recorded on 1 December: a medium-sized tuatara was in the burrow. Both petrel and tuatara were very active and the egg was badly soiled with mud. It seemed that this female had been fighting the reptile, possibly defending its egg. The female's brood patch was bare and vascular. We evicted the tuatara and ♀76 incubated until the night of 2-3 December. On the morning of 3 December the burrow was open, there were signs of upheaval and fighting: scrapings, dislodged soil and stones, a broken egg with the yolk intact on the ground, and no bird.

The males we found taking over their first incubation stint all had a bare brood patch, and one male already had a bare brood patch the day before the egg was laid.

In January birds which were still incubating had bare brood patches, although one, whose sex was not determined, had some new down even though it was still incubating: however, its egg had been laid very late in the season and was abandoned long before it would have been due to hatch. We examined 13 non-breeders in January. Of these, six had bare brood patches and seven had brood patches with extensive new growth of down. Of four "pairs" of non-breeders examined in January, both birds of one pair had bare brood patches whereas, in the other three pairs, one bird was bare while the other had regrowing down.

It is interesting to consider the brood patches of those birds which we thought might be failed breeders. Birds 01 and 23 occupied one burrow. On 26 November the brood patch of 01 was "completely downy", and on 27 November that of bird 23 was bare. These birds were together in the burrow on 14 January, when the brood patch of 01 was still bare and vascular, but that of bird 23 had down "regrowing extensively". At another burrow birds 16 and 27 were present during the laying period. At the end of November both had bare brood patches, and on 14 January the brood patch of bird 16 had considerable regrowth of down. Bird 73, having lost its egg on 3 December, broken during a fight in the burrow, was found in a different burrow on 11 January. Its brood patch was still bare and the remiges and rectrices were not in moult.

From these data it is difficult to tell whether pairs 01/23 and 16/27 had lost their egg. An interesting feature, however, is that bird 01 developed a bare brood patch between 26 November, when it was completely downy, and 14 January, when it was bare, whereas its presumed mate had a bare brood patch on 27 November and a downy one on 14 January. The positive data from bird 73 indicates that a bare brood patch can persist for almost 6 weeks after the loss of the egg.

Egg formation

Imber (1976) has drawn attention to the physiological adaptations which must be associated with the absence of breeding petrels from their breeding colonies, often for several weeks, before the egg is laid. Copulation is assumed to take place when the birds are attending the breeding colonies, and so either sperm is stored in the female for several weeks before fertilisaton (Hatch 1983) or development is delayed after fertilisation, or both. Grau (1976) has described the ring structure of avian egg yolk and has also developed staining methods to mark growth rings in the yolk and so identify the dates on which they were laid down. The dye used was Sudan Black and it was administered orally by capsule.

We administered dye capsules to three pairs of Pyrcroft's Petrels during their prelaying attendance in their burrows, about a month before laying, but could not administer a second capsule several days later because none of the birds remained in the burrows for long enough. The eggs were collected on the day they were laid and processed according to Grau's techniques (Imber, pers. comm.). On examination, none had any sign of a dark ring in the yolk, indicating that yolk was not being laid down at the time the dye was absorbed 26, 27 and 29 days before laying. The number of detectable concentric rings, however, was 12, 13 and 14, indicating that the birds took about two weeks to deposit the yolk.

We found breeding Pycroft's Petrels in their burrows by day from 40 days before laying to 20 days before laying. Indeed, they may well remain at or near their burrows until closer to laying, but our observation periods were too short. We did not see copulation but presumably it takes place at the breeding colony as with other petrels (Thoresen 1967, Serventy *et al.* 1971, Crockett 1975). Perhaps the female goes to sea, straight after copulation, with the fertilised egg, which then takes about 20 days to develop, or perhaps she goes to sea before the ovum has begun to develop and stores the sperm. After the ovum matures, fertilisation occurs and the egg takes a further 1-2 weeks to develop fully (cf. Imber 1976 for *P. macroptera*).

Failed breeders

Very little is known about failed breeders. Two sites with an egg in December had no egg or chick in January and no sign of the breeders, all of which were marked and known. At a third site, where the pair was known in November, broken egg shells were scattered near the entrance on our arrival on 11 January. That night the male was digging out the burrow, and on the night of 14 January the female was digging an extension to the burrow and was using a plastic tunnel with which we had sought to reconstruct the entrance. We did not note the state of the brood patch or of moult in these birds. At a fourth site, where the egg was broken on 3 December, the male was in the burrow on 11 January, six weeks later; its brood patch was still bare and it was not in wing or tail moult. The bird was gone the next day.

Known history of previously ringed birds

During the study we recaptured 12 ringed adults. All had been ringed as breeders, one in the breeding season of 1980/81 and the others in 1981/82. The following notes include their history in the 1982/83 breeding season.

One bird, of unknown sex, bred in the same burrow for the three consecutive years, with the same mate in the last two. A further six birds bred in the same burrow with the same mate in the last two years, and two males and one bird of unknown sex bred in the same burrows in the last two years.

There are two interesting situations. Bird 79, which had bred unsuccessfully in 1981/82, was caught in the same burrow on 30 October and 3 December 1982, weighing 155 and 149 g respectively. We classed it as a non-breeder in 1982/83, and it may not have attempted to breed in that year. Secondly, male 71 bred in burrow A in 1981/82 and in burrow B in 1982/83. It was recorded incubating in burrow B for 12 consecutive days in November-December (which confirmed that it was male) and was still incubating in January, when the intact egg was found to be dead. Male 75 was also caught in burrow A on 31 October, 1 November and 2 November, during which time its weight dropped from 149 to 141 g, and on the following day, 3 November, it was found in burrow C, weighing 135 g. It bred in burrow C where it was incubating on 3 December, female 80 having been found in the burrow with an egg in her abdomen on 1 December. Male 75 had bred with female 80 in burrow C in 1981/82 and again in 82/83: its presence in burrow B for three consecutive days in October-November was unusual.

ACKNOWLEDGEMENTS

I thank Malcolm Crawley, M.J. Imber, D.G. Newman and I. MacFadden of the NZ Wildlife Service for support, advice and assistance in the field. My wife, Mom, provided invaluable assistance in the field. I am grateful to the Board of the Hauraki Gulf Maritime Park for permission to work on Lady Alice Island and to J.A. Bartle and the Ornithology Department of the National Museum, Wellington, for advice and for providing dummy eggs for the experiment. Barry and Sally Keen of Whangarei and Jim Cossey of Taurakura were most hospitable and helpful with transport arrangement. M.J. Imber kindly commented on an earlier draft of the paper. The editor, despite his surname, found the Scottish prose of an earlier draft hard to digest and accept and greatly improved it without recourse to Newzild.

LITERATURE CITED

BARTLE, J.A. 1968. Observations on the breeding habits of Pycroft's Petrel. Notornis 15: 70-99.

CROCKETT, D.E. 1975. The Wedge-tailed Shearwater *Puffinus pacificus* in the northern Kermadecs. Notornis 22: 1-9.

FALLA, R.A. 1934. The distribution and breeding habits of petrels in northern New Zealand. Rec. Auck. Inst. Mus. 1:245-262.

FLEMING, C.A. 1941. Notes on neozelanic forms of the subgenus *Cookilaria*. Emu 41:69-80.

GRANT, G.S.. WARHAM, J.; PETTIT, T.N.; WHITTOW, G.C. 1983. Reproductive behavior and vocalizations of the Bonin Petrel. Wilson Bull. 95:522-539.

GRAU, C.R. 1976. Ring structure of avian egg yolk. Poultry Science 55:1418-1422.

HATCH, S.A. 1983. Mechanism and ecological significance of sperm storage in the northern fulmars with reference to its occurrence in other birds. Auk 100:593-600.

HINDWOOD, K.A.; SERVENTY, D.L. 1941. The Gould Petrel of Cabbage Tree Island. Emu 41:1-20.

IMBER, M.J. 1976. Breeding biology of the Grey-faced Petrel *Pterodroma macroptera gouldi*. Ibis 118:51-64.

JENKINS, J.A.F.; CHESHIRE, N.G. 1982. The Black-winged Petrel (*Pterodroma nigripennis*) in the South-West Pacific and the Tasman Sea. Notornis 29:293-310.

PERCY, C.A. 1956. A primary survey of the vegetation of Marotiri Island. Tane 7:3-6.

REISCHEK, A. 1885. Notes on New Zealand ornithology. Trans. NZ Inst. 18:87-96.

RICHDALE, L.E. 1963. Biology of the Sooty Shearwater *Puffinus griseus*. Proc. Zool. Soc. Lond. 141:1-117.

SERVENTY, D.L. 1956. A method of sexing petrels in field observations. Emu 56:213-214.

SERVENTY, D.L.; SERVENTY, V.; WARHAM, J. 1971. The handbook of Australian sea-birds. 254 pp. Sydney: Reed.

SKEGG, P.D.G. 1964. Birds of the Hen and Chicken Islands. Notornis 11:159-176.
STEAD, E.F. 1936. A new nesting-site of Cook's Petrel *Pterodroma cooki*. Trans. Roy. Soc. NZ 66:315.
THORESEN, A.C. 1967. Ecological observations on Stanley and Green Islands, Mercury Group. Notornis 14:18-200.

G.M. DUNNET, *Culterty Field Station, Zoology Department, University of Aberdeen, Scotland*

APPENDIX 1. **PYCROFT'S PETRELS** – Measurement of bill length, bill depth and wing length

BIRD	BILL		WING		BIRD	BILL		WING	
	L	D				L	D		
90	26.4	8.3	220	♀	09	25.9	8.2	227	
87	24.3	7.7	222	♀	15	25.8	8.2	219	♂
88	26.0	9.0	220		11	24.5	8.6	225	
71	25.4	8.2	216	♂	12	24.8	7.7	211	♂
72	23.0	7.9	220		13	24.3	7.8	210	♂
81	24.2	7.0	224		14	25.2	8.1	222	♀
91	24.3	8.1	216	♂	16	24.6	8.3	204	
89	24.4	8.0	216	♀	17	23.7	7.6	208	♂
92	24.7	7.7	214		18	25.9	8.0	219	♂
79	24.4	8.0	228		19	23.5	7.4	216	♂
95	24.2	8.0	219	♂	20	25.0	7.7	215	
96	23.6	7.3	221	♀	21	24.8	8.2	222	♀
98	23.5	7.5	216	♀	22	26.2	8.0	222	
99	24.5	8.2	225	♂	23	25.0	8.1	221	
73	26.0	8.2	224	♂	24	24.3	8.1	216	
72	23.9	7.8	224		25	25.3	7.8	221	♀
97	24.3	7.5	219		26	23.5	8.1	218	♀
00	25.3	8.6	221		27	24.9	8.0	226	
01	25.2	7.9	224		28	24.1	8.3	229	♂
75	26.3	8.3	223	♂	29	24.7	8.0	225	♀
02	25.3	7.9	213	♀	30	25.1	7.9	215	♂
03	23.6	7.8	222		77	25.1	8.2	224	♀
04	25.4	8.4	227		62	25.2	8.2	221	
76	23.4	7.8	228	♀	31	24.0	8.3	216	♀
05	24.4	8.1	220	♂	33	23.5	8.3	218	
78	23.7	8.0	223	♂	32	24.8	7.7	224	
80	24.2	8.2	225	♀	34	25.1	8.1	216	
06	24.8	8.0	217		35	25.0	8.2	228	
07	25.6	7.8	218		36	24.4	7.5	223	
74	26.6	8.2	219	♂	37	24.6	7.9	221	
10	26.5	8.6	221	♀	38	25.6	8.6	231	
08	23.5	7.9	219		39	24.0	8.0	218	
44	25.0	7.9	-		45	26.0	8.4	217	

Mean Bill length = 24.77, s.d. 0.87 mm;
Mean Bill depth = 8.02, s.d. 0.34 mm;
Mean Wing length = 220.18, s.d. 5.09 mm.

	TARSUS	MID TOE AND CLAW			TARSUS	MID TOE AND CLAW	
20	30.3	38.0		23	28.9	37.8	
44	30.2	35.4		11	28.8	38.1	
45	29.3	36.8		34	28.8	36.1	
05	29.0	38.5	♂	35	29.2	36.5	
62	31.0	37.6		87	28.8	36.5	♀
25	30.3	38.0	♀	96	30.4	38.3	♀
35	28.6	36.4		04	30.0	36.4	
16	30.1	37.7		80	29.6	38.3	
01	29.7	39.0		89	30.5	37.9	

Mean Tarsus length = 29.64, s.d. 0.73 mm;
Mean length Mid Toe and Claw = 37.41, s.d. 0.99 mm.

SHORT NOTE

Another Example of Tree-Nesting Harriers

Australasian Harriers (*Circus approximans gouldi*) nesting in New Zealand generally favour swamps but will also nest in scrub, fern and among crops. Tree nesting is most unusual. Skinner (1979, *Notornis* 26:119) mentioned two presumed nests in a tawa (*Beilschmiedia tawa*) at 12 m and 15 m, one containing what appeared to be a well-fledged juvenile, and also mentioned another nest at 2.5 m seen by Geoff Moon.

Recently, while checking on a pair of New Zealand Falcons (*Falco novaeseelandiae*) in the western King Country, I met Mr Andrew Haswell from Hauturu, who told me of a curious nest he and a workmate had found during the summer of 1981-82 when tree-felling on his parents' property. While working among trees felled the previous day they found two young Australasian Harriers sitting on the ground under a fallen tree amid the remains of a nest. From Mr Haswell's description the young Harriers, one well-feathered and the other still in down, were aged about two and four weeks. Both birds were taken by the workers but died within a short time. According to Mr Haswell the nest was constructed, rather loosely he thought, of sticks and was about 60 cm across. Although not sure, he thought the tree to be a mahoe (*Melicytus ramiflorus*) 5-7 m tall. Certainly it was not an emergent such as New Zealand Falcons nest in.

Naturally I checked the accuracy of these observations but Mr Haswell was adamant that the nest and young had been in the tree, and not under it when it fell, and that the young were Harriers and not Falcons. He had previously found other Harrier nests on the ground containing young, and he had watched an adult Harrier, which he presumed to be one of the parents, circle low over them while they examined the nest and young.

I am unable to explain why these birds chose to nest in a tree as there appeared nothing advantageous in the general situation of the nest, in a shallow bush-clad gully, and wide range of more typical nest sites was available nearby. However, two nestlings were being reared, and had these fledged, this nest would have been as successful as other more usual Harrier nests. Both of New Zealand's diurnal raptors, the Harrier and the New Zealand Falcon, have been reported as being markedly conservative and traditional in their choice of nest sites. It would be worthwhile for observers to report occurrences of tree-nesting Harriers so that the incidence of this behaviour can be established, together with just why these birds nest in this remarkable way.

L. A. HEDLEY, *61 Bailey Street, Huntly*

SEABIRDS FOUND DEAD ON NEW ZEALAND BEACHES IN 1983 AND A REVIEW OF ALBATROSS RECOVERIES SINCE 1960

By R. G. POWLESLAND

ABSTRACT

In 1983, 4559 kilometres of coast were patrolled and 5991 dead seabirds were found. A new record for the Beach Patrol Scheme was a Pomarine Skua (*Stercorarius pomarinus*). Unusual finds were Yellow-nosed Mollymawk (*Diomedea chlororhynchos*), Stejneger's Petrel (*Pterodroma longirostris*), White-tailed Tropicbird (*Phaethon lepturus*), Lesser Frigate Bird (*Fregata ariel*) and Grey Ternlet (*Procelsterna cerulea*). A wreck of Long-tailed Skuas (*Stercorarius longicaudus*) occurred mainly on Auckland West beaches in January and February.

A summary is given of the coastal and monthly distribution for each species and subspecies of the 2401 albatrosses found during the 1960-1983 period. Of the various coastal regions, albatrosses were found most frequently (number of birds per 100 km covered) on Southland beaches. The most frequently found albatross was the Grey-headed Mollymawk (*Diomedea chrysostoma*).

INTRODUCTION

This paper records the results of the Ornithological Society of New Zealand's Beach Patrol Scheme for 1983. Patrols were carried out on all sections of coast, except Fiordland. Some beaches on the Chatham Islands were patrolled and the results are given under the heading Outlying Islands. In all, 570 Beach Patrol Cards and 16 Specimen Record Cards were submitted. Conventions used are the same as in previous papers (see Powlesland 1983).

RESULTS AND DISCUSSION

In 1983, the total distance of coast travelled was 4559 km and 5991 seabirds were found dead by 316 members of the Ornithological Society of New Zealand and their friends. The average number of birds found per kilometre of coast covered monthly was 1.49 (Table 1). The total distance travelled in 1983 was much longer than the average of 3618 km for the previous 13 years (1970-1983). However, the averages of 9023 birds per year and 2.97 birds per kilometre covered for the previous 13 years are much greater than the values for 1983. During the previous 13 years, only in 1972 (1.47) have fewer birds per kilometre been found than in 1983. Table 1 also gives the kilometres covered and the number of seabirds found per month and in total for the various coasts, plus the number of birds picked up per kilometre covered for each coast. Table 2 gives the coastal and monthly distributions of the less commonly found seabirds (1-15 in 1983) and Tables 3 and 4 give these of the more commonly found seabirds.

NOTORNIS 32: 23-41 (1985)

TABLE 1 — Numbers of dead seabirds recovered and kilometres covered on each coast in 1983

COAST	CODE		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL KM	TOTAL BIRDS	BIRDS/KM /COAST
AUCKLAND WEST	AW	KM	215	188	164	178	187	187	186	190	181	193	171	191	2231		
		BIRDS	715	451	274	142	160	163	227	76	111	123	204	648		3294	1.48
TARANAKI	TA	KM	14	8	16	23	22	1	29	4	12	10	23	15	177		
		BIRDS	74	35	28	14	32	12	49	4	5	4	23	44		324	1.83
WELLINGTON WEST	WW	KM	11	39	10	8	50	23	32	29	45	30	53	28	358		
		BIRDS	80	388	16	9	52	21	33	40	125	16	84	88		952	2.66
AUCKLAND EAST	AE	KM	95	24	54	40	49	60	52	35	53	67	24	107	660		
		BIRDS	102	37	121	58	23	28	25	7	12	44	34	291		782	1.19
BAY OF PLENTY	BP	KM	-	-	-	-	-	19	90	-	-	44	30	11	194		
		BIRDS	-	-	-	-	-	1	34	-	-	49	34	20		138	0.71
EAST COAST NI	EC	KM	8	5	6	1	12	8	-	9	8	25	8	8	98		
		BIRDS	1	1	10	1	14	0	-	1	2	7	11	17		65	0.66
WAIRARAPA	WA	KM	-	-	-	10	-	4	-	5	-	-	-	-	19		
		BIRDS	-	-	-	1	-	3	-	0	-	-	-	-		4	0.21
WELLINGTON SOUTH	WS	KM	-	-	1	-	3	3	1	-	-	2	8	6	24		
		BIRDS	-	-	1	-	4	6	2	-	-	0	4	13		30	1.25
NORTH COAST SI	NC	KM	3	-	-	2	-	-	1	-	-	-	2	-	8		
		BIRDS	25	-	-	3	-	-	0	-	-	-	0	-		28	3.50
WESTLAND	WD	KM	-	2	-	2	2	-	-	2	6	2	5	3	24		
		BIRDS	-	0	-	0	0	-	-	0	2	0	0	4		6	0.25
CANTERBURY NORTH	CN	KM	-	13	12	10	26	6	10	8	19	7	7	11	129		
		BIRDS	-	24	8	10	28	3	8	8	9	4	28	17		147	1.14
CANTERBURY SOUTH	CS	KM	6	1	1	9	9	10	9	10	6	7	2	2	72		
		BIRDS	22	26	1	14	11	9	18	10	6	1	1	5		124	1.72
OTAGO	OT	KM	5	9	21	12	5	6	9	5	5	7	5	5	94		
		BIRDS	1	7	35	20	0	4	4	0	0	0	0	0		71	0.75
SOUTHLAND	SD	KM	-	-	-	2	-	-	-	-	-	-	-	-	2		
		BIRDS	-	-	-	1	-	-	-	-	-	-	-	-		1	0.50
OUTLYING ISLANDS	OI	KM	15	10	6	-	15	-	-	-	-	-	-	-	46		
		BIRDS	14	4	0	-	7	-	-	-	-	-	-	-		25	0.54
TOTAL KILOMETRES TRAVELLED			403	339	305	303	403	347	456	313	355	450	370	515	4559		
TOTAL KILOMETRES COVERED			372	299	291	297	380	327	419	297	335	394	338	387	4136		
TOTAL SEABIRDS RECOVERED			1034	973	494	273	331	250	400	146	272	248	423	1147		5991	
BIRDS/KM COVERED/MONTH			2.78	3.25	1.70	0.92	0.87	0.76	0.95	0.49	0.81	0.63	1.25	2.97			1.49

Unusual finds

A new record for the Beach Patrol Scheme is the Pomarine Skua, a specimen of which was found on Omamari Beach, Northland (AW), in January (Table 2). Oliver (1955) recorded a specimen having been shot at the Bay of Islands in December 1933. Although rarely seen about New Zealand coasts, it may be a regular visitor. After breeding, mainly within the Arctic Circle, it migrates to the Southern Hemisphere during our summer. In the Pacific region its main wintering area seems to be off the eastern and south-eastern coasts of Australia, where it is commonly seen from October to May (Falla *et al.* 1979, Barton 1982). Thus, some birds are likely to be blown off course to New Zealand.

A Yellow-nosed Mollymawk that came ashore on Mount Maunganui Beach (BP) in July (Table 2) is the sixth for the Beach Patrol Scheme. The five previous birds were found on Auckland West beaches: two in May and August 1980, and three in April, June and November 1981.

Two subspecies of this mollymawk are known, having different nesting distributions and breeding times. *D. c. chlororhynchos* nests on the Tristan da Cunha group and Gough Island in the southern Atlantic, and it is presumed to lay in early September (Watson 1975). In contrast, *D. c. bassi* breeds on St Paul, Prince Edward, Amsterdam and the Crozet Islands in the southern Indian Ocean, where it lays in early October (C. J. R. Robertson, pers. comm.) Banded young from Tristan da Cunha have moved north-eastwards to the southwest coast of Africa. However, those that have ranged eastwards to the southern Australian coast from May to October are mainly *bassi.* Both subspecies have been recorded about New Zealand (C. J. R. Robertson, pers. comm.)

Up to 1975, only 11 records of sightings were recorded from New Zealand. However, since then Yellow-nosed Mollymawks have been seen frequently in the outer waters of the Hauraki Gulf, near the Three Kings Islands and off the Bay of Plenty coast, especially in 1980 (Booth 1982). Therefore, it was to be expected that a few beach-wrecked Yellow-nosed Mollymawks would be recorded from New Zealand during the last few years.

Three Stejneger's Petrels were picked up on Ninety Mile Beach (AW) in December (Table 2). Previously, three specimens had been found by patrollers: 1961, WS, December; and 1962 (2), BP (2), January (2) (Falla 1962). This petrel is known to breed only on Mas Afuera Island in the Juan Fernandez group off the coast of Chile (Falla *et al.* 1979). During the non-breeding season it migrates to the northern Pacific Ocean, where birds in moult regularly occur off Japan. All six specimens were picked up from New Zealand beaches during the petrel's breeding season, November to March (Harrison 1983), and so they were presumably non-breeders.

Three White-tailed Tropicbirds were found on Auckland West beaches in 1983. Two were on Ninety Mile Beach in March and May, and the other was on Omamari Beach in April. Only four specimens of this tropicbird have been previously recovered: 1973, BP, January; 1979 (3), TA and AW (2), February (2) and June. White-tailed Tropicbirds breed on many islands in the tropical Pacific from the Hawaiian Islands to New Caledonia (Harrison 1983). It is

TABLE 2 — Seabirds of which 1 to 15 specimens were found in 1983

SPECIES OR SUBSPECIES	NUMBER FOUND	COAST(S)	MONTH(S)
Megadyptes antipodes	9	WW, CS(3), OT(5).	JAN, FEB, MAR(2), APR(3), JUL, AUG.
Eudyptes pachyrhynchus	2	AW, OT.	JAN, MAR.
sclateri	1	OT.	MAR.
Diomedea exulans	9	AW(6), TA, CN, OI.	JAN, FEB(2), MAR, MAY, JUN(2), SEP, DEC.
epomophora	2	AW, WS.	JAN, JUL.
melanophrys	5	AW(4), WW.	JAN(3), MAR, SEP.
chlororhynchus	1	BP.	JUL.
bulleri	7	AW(7).	MAR, JUN(3), JUL, AUG, OCT.
cauta salvini	5	WW(2), BP, WS, CN.	MAR, MAY, NOV(2), DEC.
Fulmarus glacialoides	2	AW(2).	JAN, OCT.
Pterodroma spp.•	3	AW, TA, AE.	JAN, JUL, DEC.
brevirostris	12	AW(7), TA, WW(4).	JAN, AUG, SEP(7), OCT(2), NOV.
longirostris	3	AW(3).	DEC(3).
pycrofti	3	AW(2), AE.	MAR, DEC(2).
leucoptera	2	AW(2).	JAN, DEC.
Halobaena caerulea	15	AW(7), TA(3), WW(5).	JUL(3), AUG(4), SEP(4), OCT(3), DEC.
Pachyptila crassirostris	1	TA.	JUL.
Procellaria cinerea	6	AW(6).	JAN, MAY, SEP, DEC(3).
parkinsoni	9	AW(2), AE(7).	JAN(2), FEB(3), APR(3), DEC.
westlandica	7	AW(7).	JAN(6), JUN.
aequinoctialis	14	AW(13), EC.	JAN(11), SEP, NOV, DEC.
Puffinus pacificus	3	AW(2), TA.	JAN, SEP, DEC.
Phaethon lepturus	3	AW(3).	MAR, APR, MAY.
Phalacrocorax spp.*	1	EC.	NOV.
sulcirostris	1	BP.	OCT.
melanoleucos	6	AW, TA(2), BP, CS(2).	JAN, MAY, JUN(2), OCT, DEC.
Leucocarbo carunculatus chalconotus	5	OT(5).	FEB, MAR(4).
Fregata ariel	1	AW.	NOV.
Stercorarius spp.*	1	AW.	DEC.
pomarinus	1	AW.	JAN.
Larus spp.*	2	OT(2).	FEB, MAR.
bulleri	13	WW(3), EC(2), CS(6), OT(2).	MAR(5), APR, MAY, JUN(3), SEP(3).
Hydroprogne caspia	14	AW(12), AE, CN.	JAN(3), FEB(3), MAR, APR(2), MAY, JUN, JULY, AUG, DEC.
Sterna spp.*	1	CS.	APR.
albostriata	1	NC.	JAN.
fuscata	1	WW.	MAY.
Procelsterna cerulea	1	AE.	DEC.
TOTAL	173		

• Species could not be identified by the patroller.

a regular though rare visitor to the coasts of eastern Australia, with the stragglers that reach New Zealand possibly being swept south by tropical cyclones (Falla *et al.* 1979).

A Lesser Frigate Bird picked up on Ninety Mile Beach (AW) in November (Table 2) is the second to be recorded in the Beach Patrol Scheme. The previous bird was found in January 1971, also from Ninety Mile Beach. This species straggles to New Zealand from the tropical Pacific, where it breeds on New Caledonia, Fiji, and off the Queensland coast. Between 1907 and 1970 at least 13 sightings were made of Lesser Frigate Birds from the shore of the New Zealand mainland (Kinsky 1970), mostly about the northern North Island coasts during or after tropical storms.

The Grey Ternlet found on Ocean Beach (AE) in December is the fifth specimen of this species to be recovered. Previous records are: 1974, AE, January; 1976, AW, April; 1977, AE, February; and 1980, AW, March. This tern inhabits the coastal waters of the central and southern Pacific Ocean, breeding on islands throughout its range, including the Kermadec, Norfolk and Lord Howe Islands. Flocks have occasionally been seen in northern coastal waters of New Zealand, the sightings becoming more frequent in recent years. In 1970 flocks of several hundred birds were seen roosting on and feeding about Volkner Rocks near White Island and Sugarloaf Rock near the Alderman Islands (Falla 1970). At the Kermadecs the birds nest from August to January and feed in flocks close to shore on small fish and crustaceans picked up from the surface (Soper 1969).

Three species were found in greater numbers in 1983 than in previous years. Thirty-eight White-capped Mollymawks *(Diomedea cauta cauta)* were found, mainly on Auckland West beaches (Table 3), in January and February (Table 4). The previous highest annual total was 34 in 1975. Fourteen White-chinned Petrels *(Procellaria aequinoctialis)* were picked up in 1983, whereas the previous highest annual total was nine in 1982. Most of the 1983 birds were on Auckland West beaches in January (Table 2).

Of interest is the recovery of 30 Black-winged Petrels *(Pterodroma nigripennis)* in 1983, mainly from Auckland West beaches in summer (Tables 3 and 4). Increasing numbers of this petrel have been beach wrecked since 1977. Two, one or no birds were found in each of the years 1960 to 1977, followed by eight in both 1978 and 1979, seven in 1980, 13 in 1981 and 10 in 1982. Over the past 38 years, since being found breeding on the Three Kings Islands in 1945, the Black-winged Petrel has expanded its breeding range about New Zealand. Colonies have been established or birds found prospecting on several of the islands of the Chathams group, on Aorangi Island of the Poor Knights, East Island off East Cape and Portland Island (EC) in the 1970s (Jenkins & Cheshire 1982, M. J. Imber, pers. comm.) Therefore, the incidence of beach-wrecked Black-winged Petrels would be expected to increase over the same period.

Many of this petrel's breeding islands are to the east and north of New Zealand and most sightings of it at sea have been made to the north-east of the North Island, although birds have regularly been seen over the Tasman Sea (Jenkins & Cheshire 1982). Nevertheless, 86% of the 90 Black-

TABLE 3 — Coastal distribution of the seabirds more commonly found dead in 1983

SPECIES OR	COAST															TOTAL
SUBSPECIES	AW	TA	WW	AE	BP	EC	WA	WS	NC	WD	CN	CS	OT	SD	OI	BIRDS
Eudyptula minor subspp.*	674	62	34	259	15	4	-	2	5	-	3	-	2	-	2	1062
albosignata	1	-	-	-	-	-	-	-	-	-	6	9	-	-	-	16
Diomedea spp.*	13	-	1	-	-	-	-	-	-	-	-	1	-	-	2	17
chrysostoma	16	-	8	1	-	-	-	-	-	-	-	-	-	-	-	25
*cauta subspp.**	13	-	6	-	-	-	-	-	-	-	1	-	-	-	-	20
cauta cauta	27	2	5	-	1	-	1	-	-	-	1	-	-	-	1	38
Phoebetria palpebrata	17	-	-	-	1	-	-	-	-	-	-	-	-	-	-	18
Macronectes spp.*	15	-	3	-	-	-	-	3	-	-	-	-	-	-	1	22
Daption capense	8	2	1	1	-	-	-	-	-	-	4	3	1	-	-	20
Pterodroma macroptera	44	2	3	9	2	-	-	-	-	-	-	-	-	-	-	60
lessonii	57	-	7	2	-	-	-	-	-	-	-	-	-	-	-	66
inexpectata	40	2	1	-	-	-	-	-	-	-	-	-	-	-	1	44
cookii	11	2	-	6	-	-	-	-	-	-	-	-	-	-	-	19
nigripennis	18	3	-	-	-	5	-	3	-	-	1	-	-	-	-	30
Pachyptila spp.*	111	21	306	5	-	2	-	-	11	3	-	-	-	-	2	461
vittata	15	3	13	-	-	-	-	-	-	1	2	1	-	-	-	35
salvini	18	2	4	-	-	-	-	-	-	-	-	1	-	-	-	25
desolata	39	4	2	-	-	-	-	-	-	-	1	-	-	-	-	46
belcheri	39	2	3	2	-	-	-	-	-	-	-	1	-	-	-	47
turtur	219	30	255	8	9	-	-	1	3	-	3	-	-	-	-	528
Puffinus spp.*	2	7	6	4	-	-	-	-	2	1	-	-	1	-	-	23
carneipes	38	1	2	59	2	-	-	-	-	-	-	-	-	-	-	102
bulleri	155	13	18	57	11	-	1	-	-	-	-	-	-	-	-	255
griseus	536	44	64	49	19	22	1	7	1	-	6	3	5	-	10	767
tenuirostris	150	15	38	35	1	-	-	-	-	-	1	2	-	-	2	244
gavia	248	29	27	88	24	1	-	1	-	-	1	1	-	-	-	420
huttoni	15	-	11	1	-	-	-	-	2	-	12	-	-	-	-	41
assimilis	24	1	1	7	2	-	-	-	-	-	-	-	-	-	-	35
Pelagodroma marina	15	-	-	3	-	-	-	-	-	-	-	5	-	-	-	23
Pelecanoides urinatrix	109	9	11	50	17	-	-	1	-	-	1	-	-	-	-	198
Sula bassana	217	10	6	24	11	3	-	-	-	-	1	-	-	-	-	272
Phalacrocorax carbo	2	1	4	-	-	8	-	-	-	-	-	-	1	-	-	16
varius	5	-	-	15	4	-	-	-	-	-	1	-	-	-	-	25
Stictocarbo punctatus	-	-	-	-	-	-	-	1	1	-	16	57	24	-	-	99
Stercorarius longicaudus	33	-	3	-	-	-	-	-	-	-	-	-	-	-	-	36
Larus dominicanus	168	28	77	46	8	13	1	8	1	1	30	18	13	-	2	414
novaehollandiae	33	10	9	27	7	-	-	1	1	-	50	5	6	-	-	149
Sterna striata	57	9	6	13	-	3	-	-	-	-	3	5	2	1	1	100
TOTALS	3202	314	935	771	134	61	4	28	27	6	144	112	55	1	24	5818

* *Species or subspecies could not be identified by the patroller.*

winged Petrels found since 1960 have been on western North Island beaches. Presumably, this is a result of currents and winds that drive weak or dead birds ashore off the west coast more readily than off the east coast.

From observations at sea, Jenkins & Cheshire (1982) reported that Black-winged Petrels were absent from the Tasman Sea and the Pacific south of Tonga from July to late October, returned to the breeding sites in the New Zealand region during November, and were in highest numbers at sea about New Zealand in December and January. The same trend of numbers is apparent from the Beach Patrol Scheme data. During 1960-1983, 80% of the 90 petrels found were collected in December to March, and only 3% in June to October.

Wreck

Thirty-six Long-tailed Skuas were found in 1983. Only two had been found previously: 1981, AE, September; and 1982, AW, January. Of the birds in 1983, 33 were recovered from Auckland West beaches and the rest from Wellington West beaches during January (29) and February (7). This skua is a northern circumpolar breeder that makes a transequatorial migration to winter in the Southern Hemisphere. Most overwinter off the coasts of South America, but very occasionally the species is sighted in the south-west Pacific. However, because the Long-tailed Skua was so rarely seen or found along New Zealand's coast before 1980, it is worth speculating on why so many were beach wrecked in 1983.

A likely contributing factor was the occurrence in the central and eastern Pacific during the second half of 1982 of a warm-water event, commonly referred to as "El Nino" conditions. The unusual oceanographic and climatological conditions included an abrupt increase in sea-surface temperatures and changes in wind patterns, salinity, currents and sea levels (Schreiber & Schreiber 1983). Associated with these conditions, the same authors found that, at Christmas Island in November 1982, almost all of the petrels, shearwaters, tropicbirds, boobies, frigate birds and terns that normally nest there failed to breed.

Most of the birds abandoned the island, including an estimated 14 million Sooty Terns (*Sterna fuscata*), leaving many dead and starving nestlings. Schreiber & Schreiber (1983) speculated that the birds had left the island because the El Nino conditions had resulted in their prey being in very short supply. Similarly, Boekelheide *et al.* (1983) reported that the breeding success of seabirds, particularly alcids and cormorants, on Farallon Island off the California coast was very poor during the El Nino period and that important prey were absent from the diets at the time. Thus, like the birds from these islands, the Long-tailed Skua, which pirates some of its food from several other seabirds, may have been forced to search further afield for food.

December 1982 was very windy, particularly in the Tasman Sea, with predominantly northerly and westerly winds blowing on to the Auckland West coast (P. Bruce, Meteorological Service, pers. comm.) Any skuas wandering south of the central Pacific Ocean in search of food may have been forced by these winds into the Tasman Sea and towards New Zealand. During early January 1983, moderate to strong northerly and westerly winds continued to blow on to Northland, culminating in several periods of gale-force westerly winds during 13-19 January. A few days later, beach patrollers found most

TABLE 4 — Monthly distribution of the seabirds more commonly found dead in 1983

SPECIES OR	MONTH												TOTAL
SUBSPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	BIRDS
Eudyptula minor subspp.*	159	115	119	60	45	32	55	32	25	32	35	353	1062
albosignata	1	7	-	2	2	-	2	-	1	-	-	1	16
Diomedea spp.*	3	3	6	-	-	-	-	-	1	3	-	1	17
chrysostoma	3	-	1	1	-	3	4	3	10	-	-	-	25
cauta subspp.*	1	6	1	-	1	1	7	2	-	-	-	1	20
cauta cauta	9	10	1	1	3	3	4	1	2	3	-	1	38
Phoebetria palpebrata	9	2	-	-	2	-	1	-	1	3	-	-	18
Macronectes spp.*	1	-	1	-	2	4	5	2	4	1	1	1	22
Daption capense	4	2	1	2	-	-	2	1	5	1	1	1	20
Pterodroma macroptera	22	2	2	-	1	4	5	3	5	9	2	5	60
lessonii	26	11	2	1	-	1	4	1	3	4	6	7	66
inexpectata	23	12	2	1	-	-	-	-	1	-	-	5	44
cookii	1	4	3	5	1	-	-	-	-	-	-	5	19
nigripennis	8	3	5	1	1	-	-	-	-	-	-	12	30
Pachyptila spp.*	33	255	24	4	13	18	19	10	43	6	14	22	461
vittata	2	-	-	-	5	-	4	1	1	-	-	22	35
salvini	1	1	-	-	5	5	8	2	2	1	-	-	25
desolata	1	-	-	-	17	10	10	6	-	2	-	-	46
belcheri	1	6	-	-	4	2	23	6	2	2	-	1	47
turtur	38	172	3	3	12	18	82	18	45	16	73	48	528
Puffinus spp.*	5	5	1	-	1	2	2	-	1	-	1	5	23
carneipes	14	14	31	15	6	1	-	-	-	5	8	8	102
bulleri	60	20	25	22	18	5	5	1	3	28	27	41	255
griseus	257	93	41	9	45	37	8	7	-	16	77	177	767
tenuirostris	53	6	2	7	41	3	-	2	-	-	7	123	244
gavia	41	16	53	29	9	20	33	6	26	33	55	99	420
huttoni	3	10	1	4	3	1	-	-	-	8	6	5	41
assimilis	9	6	3	1	2	3	3	-	1	1	3	3	35
Pelagodroma marina	3	-	2	-	1	2	1	1	2	1	5	5	23
Pelecanoides urinatrix	80	6	3	2	1	8	9	1	13	18	7	50	198
Sula bassana	32	64	20	8	10	10	28	5	13	18	15	49	272
Phalacrocorax carbo	1	1	3	1	2	-	-	2	3	1	2	-	16
varius	1	1	3	2	1	1	5	-	-	3	1	7	25
Stictocarbo punctatus	18	20	6	20	7	4	12	1	1	-	1	9	99
Stercorarius longicaudus	29	7	-	-	-	-	-	-	-	-	-	-	36
Larus dominicanus	23	47	83	39	49	28	34	14	26	15	29	27	414
novaehollandiae	14	24	10	6	12	5	12	8	8	4	31	15	149
Sterna striata	7	11	15	16	1	7	3	2	5	5	10	18	100
TOTAL	996	962	473	262	323	238	390	138	253	239	417	1127	5818

* Species or subspecies could not be identified by the patroller.

of the 36 Long-tailed Skuas, several of them emaciated, only recently washed or blown ashore. As well as these skuas, other seabirds from the central Pacific were also found about New Zealand in early 1983, including a Masked Booby (C. R. Veitch, pers. comm.), White-tailed Tropicbirds and a Lesser Frigate Bird.

Miscellaneous birds

Miscellaneous birds recovered in 1983, but not considered to be seabirds, totalled 216. There were 44 magpies, 21 Mallards, 20 Black Swans, 12 Rock Pigeons, 10 each of Song Thrushes and Starlings, eight each of Grey Ducks and Australasian Harriers, seven Pukekos, six each of duck species and South Island Pied Oystercatchers, five each of Paradise Shelducks, Pheasants and Goldfinches, four each of California Quail, passerine species and Blackbirds, three each of domestic geese, domestic fowl, Variable Oystercatchers, Silvereyes and Indian Mynas, two each of White-faced Herons, domestic turkeys, New Zealand Kingfishers and Skylarks, and one each of Cattle Egret, Canada Goose, Western Weka, Spur-winged Plover, New Zealand Dotterel, Eastern Bar-tailed Godwit, Knot, North Island Kaka, Eastern Rosella, Oriental Cuckoo, Long-tailed Cuckoo, Welcome Swallow, New Zealand Pipit and Chaffinch.

ALBATROSS RECOVERIES 1960-1983

The following is a summary of the coastal and monthly distributions of the various albatrosses found by patrollers during the past 24 years, except for those picked up about the Wellington coasts immediately after the "Wahine storm" of 1968 (Kinsky 1968). In total, 2401 albatrosses were found, of which 366 were not identified to species and 217 *Diomedea cauta* were not identified to subspecies. The remaining 1818 birds were made up of six *Diomedea* species, three subspecies of *D. cauta,* and *Phoebetria palpebrata* (Table 5).

Overall, a mean of 4.43 albatrosses was found for every 100 km of beach covered. Of the various coastal regions, albatrosses were found most often on Southland beaches (8.88 birds/100 km covered), followed by Auckland West (6.44), Wellington South (5.42) and Wellington West beaches (4.68). Fewer than three albatrosses were found for each 100 km of beach covered for the other mainland New Zealand coasts (Table 5).

A description is given of the coastal and monthly rate of recovery (number of birds per 100 km of beach covered) for each species and subspecies of albatross, except for the Yellow-nosed Mollymawk, which was discussed above.

The annual pattern of recovery for each species and subspecies depicted in Figure 1 was compared, by chi-squared test, with the theoretical situation whereby an equal number of birds were found each month. The chi-squared values, as shown in Figure 1, indicate that for each of the species and subspecies the monthly rate of recovery changed significantly through the year.

In some species of albatross, breeding pairs that fledge chicks do not nest in the following breeding season but remain at sea. In other species, the breeding pairs nest each year. The breeding cycle of all albatrosses, whether biennial or annual breeders, can be divided into five stages. During some

TABLE 5 — Rate of recovery (number of albatrosses found per 100 km of beach covered) of five *Diomedea* species, two subspecies of *D. cauta*, and *Phoebetria palpebrata* on each coast during 1960-1983

SPECIES SUBSPECIES								COAST							
	AW	TA	WW	AE	BP	EC	WA	WS	NC	WD	CN	CS	OT	SD	OI
Diomedea exulans	0.61	0.18	0.16	0.08	0.19	0.38	-	0.43	-	-	0.47	0.91	-	0.35	0.46
D. epomophora	0.10	0.07	0.16	0.01	-	0.38	0.72	0.93	-	-	0.23	0.08	0.14	0.09	1.16
D. melanophrys	0.48	0.28	0.34	0.08	0.05	0.38	-	0.25	-	-	0.06	0	0.07	0.35	-
D. chrysostoma	2.04	0.14	1.20	0.09	0.10	0.19	-	0.46	-	-	0.06	0.08	-	0.44	0.46
D. bulleri	0.28	0.11	0.15	0.03	0.05	0.19	-	0.46	-	0.21	0.18	0.15	0.43	1.83	0.23
D. cauta cauta	0.91	0.78	0.95	0.04	0.14	-	0.36	0.78	0.36	0.41	0.29	0.23	0.64	1.31	0.23
D. c. salvini	0.12	-	0.11	0.06	0.24	-	-	0.78	-	-	0.35	0.15	0.28	0.09	0.23
Phoebetria palpebrata	0.66	0.07	0.09	0.11	0.10	-	-	0.18	0.18	-	0.29	0.23	-	0.09	0.23
Total*	6.44	2.46	4.68	0.72	1.01	2.30	1.80	5.42	1.62	0.82	3.05	2.57	2.34	8.88	4.64

* Includes *D.* spp (366), *D. chlororhynchos* (6), *D. cauta* (217) and *D. cauta eremita* (6)

stages birds other than the breeding adults are at the colony. The following categories (C. J. R. Robertson & the late L. E. Richdale, pers. comm.) are used in the discussion:

Breeding adults: Paired birds associated in the production of an egg
Bereaved breeders: Single birds that have bred in previous years but that have lost their mate and are not currently engaged in breeding
Birds keeping company: Adult birds that have formed pair bonds for one or more seasons before laying in a subsequent season; the pairs may consist of adults which have not previously bred, bereaved breeders, or a combination of the two.
Adolescents: Young birds that have not formed a pair bond

For the Royal Albatross (*Diomedea epomophora*), birds in each category have a slightly different time of arrival at and departure from the colony (Robertson & Richdale 1975). Breeders and birds keeping company return to the colony before and during laying. Unsuccessful breeders, bereaved breeders and birds keeping company begin leaving the colony during incubation and have all left by the end of the guard stage (when the young chicks are being guarded on the nest by parents). Adolescents, however, begin arriving during incubation, highest numbers being present just before hatching. The number of adolescents declines during the guard stage and they cease visiting the colony two and a half months after hatching occurs. For the rest of the breeding cycle until fledging, successful breeders are the only birds at the colony. Although the timing and length of the stages of the breeding cycle differ between species and subspecies, the presence of birds of the various categories at the colonies probably, for all albatrosses, follows a similar pattern to that described for the Royal Albatross.

WANDERING ALBATROSS (*Diomedea exulans*)

The taxonomic status of this species is at present under review (J. Warham & C. J. R. Robertson, pers. comm.) Although two forms are present about New Zealand (Falla *et al.* 1979), they were not distinguished by patrollers. The Wandering Albatross is a circumpolar species that nests on many subantarctic islands. It is fairly common over New Zealand seas, particularly around Stewart Island and further south (C. J. R. Robertson, pers. comm.) In the New Zealand region it nests on Antipodes, Auckland, Campbell and Macquarie Islands, but the timing of the breeding cycle differs between the islands. A successful nesting attempt lasts about a year, the adults returning to the colonies in November-December, depending on location, and their chicks fledging during December-February (C. J. R. Robertson, pers. comm.).

In total, 203 Wandering Albatrosses were found at a rate of 0.37 birds per 100 km of beach covered (Table 5). The highest rate of recovery was from Canterbury South beaches (0.91) and the lowest from Auckland East beaches (0.08). The monthly rate of recovery varied through the year ($p < 0.001$) from a low of 0.17 birds in September to a maximum of 0.66 in January (Fig. 1A). The period of high mortality in December-January coincides with the departure of local fledglings and so presumably results from the greater mortality of young birds learning to forage rather than an increased rate of mortality of adults. The increased mortality in June may be related to the

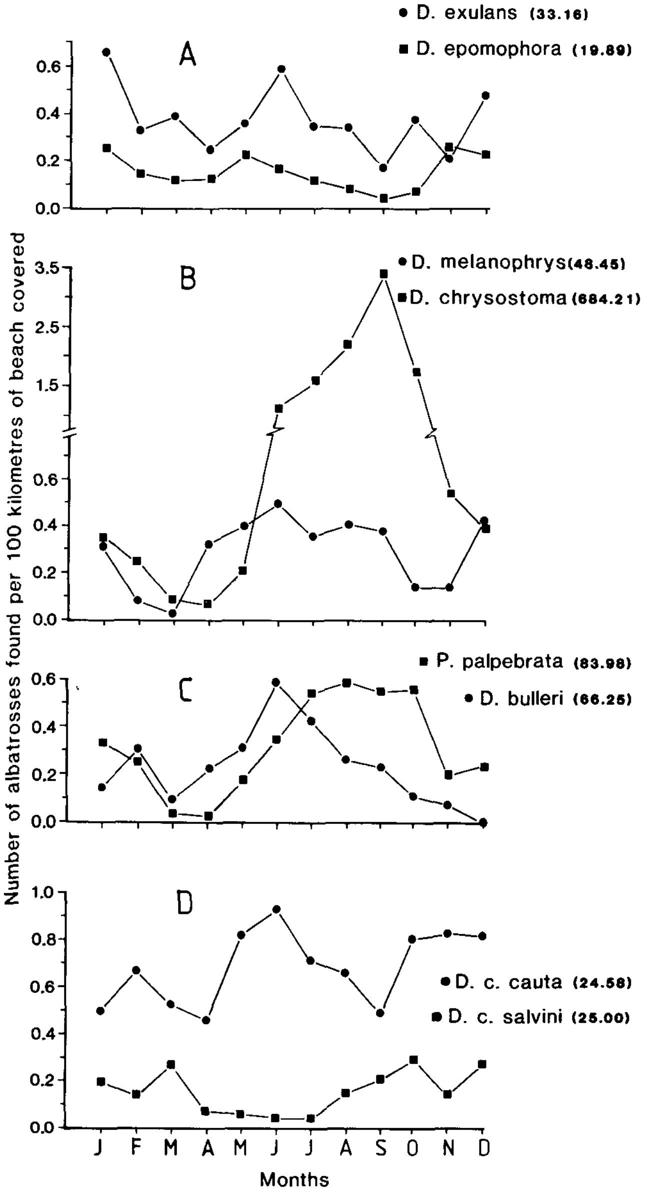


FIGURE 1 — Monthly rate of recovery (number of birds found dead per 100 km of beach covered) of five species of *Diomedea*, two subspecies of *D. cauta*, and *Phoebetria palpebrata* during 1960-1983. Figures in brackets are chi-squared values.

arrival of young birds (fledglings and adolescents) on migration from breeding colonies in the southern Atlantic Ocean.

ROYAL ALBATROSS (*D. epomophora*)

Beach patrollers usually did not distinguish between Royal Albatrosses of the northern race (*D. e. sanfordi*) and southern race (*D. e. epomophora*). The northern race breeds at Taiaroa Head in Otago and on the Sisters and Forty Fours Islands of the Chathams group, and the southern race breeds on Enderby Island of the Auckland Islands and on Campbell Island.

Eighty-one Royals were found from 1960 to 1983 at a rate of 0.15 birds per 100 km of beach covered. The highest rates of recovery were on the beaches of Outlying Islands (1.16), Wellington South (0.93) and Wairarapa (0.72) (Table 5). Although the monthly rate of recovery changed significantly during the year ($p < 0.05$), *the chi-squared value is the smallest for the* eight species under consideration (Fig. 1A). As for the Wandering Albatrosses, the period of greatest mortality of Royals was November to January (Fig. 1A), which coincides with laying and incubation by adults and the fledging of young of the southern race (Falla *et al.* 1979). This mortality may possibly be largely of recently fledged young, but birds in other categories probably contributed. Royal Albatrosses increase about our coasts during November-January because of adolescents moving to the colonies and bereaved breeders and those keeping company away from the colonies. Kinsky (1968) noted that both Royal and Wandering Albatrosses were more vulnerable to storm mortality when moulting. As both species have been found in heavy moult in April (Kinsky 1968), perhaps the high rate of recoveries of both species in May-June is related to moult.

BLACK-BROWED MOLLYMAWK (*D. melanophrys*)

There are two subspecies of this mollymawk. *D. m. melanophrys* is the most plentiful of all albatrosses, being a circumpolar breeder in the millions on many subantarctic islands. The main nesting islands are in the south-west Atlantic and about Cape Horn (C. J. R. Robertson, pers. comm.). In the New Zealand region, small colonies are on Macquarie and Antipodes Islands. The other subspecies, *D. m. impavida*, breeds only on Campbell Island and numbers about 75 000 pairs (Robertson 1980). The subspecific status of the 165 Black-browed Mollymawks picked up was not determined by patrollers. Overall, the average rate of recovery was 0.3 birds per 100 km of coast covered. Of the coastal regions, Auckland West had the greatest rate of recovery (0.48), followed by East Coast North Island (0.38), Southland (0.35) and Wellington West (0.34) (Table 5).

The monthly rate of recovery for the Black-browed Mollymawk changed markedly during the year ($p < 0.001$). Two periods of high mortality are evident (Fig. 1B), one from April to September and the other in December-January. At Campbell Island *D. m. impavida* starts returning in late August, most eggs being laid in late September-early October, and the young fledge in April (Bailey & Sorensen 1962, Robertson 1980). The fledglings move north to south-eastern Australian waters and equatorial Pacific regions (Robertson 1980).

Therefore, most of the Black-browed Mollymawks found on New Zealand beaches from April to June are likely to be *impavida* fledglings. The continued high mortality from July to September may be mainly of fledglings of the *melanophrys* subspecies, from colonies in the southern Indian Ocean that fledge slightly later than the *impavida* from Campbell Island.

The high rate of recovery in summer coincides with the period when successful breeders are feeding young nestlings. It is also when most non-breeding birds leave the colonies, and so more Black-browed Mollymawks than usual are likely to be moving past our northern coasts in summer than at other times of the year.

GREY-HEADED MOLLYMAWK (*D. chrysostoma*)

The Grey-headed Mollymawk was the *Diomedea* species most frequently found by patrollers and yet it is generally assumed to be a bird of the open oceans (Watson 1975). The species has a circumpolar breeding distribution and is the only mollymawk which is a biennial breeder. Almost all Grey-headed Mollymawks in the New Zealand region nest on Campbell Island (c. 11 500 pairs per annum), and only about 40 pairs nest on Macquarie Island (Robertson 1980). On Campbell Island, eggs are laid in late September to early October and the chicks depart in May (Bailey & Sorensen 1962, Robertson 1980). In total, 592 Grey-headed Mollymawks were found at a rate of one bird for every 100 km of beach covered. The highest rates of recovery were on Auckland West beaches (2.0 birds per 100 km covered) and Wellington West beaches (1.2) (Table 5).

The monthly rate of recovery changed markedly during the course of the year ($p < 0.001$). Fewest mollymawks were picked up in March-April (Fig. 1B), when only adults raising chicks are about the colonies. Presumably, the rate of recovery is high in winter largely because recent fledglings are moving through New Zealand coastal regions. In support of this suggestion, some banded as fledglings on Campbell Island have been recovered from eastern Australia (C. J. R. Robertson, pers. comm.). The continued high mortality from July to October suggests that many more Grey-headed Mollymawks than Black-browed Mollymawks spend the non-breeding season about our coasts. Adult Grey-headed Mollymawks return to Campbell Island in September (Bailey & Sorensen 1962), and so some of the beached birds found in August-September are probably adults returning to breed.

BULLER'S MOLLYMAWK (*D. bulleri*)

Two subspecies of Buller's Mollymawk are apparent (Peters 1979), which have separate breeding localities and different breeding seasons. About 26 000 pairs of the Northern Buller's Mollymawk (*D. b. platei*) breed on the Sisters and Forty Fours Islands of the Chathams group (Robertson 1974). Eggs are laid in October-November, and the young leave in June (C. J. R. Robertson, pers. comm.). The Southern Buller's Mollymawk (*D. b. bulleri*) consists of an estimated 7000 pairs nesting on Solander (2000) and the Snares Islands

(5000) (C. J. R. Robertson, pers. comm.). Eggs are laid at the Snares in January-February and the young fledge in September-October (Warham & Bennington 1983). Overall, 128 Buller's Mollymawks have been found at a rate of 0.24 birds per 100 km of beach covered. The highest rate of recovery was from Southland (1.8 birds), Wellington South (0.46) and Otago beaches (0.43) (Table 5). Southland beaches are the closest to the breeding islands of Solander Island and the Snares.

The monthly rate at which Buller's Mollymawks were found changed significantly during the year ($p < 0.001$), with a June peak in recoveries (Fig. 1C). All beach-wrecked specimens of Buller's Mollymawk that are in museums are the southern subspecies (C. J. R. Robertson, pers. comm.). As most Buller's Mollymawks found beach-wrecked are from Southland beaches (Table 5), presumably they are mainly birds from the Snares. If so, the peak in recoveries in June is possibly related to the movement of adolescents away from the colonies. In future, specimens of Buller's Mollymawk found, particularly on North Island beaches, in suitable condition for identification should be kept for critical examination as to subspecies.

WHITE-CAPPED MOLLYMAWK (*D. cauta cauta*)

The White-capped (Shy) Mollymawk has two forms that recent field studies suggest should be considered as different subspecies (C. J. R. Robertson, pers. comm.). The nearest colonies of this mollymawk to New Zealand are on Disappointment, Auckland and Adams Islands of the Auckland Island group, where about 64 000 pairs nest (Robertson 1975). Its breeding has not been studied in detail, but it is estimated that laying begins in late November and that the chicks fledge in August (C. J. R. Robertson, pers. comm.). The nominate form of this mollymawk, of which there are only about 5000 pairs, breeds on Albatross Rock in Bass Strait and on the Mewstone and Pedra Branca Islands south-west of Tasmania (C. J. R. Robertson, pers. comm.). At these colonies laying occurs in September (Robertson & van Tets 1982) and the chicks depart in April (C. J. R. Robertson, pers. comm.).

The White-capped Mollymawk was the second most beach-wrecked albatross after the Grey-headed; 372 were reported. As for Buller's, the rate of recovery was greatest for Southland (1.3), followed by the three western North Island regions (Table 5). This pattern is to be expected because most nest on the Auckland Islands to the south of Southland. For all coasts over the 1960-1983 period, this mollymawk was found at the rate of 0.7 birds per 100 km covered.

The monthly rate at which the mollymawk was beach-wrecked varied during the year ($p < 0.05$), with peaks of mortality in May-June and October-December (Fig. 1D). The departure of young from the Auckland Island colonies in August may account for the increased recoveries in October-December. If it does, however, the mortality is unexpectedly low in September, directly after the nestlings have fledged. As suggested for some of the other albatrosses, the October-December mortality, which coincides with laying and incubation by breeders, may be as a result of the movements of unsuccessful and bereaved breeders from the colonies towards New Zealand and the opposite movement of adolescents.

During the peak of recoveries in May-June, only adults feeding large chicks may be present about the Auckland Islands. However, the location of non-breeding birds is as yet unknown. This May-June mortality may be high because *Diomedea* species are vulnerable to storms when moulting. All 45 White-capped Mollymawks found beach-wrecked in April 1968 after the "Wahine storm" were in full moult (Kinsky 1968).

SALVIN'S MOLLYMAWK (*D. c. salvini*)

Eighty-three Salvin's Mollymawks were found during 1960-1983 at a rate of recovery of 0.15 birds. Although the species breeds on the Western Chain Islets of the Snares (Miskelly 1984) and on the Bounty Islands (Robertson & van Tets 1982) to the south and east of New Zealand respectively, it has been found beach-wrecked mostly along the Wellington South Coast (0.78), not on Southland beaches (0.09) as might be expected (Table 5). Almost all of the approximately 77,000 breeding pairs of Salvin's Mollymawk nest at the Bounties (Robertson & van Tets 1982, Miskelly 1984).

The monthly rate of recovery of this mollymawk changed during the year ($p < 0.01$), with increased mortality in September-December and March (Fig. 1D). The spring mortality coincides with laying through to the raising of young chicks. At this time, adolescents are at the colonies, taking part in courtship activities. Thus, the increased mortality of Salvin's Mollymawk about the New Zealand coast in spring may be a result of the return and departure of these less experienced birds. Kinsky (1968) noted that all three specimens of this species picked up in February 1947 were in full moult. Therefore, the peak in mortality of Salvin's Mollymawk in March may result because it is moulting then and more vulnerable to storms. Unlike the other mollymawks, Salvin's Mollymawk does not show a higher mortality soon after the chicks leave in April (Oliver 1955), perhaps because it disperses widely away from New Zealand to the South Atlantic and South Pacific coasts of South America (C. J. R. Robertson, pers. comm.).

CHATHAM ISLAND MOLLYMAWK (*D. c. eremita*)

This mollymawk breeds only on Pyramid Rock of the Chatham Islands group, where about 4000 pairs nest (C. J. R. Robertson, pers. comm.). Its distribution at sea is probably into the southern Pacific Ocean because it is rarely seen in New Zealand coastal waters. Presumably because of its rarity in New Zealand coastal waters and its small population, only six Chatham Island Mollymawks have been found by patrollers, three of them on Chatham Island beaches in January 1979. The details for the other three are 1964, AW, August, and 1971 (2), WW and BP, September and December.

LIGHT-MANTLED SOOTY ALBATROSS (*Phoebetria palpebrata*)

This albatross has a circumpolar distribution, breeding on several subantarctic islands. In the New Zealand region, an estimated 5000-10 000 pairs breed on the Auckland, Antipodes, Campbell and Macquarie Islands

(C. J. R. Robertson, pers. comm.). In total, 182 Light-mantled Sooty Albatrosses were found during 1960-1983, the rate of recovery being 0.34 birds.

Instead of being found mainly on Southland beaches (0.09 birds), as would be expected from its southern breeding distribution, it was beach-wrecked most often on Auckland West beaches (0.66 birds) (Table 5). Perhaps Sooty Albatrosses from outside the New Zealand region are washed ashore on New Zealand beaches more often than those from our subantarctic islands. The rate at which Sooty Albatrosses were found each month changed markedly during the year ($p < 0.001$). The rate of recovery increases steadily from almost zero in March and April to about 0.55 birds during July-October, after which it declines (Fig. 1C). This species returns to Campbell Island to breed in early October, lays in late October-early November and the young leave in late May-early June (Bailey & Sorensen 1962).

The greater mortality of Sooty Albatrosses on our beaches from April to July is perhaps mainly of recently fledged young that, being poor foragers, die from starvation or in storms. It is not known whether the high mortality that continues from July to October is of Sooty Albatrosses from colonies outside the New Zealand region moving into our coastal waters or of birds from the colonies near New Zealand remaining about our coasts in winter.

The future

The discussion of the results shows that the movements and distribution at sea of most local albatrosses are poorly known. Beach patrollers can do a lot to help answer much of the speculation put forward. Whenever possible, it is important to state whether a beach-wrecked albatross is a juvenile or an adult and whether it is moulting primaries and secondaries or not. Whenever you find a fresh specimen of a species whose subspecific status is of interest, for example, *D. melanophrys* and the *D. cauta* group, the specimen should be frozen, if possible, and sent to a museum for such a determination.

ACKNOWLEDGEMENTS

The success of the Beach Patrol Scheme in 1983 is due to the patrollers listed below, who are known to have taken part, and all others who took part but whose names were not entered on the cards.

J. Ackley, Auckland team, D. Baker, M. Barnes, D. Bate, P. Batley, B. Bell, M. Bellingham, P. Bellingham, A. Betteswork, D. & C. Betteswork, B. Binning, M. Bishop, J. Black, T. Blake, N. Bligh & family, D. Bollschweiler, K. Bond, D. Booth, E. Bot, G. Brackenbury, K. Brash, B. Brown, G. Brown, R. Bryant, G., P. & A. Bull, B. Burch, D. Buzan, B. Byford, A. Campbell, B. & J. Campbell, G. Campbell, J. & H. Campbell, W. Cash, S. Chamberlain, J. Charteris, B. Chudleigh, K. Clapperton, M. & G. Clark, P. Clerke, R. Cossee, C. Cosslett, R. Cotter, S. Cotter, P. Cozens, M. Craven, B. & S. Cresswell, J. Croad, R. & D. Crockett, P. Crombie, F. Crouch, T. Crouch, L. Cunningham, R. Dackers, M. Daly, I. Daniel, I. Davies, L. Davies, A. Davis, A. M. Davis, J. Dawn, A. Dench, D. Dombroski, G. Dreardon, J. Driessen, P. Druitt, B. Dunwoody & family, G. Eller, B. Elliott, B. Ellis, B. Enticott, C. Exley, M. Falconer, K. Fisher, K. Fletcher, M. Fordham, G. Foreman, M. Francis, R. Froggatt, K. Gager, M. Galbraith, A. Giblin, D. Gillman, B. Goffin & family, D. Goodale, A. Goodwin, A. & A. Gordon, A. Graeme,

D. Graham, E. Graham, U. Grundy, E. Gundry, H. Hagen, J. & R. Hamilton, V. Hamilton, J. Hampton. B. Harlow, D. Harlow, P., J. & M. Harris, K. & J. Haslett, F. Hassan, J. Hawken, B. Heather, M. Hemingway, V. & A. Hensley, E. Henwood, P. Herbert, M. Herd, R. Hitchmough, A. Hodgson, R. Holdaway, C. Holloway, D. & G. Horne, M. Horseford, L. & A. Howell, W. Hutton, S. Hyde, J. Innes, M. Jackson, W. Jackson, P. Jenkins, S. Jenkins, P. Jenner, C. Jowett, M. & H. Kearns, S., A., R. & R. Kennington, P. Knott, B. Laffey, R. & R. Lambert, M. Lane, P & T. Lanham, P. Latham, S. Lauder, R. Law, R. Lawes, D. Lawrie, B. & A. Lindsay. P. Lo, C. Long, J. Lusk, J. McBirnie, M. McConnell, C. McRae, C. & J. MacBain & family, A. MacDonald, A. MacGregor, F. Malcolm, K. Malloy, P. Mayhill, D. & J. Medway, P. Medway, R. & S. Meiklejohn, D. Melville, G. & M. Messenger, E. Midwinter, J. Miles, P. & K. Miller, P. Moore, R. Moorhouse, D. & V. Morgan, S. Morris, J. Morrison, T. Morrison, D. Mules, S. Murdoch, P. Notman, M. O'Dea, C. & H. O'Donnell, C. & R. Ogle, M. Olson, C. Olver, I. Painter, P. Parker, K. & J. Parkinson, S. Parr, S. Pauley, N. & R. Peachman, B. Pearson, P. Pearson, C. Peebles, L. Penny, T., M., P., R. & J. Picot, S., J. & R. Pitt, J. & R. Poole, H. Poppe, B. & A. Poulton, M. & R. Powlesland, M. Ramshaw, F. Ranford, D. Reed, E. Reed, R. Reed, J. Richards, D. Riddell, J. & S. Roos, R. Rothschild, N. Rothwell, A. Rowe, D. Russell, V. Rutherfurd, D. Ryan, S. Ryan, J. & C. Sale, I. Sangster, E. Saul, A. Saxby, C. & G. Schischka, P. Scofield, B. Searle, O. Seccombe, J. & B. Seddon, D. Shand, A. Shore, L. Silcock, D. Sim, B. & I. Simmons, M. Skinner, R., P. & A. Slack, A. Slade, I. Southey, K. Spencer, A. Spurgeon, R. Stace, L. Stanton, K. Stark, D. Starnes, B. Stephens, M., K. & S. Tarburton, A. Taylor, B. Taylor, G. Taylor, J. Taylor, M. Taylor, M. J. Taylor, A. Tennyson, B. Tennyson, R. Thomas, C. Thomlinson, C. & S. Thompson, K. Todd, U. Tolks, B. Trott, M. Turner, S. Walker, M. Wallis, D. Ward, A. Watkins, D. Watkins, R. Watkins, L. Watling, D. Watson, N. Webber, R. Weston, C. Wetzel, R. Wheeler, R. Wiblin, Mr & Mrs Wilkie, R. Wilson, R. Wood, S. & P. Wood.

E. & OE

My thanks to Malcolm Crawley, Barrie Heather, Mike Imber, Jim Mills and Chris Robertson for their constructive comments and improvements to drafts of this paper.

LITERATURE CITED

BAILEY, A.M.; SORENSEN, J.H. 1962. Subantarctic Campbell Island. Denver: Denver Museum of Natural History, proceedings No. 10.

BARTON, D. 1982. Notes on skuas and jaegers in the western Tasman Sea. Emu 82:56-59.

BOEKELHEIDE, R. J.; McELROY, T.; CARTER, H.R. 1983. Farallon Island seabirds and the 1983 El Nino. Pacific seabird group bulletin 10:46-47.

BOOTH, D.F. 1982. Classified summarised notes. 30 June 1980 to 30 June 1981. Notornis 29:49-74.

FALLA, R.A. 1962. New Zealand records of *Pterodroma longirostris* (Stejneger) and a new record of *Pterodroma leucoptera* (Gould). Notornis 9:275-277.

FALLA, R.A. 1970. Grey Ternlets in the Bay of Plenty. Notornis 17:83-86.

FALLA, R.A.; SIBSON, R.B.; TURBOTT, E.G. 1979. The new guide to the birds of New Zealand and outlying islands. Auckland: Collins.

HARRISON, P. 1983. Seabirds — an identification guide. Wellington: Reed.

JENKINS, J.A.F.; CHESHIRE, N.G. 1982. The Black-winged Petrel (*Pterodroma nigripennis*) in the south-west Pacific and the Tasman Sea. Notornis 29:293-310.

KINSKY, F.C. 1968. An unusual seabird mortality in the southern North Island (NZ) April, 1968. Notornis 15:143-155.

KINSKY, F.C. 1970 Annotated checklist of the birds of New Zealand. Wellington:Reed.

MISKELLY, C.M. 1984. Birds of the Western Chain, Snares Islands 1983-84. Notornis 31:209-223.

OLIVER, W.R.B. 1955. New Zealand birds. 2nd edn. Wellington:Reed.

PETERS, J.L. 1979. Checklist of the birds of the world. Vol. 1, 2nd edn. Cambridge: Museum of comparative zoology.

POWLESLAND, R.G. 1983. Seabirds found dead on New Zealand beaches in 1981. Notornis 30:125-135.

ROBERTSON, C.J.R. 1974. Albatrosses of the Chatham Islands. Wildlife — a review 5:20-22.

ROBERTSON, C.J.R. 1975. Report on the distribution, status and breeding biology of the Royal Albatross, Wandering Albatross and White-capped Mollymawk on the Auckland Islands. pp 143-151 *in* Preliminary results of the Auckland Islands expedition, 1972-1973. Department of Lands & Survey, Reserve series No. 1975/3.

ROBERTSON, C.J.R. 1980. Birds on Campbell Island. pp 106-116 *in* Preliminary reports of the Campbell Island expedition, 1975-1976. Department of Lands & Survey, Reserve series No. 1980/7.

ROBERTSON, C.J.R.; RICHDALE, L.E. 1975. The breeding phenology of the Royal Albatross *Diomedea epomophora sanfordi*. Emu 74 (Supplement):292.

ROBERTSON, C.J.R.; VAN TETS, G.F. 1982. The status of birds at the Bounty Islands. Notornis 29:311-336.

SCHREIBER, R.W.: SCHREIBER, E.A. 1982. Reproductive failure of marine birds on Christmas Island, fall 1982. Tropical Ocean-Atmosphere Newsletter 16:10-12.
SOPER, M.F. 1969. Kermadec Islands expedition reports. The Grey Ternlet (*Procelsterna cerulea albivitta*). Notornis 16:75-80.
WARHAM, J.; BENNINGTON, S.L. 1983. A census of Buller's Albatross *Diomedea bulleri* at the Snares Islands, New Zealand. Emu 83:112-114.
WATSON, G.E. 1975. Birds of the Antarctic and sub-Antarctic. Washington DC: American Geophysical Union.

RALPH G. POWLESLAND, *Wildlife Service, Department of Internal Affairs, Private Bag, Wellington*

SHORT NOTE

Mouth-Spots in nestling Fernbirds

The relationships of the endemic Fernbird (*Bowdleria punctata*) are obscure, but this species is usually associated with either the Old World warblers (Sylviidae) or Australo-Papuan warblers (Acanthizidae). Plumage and morphology suggest a relationship with the grassbirds (*Megalurus*), a genus of sylviid warblers.

In a comparison of the mouth-spots of nestling Australian songbirds with those from other parts of the world, Boles & Longmore (in press) found that no Australo-Papuan warbler they examined had mouth-markings but that all Australian species of Old World warblers, including both species of *Megalurus*, had markings of the tongue.

A photograph by Moon (1979) clearly shows the inside mouth of a nestling Fernbird. There are two spots at the base of the tongue and one on the tip (Fig. 1). Reed warblers (*Acrocephalus*) and cisticolas (*Cisticola*) have only the two spots at the base of the tongue. A three-spot pattern like that of the Fernbird is found in the Little Grassbird (*M. gramineus*). The Tawny Grassbird (*M. timoriensis*) also has this pattern but with the addition of black edging to the internal nares (Boles & Longmore, in press: fig. 1e).

This supports the inclusion of *Bowdleria* in the Sylviidae and a relationship between this genus and *Megalurus*.

LITERATURE CITED

BOLES, W. E.; N. W. LONGMORE. In press. Colours and marking of the mouths of nestling Australian songbirds. S. A. Orn.
MOON, G. 1979. The birds around us. Heinemann.

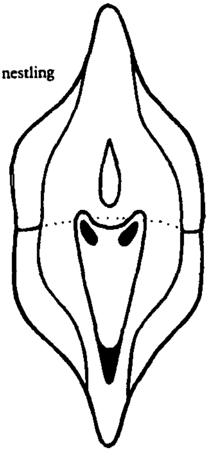


FIGURE 1 — Mouth-markings of nestling Fernbird and nestling Little Grassbird

WALTER E. BOLES, *Department of Ornithology, Australian Museum, 6-8 College Street, Sydney, NSW, Australia, 2000.*

THE RELATIONSHIP BETWEEN RIVERBED FLOODING AND NON-BREEDING WRYBILLS ON NORTHERN FEEDING GROUNDS IN SUMMER

By K. F. D. HUGHEY

ABSTRACT

I investigated the relationship between floods on the riverbed breeding grounds of Wrybills (*Anarhynchus frontalis*) and the number of Wrybills censused on northern harbours the following summer. For the purposes of the study I assumed that most birds oversummering on northern harbours are first-year non-breeders and that flood flows of the Rakaia River are representative of most other Wrybill breeding rivers. A highly significant negative correlation ($r^2=0.69$; $p<0.01$) existed for the 1968-1982 period. The study's findings provide some support for the observation that by the early 1960s the Wrybill population, after many years of growth, had begun to stabilise. Serious flooding in the 1982 and 1983 breeding seasons may have again destabilised the population structure.

INTRODUCTION

Several bird species breed only on the braided rivers of the eastern South Island, and recently there has been considerable research into these birds' behavioural ecology (Lalas 1977, Pierce 1979, 1982, Hay 1984) and habitat needs (Robertson *et al.* 1983, Hughey, in prep.). As many of these rivers are subject to existing or planned hydroelectric or irrigation development, we need to know how well these birds cope with natural hazards before we can try to assess the impact of human intervention.

The endemic Wrybill (*Anarhynchus frontalis*) relies on the braided rivers of Canterbury and the MacKenzie Basin (Fig.1) for breeding. If these rivers go on being developed by man, the entire population of about 5000 (Hay 1984) will be at risk. Most of these rivers have their headwaters in the main divide of the Southern Alps. They are partly glacially fed but also receive westerly storms that cause large floods in most of the Wrybill's spring and early summer breeding seasons. Flows in these rivers are highly variable during the breeding season, when average discharges are greater than at other times of the year. In contrast, the smaller rivers such as the Ashburton and Ashley, which drain eastern foothill catchments, do not receive the full effects of these storms and so are characterised by declining flows during the breeding season (Fig.2).

Wrybills, like most other riverbed nesting birds, require large areas of bare shingle for their nesting. The actively changing riverbeds of most high-country catchments are largely free of vegetation, but the lowland sections

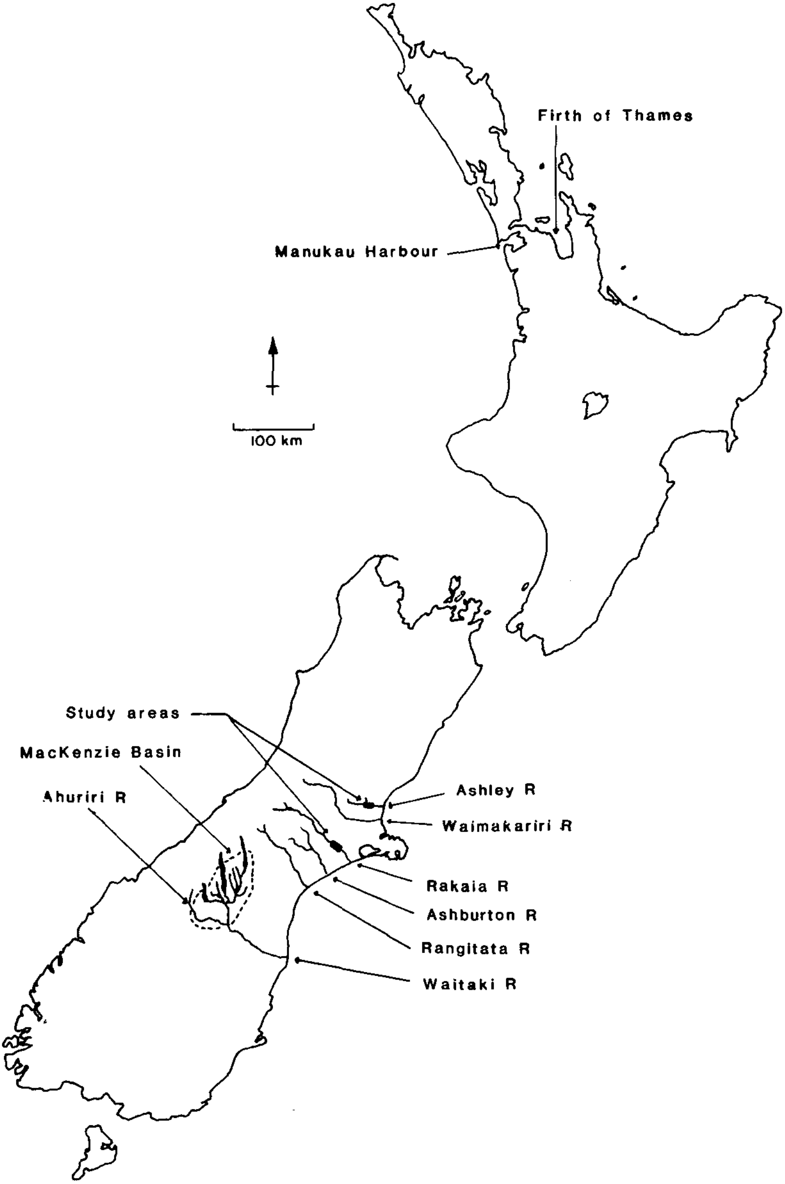


FIGURE 1 — Location map of the main Wrybill breeding areas (South Island) and winter feeding sites (North Island) discussed

of many rivers have been greatly modified by the invasion of exotic plants, including broom (*Cytisus scoparius*), gorse (*Ulex europaeus*), lupin (*Lupinus* spp.), and willow (*Salix* spp.). Stead (1932) thought that these modifications had reduced Wrybill numbers on the lower Rakaia River. However, the scouring action of floods helps maintain vegetation-free nesting areas.

The Rakaia River is the most important Wrybill river (O'Donnell & Moore 1983, Hughey, in prep.) with 1000-1500 breeding Wrybills (Cowie 1983). Only about 100 have been found on the whole Ahuriri River (Robertson *et al.* 1983), and similar numbers breed on several other MacKenzie Basin rivers (Pierce, pers. comm.). Although the Rangitata River has not been thoroughly surveyed, Wrybill numbers appear to be high on the upper reaches (Wragg, pers. comm).

Wrybills depend on aquatic and riparian habitats for their invertebrate food (Pierce 1979, Robertson *et al.* 1983) However, flooding causes a temporary but spectacular decline in available food (Pierce 1979, 1982, Sagar 1983), which affects breeding success (Hughey, in prep.). Furthermore, Hay (1984) considered floods to be the major cause of nest and egg losses. A flood on 7 December 1976 destroyed almost every Wrybill nest in his upper Rakaia study area. The peak instantaneous discharge (the absolute flood peak) on this date (2271 m^3s^{-1}) was slightly above the estimated bankful discharge (i.e. the flow equalling or exceeding the bank-to-bank capacity of the river) of 2200 m^3s^{-1} (Hughey, in prep.) that is predicted to flood all riverbed nests.

After breeding, Wrybills migrate northward to wintering grounds, mostly in the northern half of the North Island. At two especially important areas, Manukau Harbour and the Firth of Thames, summer and winter counts of Wrybills have been made annually since 1961. After their late summer and winter stay on these northern places, most Wrybills migrate south for riverbed breeding. Hay (1984) found a mixture of first- and second-year birds, and even some adults, among remaining oversummering Wrybills. Proportions of each varied, but it seems likely that birds spending the summer on northern harbours are predominantly first-year non-breeders, although this has yet to be proven. If so, summer counts are likely to reflect the breeding success of the previous nesting season. The object of my study was to see if summer counts of non-breeding Wrybills and the flood regime of the previous breeding season were related.

METHODS

I used the summer counts of Wrybills in the Manukau Harbour and the Firth of Thames, from the Ornithological Society of New Zealand records cited in O'Donnell & Moore (1983), and peak instantaneous flow data for the Rakaia and Ahuriri Rivers, from the Ministry of Works and Development. All the important Wrybill rivers, except the Ahuriri, have their headwaters within the 'Eastern Alps' hydrological region (Toebes & Palmer 1969). I therefore assumed that the flooding of these rivers would be similar in relative size, frequency, and timing. This assumption is supported by Waugh (pers. comm.), who found a generally good correlation between the Rangitata and Rakaia Rivers. Since the Rakaia is the most important Wrybill breeding river, I decided

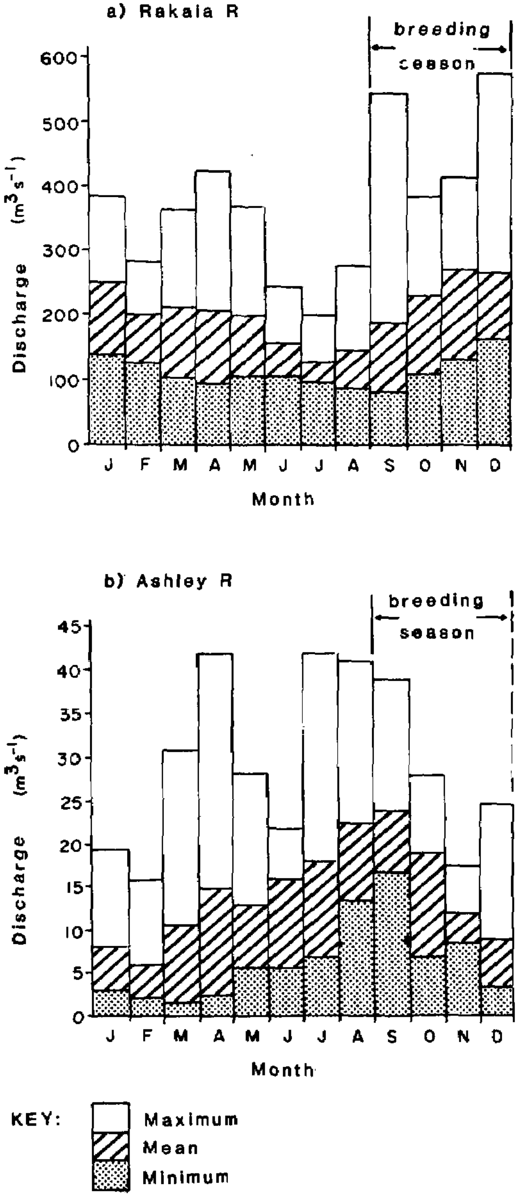


FIGURE 2 — *Annual variations in the flow regime of a mountain catchment river (the Rakaia) compared with a foothill catchment river (the Ashley)*

to use the flood flow data from this river as representative of all other major Wrybill rivers. To test this assumption I compared the flood regime of the Rakaia with that of the Ahuriri River by plotting the flows of both rivers for the 1980 season (Fig. 3). This comparison shows only minor variations in the pattern of flows. Using only Rakaia River flow data for the rest of this analysis is therefore reasonable.

I attempted to correlate summer counts of non-breeding Wrybills against the Rakaia River's peak instantaneous discharge of the previous breeding season. I selected the seasonal floods as follows:

1. I included floods that occurred only between 10 September and 10 November, when most first clutches are laid, incubated, and reared (Hay 1984, Hughey, in prep.).
2. If no medium to large floods (> 700 m^3s^{-1}) occurred between 10 September and 10 November, I assumed that most breeding would be successful. To allow some margin for late-chick growth, I extended this period to 20 November. Moreover, because Hay (1984) found that only about 20% of pairs attempt to rear two broods and because I did not record any Wrybills trying to rear two broods, I omitted flood peaks after 20 November.
3. If large flood peaks occurred between 10 September and 10 November, I extended the period for flooding to 20 December to allow time for attempted renesting.

Although Wrybills have been counted in each summer since 1960, I included only the 1968-1982 counts in this analysis for the following reasons:

1. The Wrybill population on northern harbours is considered to have risen markedly from 1940 to the late 1950s or early 1960s (Sibson 1963).
2. The early 1960s seem to mark the beginning of a population plateau, perhaps because the population was nearing the capacity of its breeding habitat. The spread of Wrybills into Otago in the 1960s (Child 1971, 1973) seems to support this view.
3. After two years of non-breeding status, Wrybills have a breeding life of around five years (Hay 1984). If the population did reach the capacity of its breeding habitat in 1961, it would have taken until 1968 for each year class to adjust to this plateau level and for the age structure of the population to become stable.
4. When the population reached this stable structure, its migratory behaviour was also likely to stabilise within the limits of natural population fluctuations. We have to be confident that the annual migratory events were consistent before we can establish any long-term relationship between flooding and birds spending the whole summer on northern harbours.
5. 1982 and 1983 are the first years since 1966-1968 with summer counts in the north of fewer than 100 birds. The low numbers in 1982 and 1983 may be associated with a population decline caused by large and frequent flooding, which is supported by a low Wrybill fledging success rate on the Rakaia River for the 1982 season at least (Hughey, in prep.) Such a decline may change existing patterns of migration. Thus, the apparently stable population plateau in 1968-1982 is the best period to study.

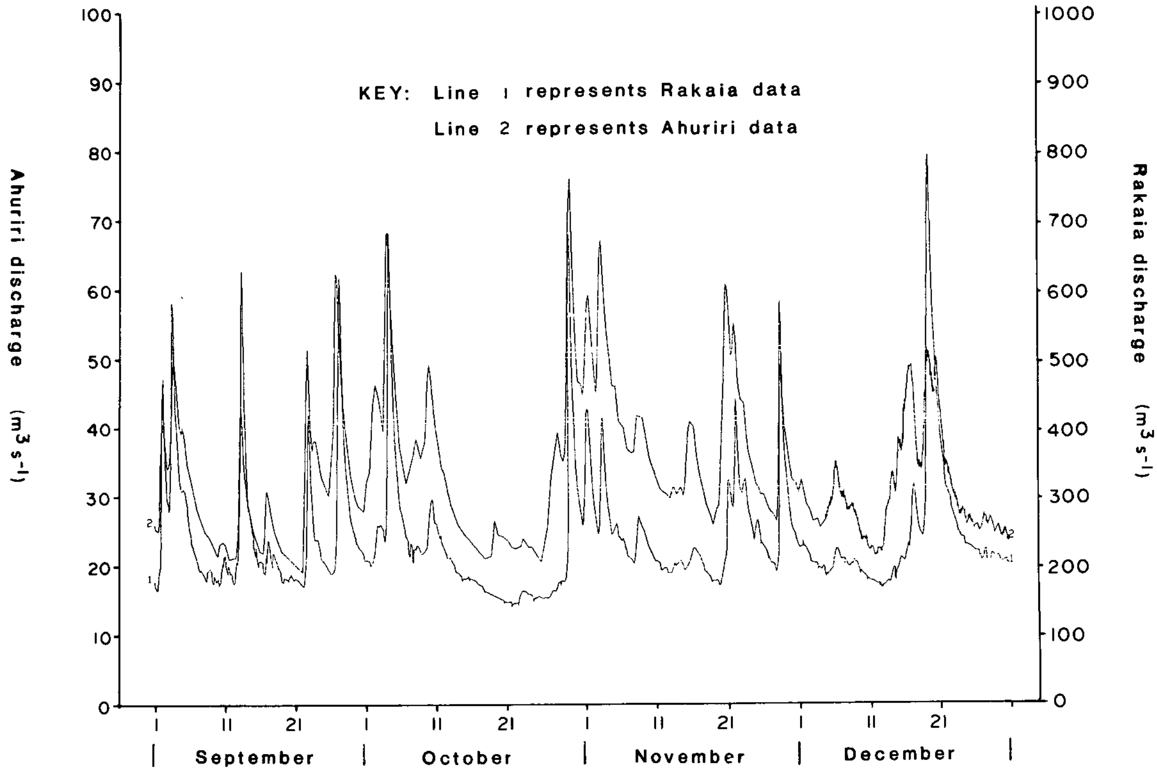


FIGURE 3 — Instantaneous discharges of the Ahuriri and Rakaia Rivers compared for the 1980 breeding season

RESULTS AND DISCUSSION

I found a highly significant negative correlation ($r^2 = 0.69$; $p < 0.01$) between summer Wrybill counts on northern harbours and the peak instantaneous discharge for the Rakaia River from the previous breeding season (Fig. 4). As the Rakaia is representative of most other Wrybill breeding rivers, it appears that over the period 1968-1982, summer counts of Wrybills were high whenever only small floods had occurred in the previous breeding season but were low whenever large floods had occurred.

These findings provide important clues to population changes of Wrybills, but these clues can be misleading. With breeding success being inversely correlated with flooding, development projects such as damming or irrigation, which harvest or level out flood peaks, might be expected to improve Wrybill breeding success and so lead to a higher population. Certainly, on the Ashley River, where flows characteristically decline in late spring and summer, Wrybill breeding success was very high in 1983 (6 pairs produced at least 6 fledglings) whereas on the flood-dominated Rakaia it was very low (30 pairs produced 2 fledglings — Hughey, in prep.). Thus, development projects that stabilise flow might also be expected to lead to an increased number of Wrybills on the river.

Although floods do limit Wrybill breeding success, they also keep the river shingle free of vegetation, which Wrybills require for suitable nest sites. Without these floods, exotic vegetation would soon spread over many Wrybill habitats (Hughey, in prep.), jeopardising the survival of the species.

The bankful flow of the Rakaia (about 2200 m^3s^{-1}) occurs about once in every 2.2 breeding seasons (Hughey, in prep.). If this flow occurs between early September and early November, it destroys many first clutches. Furthermore, if these flows were to occur in several successive seasons and more than once each season, Wrybill numbers could be seriously reduced.

Wrybill rivers are, hydrologically, broadly classified into

1. Rivers with their sources in mountain catchments such as the Ahuriri, Rakaia, Rangitata and Waimakariri, which have high breeding-season flows and are where most Wrybills breed; and
2. The smaller and less braided rivers of the eastern foothills such as the Ashburton and Ashley, which have flows that decline during the breeding season and are where only a few Wrybills breed.

However, if conditions such as the Southern Oscillation which influenced the New Zealand climate in 1982, resulting in more westerly storms, were to continue for several years, conditions on rivers like the Rakaia might become marginal for Wrybills. In the meantime, flows in rivers like the Ashley seem to have remained suitable for successful breeding. Thus, concentrating conservation efforts only on rivers that at present support large numbers of Wrybills may not be wise. The habitats of secondary rivers should also be conserved.

An important assumption of this study relates to the age structure of the Wrybills that remain for the whole summer on northern harbours. Hay

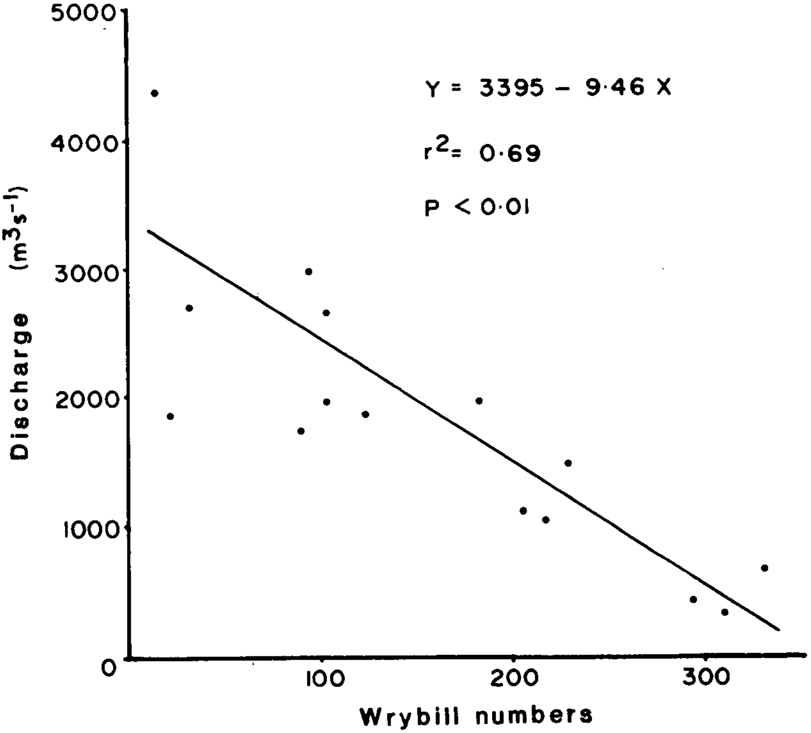


FIGURE 4 — The relationship of each summer count of Wrybills in the Manukau Harbour and the Firth of Thames to the peak instantaneous Rakaia River discharge of the previous breeding season (1968-1982)

(1983) found that about 90% of overwintering Wrybills leave the harbours for their South Island breeding grounds in August and that most of the rest leave later. This second departure appears to be of immature non-breeders, some of which return to their natal areas midway through the breeding season (Hay 1983). However, even after this second migration, some Wrybills remain on the northern harbours for the whole summer. In addition, Wrybills probably do not breed until their third year (Hay, pers. comm.). Therefore, the birds remaining in the north after the main migration are probably mostly first- and second-year non-breeders. It seems logical to expect that the secondary migration reported by Hay (1983) is mainly of second-year non-breeders, perhaps in association with a few first-year and adult birds, and that any birds staying in the north are mostly first-year birds. The high correlation between the numbers of Wrybills spending the summer on northern harbours and flood events from the previous breeding season supports this last suggestion. If the apparent relationship between flood events and birds summering in the north is true, summer counts may eventually be a useful warning of any population decline of Wrybills.

ACKNOWLEDGEMENTS

I thank Graham Davenport from the Ministry of Works and Development, Christchurch, for discharge data for the Ahuriri and Rakaia Rivers and John Waugh of the South Canterbury Catchment Board, Timaru, for comments on the relationship between Rakaia and Rangitata river flows. I thank Eric Scott, Graham Wilson, Paul Sagar, Ian Stewart, Rod Hay and Judy Grindell who read and commented on drafts of this paper, Barrie Heather for final editing, Peter Tillson for drafting several of the diagrams, and Jane Ensor for typing. Finally, I acknowledge the encouragement of the late G. R. Williams.

LITERATURE CITED

CHILD, P. 1971. A Wrybill in Central Otago. Notornis 18: 252.
CHILD, P. 1973. Wrybills in Central Otago: further records. Notornis 20: 77-78.
COWIE, B. 1983. Fisheries and wildlife. Pages 111-248 *in* M. J. Bowden, "The Rakaia River and catchment — a resource survey." Vol 3. Christchurch: North Canterbury Catchment Board and Regional Water Board.
HAY, J. R. 1979. The Wrybill — one of the world's ornithological oddities. Forest and Bird 214: 13-17.
HAY, J. R. 1983. Shore birds of the Miranda coastline. Tane 29: 15-30.
HAY, J. R. 1984. The behavioural ecology of the Wrybill Plover. PhD thesis, University of Auckland.
LALAS, C. 1977. Food and feeding behaviour of the Black-fronted Tern, *Chlidonias hybrida albostriatus*. MSc thesis, University of Otago, Dunedin.
O'DONNELL, C. F. J.; MOORE. S. M. 1983. The wildlife and conservation of braided river systems in Canterbury. Fauna Survey Unit Rep. 33. Wellington: Wildlife Service, Dept. Internal Affiars.
PIERCE, R. J. 1979. Foods and feeding of the Wrybill (*Anarhynchus frontalis*) on its riverbed breeding grounds. Notornis 26: 1-21.
PIERCE, R. J. 1982. A comparative ecological study of Pied and Black Stilts in South Canterbury. PhD thesis, University of Otago, Dunedin.
ROBERTSON, C. J. R.; O'DONNELL, C. F. J.; OVERMARS, F. B. 1983. Habitat requirements of wetland birds in the Ahuriri River catchment, New Zealand. Occ. Publ. 3. Wellington: Wildlife Service, Dept Internal Affairs.
SAGAR, P. M. 1983. Benthic invertebrates of the Rakaia River. Fish. Env. Rep. 36. Christchurch: Ministry of Agriculture and Fisheries.
SIBSON, R. B. 1963. A population study of the Wry-billed Plover (*Anarhynchus frontalis*). Notornis 10: 143-153.
STEAD, E. F. 1932. The life histories of New Zealand birds. London: Search.
TOEBES, C.; PALMER, B. R. 1969. Hydrological regions of New Zealand. Misc. Hydr. Publ. No. 4. Wellington: Water and Soil Division, Ministry of Works and Development.

K. F. D. HUGHEY, *Department of Entomology, Lincoln College. Present address: Wildlife Service, P.O. Box 1308, Christchurch.*

LONG-TAILED SKUAS *Stercorarius longicaudus* IN NEW ZEALAND

By DAVID S. MELVILLE

ABSTRACT

A wreck of Long-tailed Skuas on North Island beaches in early 1983 is reported. Characters used to identify Long-tailed and Arctic Skuas in the hand are reviewed with reference to New Zealand material. It is suggested that there may have been several New Zealand records of Long-tailed Skuas before the first accepted specimen record in 1964. The importance of retaining all small skuas found on New Zealand beaches for critical examination is emphasised. The 1983 wreck may be related to the 1982/83 El Niño, which apparently caused a reduction of food for at least some seabird species.

INTRODUCTION

Three species of holarctic-breeding skuas have been recorded from New Zealand. The first claimed specimen of the Arctic Skua (*Stercorarius parasiticus*) was collected by Buller in 1864 (Hutton 1871) and currently this species is "easily the most numerous skua off the coasts of the North and South Islands south to Foveaux Strait" (Falla *et al.* 1979). The Pomarine Skua (*S. pomarinus*), which was first collected in 1933 by Deeming (Falla 1936), is a "scarce but probably regular [austral] summer visitor to New Zealand south to Cook Strait" (Falla *et al.* 1979). The first record of the Long-tailed Skua (*S. longicaudus*) was of an immature found at Muriwai, Auckland, on 10 January 1964 (Sibson 1967). A second bird was found at this locality on 3 January 1982 and another immature was collected at East Beach (near Houhora Harbour), Northland, in 1981. Powlesland (1983) reported that the latter bird was found on 3 October 1981. However R. N. Thomas (pers. comm.) has advised that it was found alive on 23 September and died within 20 minutes of being picked up. There are also sight records of two immature Long-tailed Skuas near Picton in December 1981 (P. Hayman, *in litt.*) and of one immature observed and photographed by M. Morse at Lake Taupo in October 1981 (Sibson, in press). A wreck of Long-tailed Skuas which occurred on North Island beaches in January and February 1983, when at least 16 specimens were collected, was thus unprecedented. This paper details the 1983 wreck, reviews the criteria currently used to identify small *Stercorarius* skuas in the hand, and reconsiders earlier records of Arctic Skuas.

THE 1983 WRECK

A small skua collected at Whangaparaoa beach, Bay of Plenty, on 19 January (G. Taylor, *in litt.*) was almost certainly a Long-tailed Skua but the specimen was not kept. The first confirmed Long-tailed Skua was collected

NOTORNIS 32: 51-73(1985)

by W. J. Campbell during a beach patrol on 22 January near Dargaville. A further 13 skuas found during this patrol, which covered 57 km of beach from Maunganui Bluff south to Tikinui Stream, were disposed of, having been identified as Arctic Skuas. However, these birds were similar in appearance to the specimen kept (W. J. Campbell, pers. comm.) On the same date seven live skuas (one noticeably larger than the others) were seen between Maunganui Bluff and Omamari (W. J. Campbell), and about 12 were seen between Mahuta Gap and Glinks Gully (P. Cozens). The identity of these birds remains uncertain but W. J. Campbell (*in litt.*) suggested that they were probably Long-tailed, the larger bird being an Arctic. He reported that several of the skuas appeared to be "feeding along the tide-line, rising up into the air and then dropping with head down and picking up unidentified material".

On 17 January W. J. Campbell saw a skua flying steadily northwards, about 16 km from Dargaville on the Dargaville-Whangarei State Highway 14. This bird looked similar to those seen alive on the coast on 22 January.

S. Cotter collected a dead Long-tailed Skua at South Makara Beach, Wellington, on 28 January. Initially this bird was thought to be an Arctic Skua.

A further ten Long-tailed Skuas were collected by OSNZ members from Ninety Mile Beach, Northland, on 29/30 January (one of these specimens was mislaid after identification by the author). A further four skuas found on Ninety Mile Beach and one from Twilight were described as being similar to the specimens kept, but they were not critically examined and so their identity is uncertain.

Single Long-tailed Skuas were collected at Muriwai, Auckland, on 4 February by C. Exley, at Pekapeka and Te Horo Beaches, West Wellington, on 12 February by A. Tennyson, and at Hokio Beach, Levin, on 17 February by R. N. Thomas.

The Dargaville skuas were quite freshly dead, but the Northland specimens appeared to have been dead for a week or more. The Muriwai bird had been dead for some time and had few feathers remaining (B. J. Gill, *in litt.*)

There were several claimed sightings of Long-tailed Skuas off Sydney, Australia, at the same time as the New Zealand wreck: at least 11 on 22 January, three adults on 26 and 27 February, and a single adult on 26 March (D. Eades, *in litt.*) Also in March a dead Long-tailed Skua was found near Darwin, Northern Territory, and a live one was seen off Queensland (J. L. McKean, *in litt.*).

IDENTIFICATION

Identification of adult Long-tailed Skuas in breeding plumage should present no problems, but adults in non-breeding plumage, juveniles and immatures may be confused with pale morph Arctic Skuas, especially in the hand when differences of flight behaviour cannot be observed. While I was trying to confirm the identity of the 1983 skuas it became apparent that much of the literature on skua identification is oversimplified, confusing and at times

TABLE 1 — Body measurements (mm) of Long-tailed Skuas collected in New Zealand

Ref.	Wing*	Total head +bill	Exposed culmen	Bill at base		Tarsus	MTC	Centre rectrix
				Width	Depth			
AM1220.1**	(c.315)	-	26.5 (25)	11.5 (11)	11	42 (44)	41.5 (40)	144
AM1220.2	272	-	26	8.5	10	37.5	34.5	141
NM22692	295	74	31	12	10	44	38.5	143
NM22781***	300	-	27.8	-	-	41.4	35.8	161
NM22770	-	68.5	26.5	10	10.5	42	36.5	160
NM22771	-	72	29	10.5	10	43	41.5	144
NM22772	296	69	25	10.5	10	42	38.0	153.5
NM22773	292	70	28	12	11	40	37.5	148
NM22774	296	74	29.5	12	10.5	42	38.0	146
NM22775	294	72.5	29	10.5	10	42	38.5	135
NM22776	302	76.5	30	-	11.5	45	38.0	174
NM22777	308	72.5	27	10	10.5	43	39.5	190
NM22778	-	-	-	-	-	44.5	39.5	145
NM22780***	303	-	30	-	-	45.3	35.3	141
NM22779***	288	-	27.1	-	-	41.2	38.6	-
n	11	9	14	10	11	15	15	14
Mean	295.1	72.1	28	10.75	10.45	42.3	38.1	151.8
SD ±	9.5	2.6	1.8	1.14	0.52	2.0	2.0	15.0

* Primaries worn in all specimens
** Figures in parentheses from Sibson (1967)
*** Measurements by National Museum. All other measurements are by author.

contradictory owing, at least in part, to a shortage of specimens and a failure by some authors to considered that characters may change with the age of the bird.

Walter (1962) gave a useful review of identification characters for Long-tailed and Arctic Skuas and highlighted some of the pitfalls. A recent review by Roselaar (1983) was based on a sizeable collection of specimens but, as with Walter's, was concerned with birds in the western Palearctic and suffered from the relatively small number of specimens taken in winter*. For example, note that the collection of the British Museum (Natural History) has no winter specimens of Long-tailed Skua.

In the following discussion of identification criteria for small skuas in the hand, New Zealand material is mentioned or described where appropriate. The amount of information available for the New Zealand specimens varies because I became aware of certain identification characters only as the study progressed and I could not always re-examine material.

Standard measurements

The Long-tailed Skua is generally regarded as the smallest skua (e.g. Tuck & Heinzel 1980). However, there is some overlap of standard body measurements of this species and the Arctic Skua (e.g. Murphy 1936, Witherby *et al.* 1941, Godfrey 1966, Dement'ev & Gladkov 1969).

Measurements of the New Zealand Long-tailed Skuas (Table 1) are in general agreement with those given by Roselaar (1983) for the western Palearctic (Table 3), the shorter wing lengths of New Zealand birds being due to abrasion. Two races of the Long-tailed Skua are currently recognised (e.g. Manning 1964), based on plumage characters, there being only slight size differences. The measurements available for New Zealand and Australian Arctic Skuas (Table 2) overlap those of the Long-tailed Skuas, although the latter are generally smaller. Roselaar (1983) noted that, in Arctic Skuas breeding on the Kuriles and Bering Island, the wing length averages only 309 mm, whereas in those from southern Alaska it is 325 mm, in those from northern Alaska and northern Canada 328 mm, and in those from northern Siberia east of the Pechora River 335 mm (sample sizes not given). He also noted that these differences in wing length are also reflected in body weights and possibly in other measurements. The six adult specimens from the Kuriles/Bering Island in the British Museum (Natural History) have a considerable range in measurements, dark morph birds having shorter wings than light morph birds (Table 4). However, it is uncertain whether these birds were breeding on the islands — three were collected in late July-early August and three are undated. If small Kuriles/Bering Island Arctic Skuas occur in the western Pacific during the non-breeding season, as the relatively small wing lengths of New Zealand birds suggest, then it is likely that standard body measurements will be of little use in New Zealand for differentiating any but the smallest Long-tailed from the largest Arctic Skuas.

---

*In this paper "summer" and "winter" refer to the Northern Hemisphere. Thus, skuas breed during the summer.

TABLE 2 — Body measurements (mm) of Arctic Skuas collected in New Zealand and Australia

Sex	Age	Morph*	Wing	Exposed culmen	Bill at base Width	Bill at base Depth	Tarsus	MTC	Centre rectrix
				NEW ZEALAND					
♀	Juv		304	30	11.5	13	45	43	152
?	Juv		314	32.5	12	11	44.5	42.5	-
?	Juv		298	31	10.5	10.5	44	41	145.5
♂	Ad	D	319**	29	10	10.5	44.5	41	204
♀	Ad	L	317	31.5	13	12	46	44	200
♀	Ad***		303	31	-	-	43.5	43	165
♂	Ad***	L	325	33	-	-	48	45.2	142
	Mean		311.4	31.1	11.4	11.4	45.1	42.8	168.1
	SD±		9.9	1.4	1.2	1.1	1.5	1.5	27.4
				VICTORIA, AUSTRALIA					
?	Juv		324**	32.5	12.5	11.5	44.5	-	178
?	Juv		321	-	11	11	46	42.5	150
?	Imm		319	-	12	9.5	46	44	181
?	Imm		-	-	13.5	9.5	44.5	45	-
?	Imm	L	-	32	11.5	10.5	46.5	42	-
?	Imm	D	322	29.5	12	11	47	44	164
♂	Ad	L	316	29	11	11	41.5	42.5	-
?	Ad	D	-	-	13	10.5	43	43	-
?	Ad	L	-	29	12	10.5	45.5	43.5	193
	Mean		320.4	30.4	12.1	10.6	44.9	43.3	173.2
	SD±		3.0	1.7	0.8	0.7	1.8	1.0	16.6

* L = Light; D = Dark
** Fresh primaries, all other wings abraded
*** Records from National Museum of New Zealand

Australia (after Serventy *et al.* 1970)*

Sex	Wing	Exposed culmen	Tarsus	MTC	Centre rectrix
♂**	312 (299-335)	28.1 (25.8-31.6)	42 (39-45)	41 (38-46)	180 (158-205)
♀**	320 (304-340)	28.6 (27.2-31.5)	45 (43-46)	44 (41-46)	174 (156-199)

* Average and range
** n = 11

The bill of the Long-tailed Skua generally appears more stubby than that of the Arctic, and both Witherby *et al.* (1941) and Godfrey (1966) noted that it is narrower at the base than in the Arctic. However, Walter (1962) found a considerable overlap in bill length/bill width measurements in juvenile Long-tailed and Arctic Skuas, but not in adults.

Various authors (e.g. Brooks 1939, Godfrey 1966) have noted that the length of the 'false cere' (supranasal saddle) is longer than the cord of the 'nail' (maxillary unguis) in the Arctic Skua and equal to or less than the nail in the Long-tailed Skua. Measurements are available for eight New Zealand Long-tailed Skuas (the nail being measured from the anterior tip of the false cere on top of the bill). In seven specimens the false cere is shorter or equal to the nail, and in the eighth specimen the false cere is longer (14.5 : 14 mm). However, this character is not as promising as it first appears because, in

TABLE 3 — Body measurements (mm) of Long-tailed Arctic Skuas (after Roselaar 1983)

	Wing		Exposed culmen		Tarsus		MTC		Centre rectrix	
	Adult Long-tailed Skua*									
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Mean	306	309	28.5	28.4	42.6	42.5	35.1	36.0	c.290	c.285
Range	292-318	294-323	26-31	26-31	39-46	39-45	32-38	33-38	c.251-367	c.239-337
SD±	6.51	8.12	1.34	1.32	1.82	1.60	1.90	1.79		
n	36	38	75	53	75	54	75	54		
	Adult Arctic Skua									
	♂**	♀**	♂	♀	♂	♀	♂	♀	♂	♀
Mean	330	341	31.1	31.8	44.3	44.4	39.4	40.3	c.198.2	c.194.5
Range	327-333	328-347	29-34	30-34	41-47	42-47	38-41	38-43	c.174-227	c.173-215
SD±	2.58	6.60	1.18	1.42	1.66	2.01	1.61	1.69		
n	4	9	34	46	34	46	33	46		
Juvenile Long-tailed Skua***										
	♂	♀								
Mean	293	298								
Range	280-306	285-308								
SD±	6.24	8.10								
n	21	15								
Juvenile Arctic Skua****										
	♂	♀								
Mean	308	314								
Range	293-320	302-323								
SD±	8.79	7.21								
n	19	14								

* Adult *S. l. pallescens*, NE Greenland, June August

** Wing lengths of adults from northern Siberia, other measurements pooled for western Palearctic

*** Race unknown, Netherlands, September-early October

**** Netherlands, autumn

five New Zealand Arctic Skuas, one has the false cere and nail of equal length and four have the false cere shorter, and in seven Australian specimens (from Victoria) the false cere is longer than the nail in one and shorter in six. Walter (1962) also found the false cere: nail ratio to be an unreliable character, and Willet & Howard (1934) noted that most authors do not state whether measurements of the false cere are taken from the top or the side of the bill, the two methods giving very different results.

When examining skins I noted that in many specimens the false cere is flaky. Roselaar (1983) noted that in both Long-tailed and Arctic Skuas the ratio of exposed culmen to nail decreases with age, i.e. the nail becomes proportionately longer, presumably as a result of flaking at the anterior edge of the false cere. He gave ratios of exposed culmen to nail for Long-tailed Skuas as 2.04 in juveniles, 1.98 in immatures, and 1.89 in adults. Only about 10% of Arctic Skuas (in the western Palearctic) have bill ratios as low as Long-tailed Skuas of the same age (Roselaar 1983), but it is obviously a prerequisite to know the age of the specimen (which is not easy — see below) before determining its identity by this method. Bill ratios of nine New Zealand Long-tailed Skuas range from 1.61 to 2.07, mean 1.87 ± 0.13. In two New Zealand Arctic Skuas bill ratios are 1.76 (adult) and 1.94 (juvenile), and in five birds from Victoria, Australia, 1.76 to 1.94, mean 1.82 ± 0.08. The small ratios of the Arctic Skuas could result from damage to the false cere, or possibly Pacific birds have smaller ratios than those from the western Palearctic.

J. de Korte (*in litt.*) found that the gonys was generally longer in the Long-tailed than in the Arctic Skua (Table 5). As the culmen length is usually shorter in Long-tailed than in Arctic Skuas (see above), de Korte suggested that the ratio of gonys length (from bill tip to angle) to culmen length could be a valuable method for separating the two species. No gonys measurements are available for the New Zealand birds or for Pacific populations of the two species, but future workers could usefully explore this topic.

Walter (1962) thought the length of the mid-toe and claw (MTC) to be a useful character because he found only a slight overlap of Long-tailed

TABLE 4 — Body measurements of Arctic Skuas from Bering Island/Kuriles in the collection of the British Museum (Natural History)

					Bill at base				
Sex	Age	Morph*	Wing	Exposed culmen	Width	Depth	Tarsus	MTC	Forearm
♀	Imm	L	340	28	12	11	45	42	113
♀	Ad	L	325	29.5	12	10.5	44.5	43.5	119
♂	Ad	L	330	30	12	-	45.5	45.5	116
♀	Ad	D	307	28	9.5	10.5	39.5	41.5	104
?	Ad	D	296	29	11.5	10	41	42	107
♂	Ad	D	315	29	11.5	10	42	42.5	110
?	Ad	D	305	28	12	11	39	39.5	104.5
♀	Juv		306	29	13	10.5	44	44	108
	Mean		315.5	28.8	11.7	10.5	42.6	42.6	110.2
	SD±		14.9	0.8	1.0	0.4	2.5	1.8	5.4

* L = Light; D = Dark

and Arctic measurements. Roselaar's (1983) measurements (Table 3) suggest that birds with a MTC measurement of less than 38 mm are Long-tailed and those with more than 38 mm are Arctic. The separation is not clear-cut in New Zealand material (Tables 1 and 2), there being a slight overlap between 41 mm and 41.5 mm. Nonetheless MTC measurement should give a good indication of the identity of many specimens.

Walter (1962) measured the *unterarmlänge* (forearm) which, when plotted against wing length, provided a clear-cut separation of adult Long-tailed and Arctic Skuas, but in juveniles there was some overlap. He considered that a forearm shorter than 100 mm indicated Long-tailed and longer than 105 mm Arctic. Walter did not define the *unterarmlänge*, but it appears that he measured the length of the forearm (ulna/radius) from the carpal joint to the anterior outer end of the ulna at the humeral joint (see Baldwin *et al.* 1931:85).

Forearm measurements (as above) of three New Zealand Long-tailed Skua skins are 92.0, 102.5, and 102.5 mm. Lambert (1980) noted forearm lengths of six Long-tailed Skuas from southwest Africa, range 92 to 100 mm, mean 96.5 ± 2.9, and De Roo & Van Damme (1970) recorded a juvenile female with a forearm of 95 mm. An adult from the Commander Islands in the British Museum (Natural History) has a forearm of 102 mm, and an immature from the Kuriles in the same collection has a forearm of 101 mm.

Two New Zealand Arctic Skuas have forearms of 111.5 and 113.5 mm. For nine Victorian birds the range is 109 to 118.5, mean 113.8 ± 2.63. One of these latter birds, a juvenile, has unworn primaries with a wing length of 324 mm and a forearm of 118.5 — at the upper end of the range for Arctic Skuas shown by Walter (1962, Fig. 7). These data generally support Walter's findings and so, as far as we know, the *unterarmlänge* is probably the most reliable measurement for separating the two species in the hand.

Skeletal measurements

Willet & Howard (1934) examine the wing and leg bones of a small sample of Long-tailed and Arctic Skuas and found a total overlap in tarsus measurements (Long-tailed 43-46 mm, Arctic 42-47 mm) but that the measurements of the wing bones did not overlap and that the ratio of the tarsus to the wing bones gave a definite identification (Table 6). De Roo & Van Damme (1970) reported a very small juvenile female Long-tailed Skua

TABLE 5 — Gonys and culmen lengths (mm) of Long-tailed and Arctic Skuas*

	Gonys**	Culmen
Long-tailed Skua***	7.8-9.9	24.5-31.5
Arctic Skua****	6.4-7.8	30.1-34.8

* Information courtesy of J. de Korte, Instituut voor Taxonomische Zoölogie, Zoölogisch Museum, Amsterdam

** Measured from bill tip to angle of gonys

*** East Greenland, n = 70

**** Spitsbergen, n = 27

TABLE 6 — Key to identification of Long-tailed and Arctic Skuas (after Willet & Howard 1934)

		Length (mm)			Ratios		
		Humerus	Ulna	Radius	tarsus / humerus	tarsus / ulna	tarsus / radius
Long-tailed	max	87.6	96.7	93.7	0.541	0.502	0.527
N = c.6*	av	85.4	92.5	90.6	0.527	0.488	0.516
	min	83.0	90.9	88.3	0.507	0.474	0.506
Arctic	max	104.6	110.8	107.5	0.480	0.436	0.460
N = c.14*	av	100.4	107.2	103.5	0.454	0.425	0.440
	min	94.3	101.8	98.5	0.436	0.410	0.422

* *Their paper does not make clear exactly how many specimens of each species were examined.*

TABLE 7 — Skeletal measurements of Long-tailed Skuas collected in New Zealand

	Length (mm)*				Ratios		
Ref.	Humerus	Ulna	Radius	Tarsus	tarsus / humerus	tarsus / ulna	tarsus / radius
AM717	79.6	86.2	83.85	-	-	-	-
NM22781	87.95	97.35	94.55	44.2	0.503	0.454	0.467
NM22770	82.65	90.15	88.45	42.6	0.515	0.473	0.482
NM22771	87.7	94.5	91.7	45.95	0.524	0.486	0.501
NM22772	82.35	90.35	87.6	44.35	0.539	0.491	0.506
NM22773	81.15	88.4	85.7	42.0	0.518	0.475	0.490
NM22774	83.9	90.95	88.4	44.35	0.529	0.488	0.502
NM22775	86.0	91.65	89.3	43.8	0.509	0.478	0.490
NM22776	85.2	92.85	90.25	46.1	0.541	0.496	0.511
NM22777	85.8	92.9	90.0	44.4	0.517	0.478	0.493
NM22778	81.8	99.3	95.8	45.75	0.559	0.461	0.478
NM22780	83.0	89.6	87.6	42.1	0.507	0.470	0.481
NM22779	90.6	96.8	96.8	46.65	0.515	0.469	0.482
NM22782	86.05	94.95	92.85	47.25	0.549	0.498	0.509
AM2004**	78.65	86.5	83.8	42.4	0.539	0.490	0.506
Mean	84.16	92.16	89.78	44.42	0.526	0.479	0.493
SD$\pm$	3.29	3.88	3.99	1.73	0.017	0.013	0.013

* Bones from both left and right sides of body were measured when available. When measurements for left and right differ, the average is given.

** Measurements by B. J. Gill. All others are by the author.

with humerus 82.7 mm, radius 86.9, and ulna 89.5. However, Ten Kate (1953) reported a juvenile Long-tailed Skua with a long humerus (91 mm) and another unidentified bird with a humerus of 89 mm and a ratio of tarsus to humerus of 44.9% (0.449) — cf. Table 6.

There is considerable variation in skeletal measurements of Long-tailed Skuas collected in New Zealand (Table 7). Mean measurements are similar to those recorded by Willet & Howard (1934), but the ratios of tarsus:wing bones are somewhat lower than recorded by these authors. The variation in measurements of specimens labelled as "Arctic" Skuas is very pronounced (Table 8), and the mean measurements and tarsus:wing bone ratios approach those of Long-tailed Skuas. We should remember that "small" Kurile and Bering Island Arctic Skuas may occur in New Zealand waters (see above) and may account for the very small "Arctic" Skuas in Table 8. Alternatively, some of the specimens may be Long-tailed Skuas which have been misidentified, but of all New Zealand skins of Arctic, Long-tailed and Pomarine Skuas I have examined, none has been misidentified. However, many skeletons are likely to have come from decayed beach-washed material, where identification would be more difficult. Unfortunately, I could not examine skeletal material of the Kurile/Bering Island Arctic Skuas for comparison, there being none in the Paleontological Institute of the USSR Academy of Sciences, Moscow (E. Kurochkin, *in litt.*).

There appears to be a case for considering the possibility of misidentification for specimens NM15015, NM15284, NM17178, AM456, and AM95.9, all of which have bone lengths and tarsus:wing bone ratios well within the range of Long-tailed Skua. "Fresh" measurements are available for NM15284 (National Museum records): wing 285 mm (very worn), bill 27.3, cere 14.6, tarsus 39.8, toe 36.9, tail centre feather 181 (new). These are well

TABLE 8 — Skeletal measurements of "Arctic Skuas" collected in New Zealand

	Length (mm)*				Ratios		
Ref.	Humerus	Ulna	Radius	Tarsus	$\frac{\text{tarsus}}{\text{humerus}}$	$\frac{\text{tarsus}}{\text{ulna}}$	$\frac{\text{tarsus}}{\text{radius}}$
NM14979	103.15	109.55	106.8	48.7	0.472	0.445	0.456
NM15015	83.9	92.25	89.1	-	-	-	-
NM15284	86.8	94.75	91.95	43.65	0.503	0.461	0.475
NM17178	86.6	93.6	90.1	45.1	0.521	0.482	0.501
NM17179	105.9	108.0	106.0	45.0	0.425	0.417	0.425
NM18899	91.5	98.15	94.75	43.9	0.480	0.447	0.463
NM20992	102.65	110.7	107.5	47.3	0.461	0.427	0.440
NM22784	99.65	106.75	103.55	45.3	0.455	0.424	0.437
AM456	83.8	92.1	90.0	44.0	0.525	0.478	0.489
AM95.9	84.6	88.5	86.0	42.0	0.496	0.475	0.488
Mean	92.86	99.44	96.57	45.00	0.482	0.451	0.464
SD±	8.98	8.42	8.43	2.00	0.033	0.025	0.026

* Bones from both left and right sides of body were measured when available. When measurements for left and right differ, the average is given.

within the range of measurements of New Zealand Long-tailed Skuas (Table 1). There is also an OSNZ specimen record card for AM456, completed by S. M. Reed, details of which are wing 315 mm, bill length 31, bill width at base 12, bill depth at base 11.5, tarsus 43, MTC 40, tail 150. These measurements are at the upper end of the range for New Zealand Long-tailed Skuas. The bird, which was noted as having been dead for over a week, was of the pale morph and was moulting on the chin, sides of the breast, and the flanks.

Two skeletons from Victoria are in the National Museum of Victoria, Melbourne. One, identified as "*Stercorarius parasiticus?*", measures ulna 102.0 mm, radius 105.5, tarsus 46.5. The other, originally identified as "*Stercorarius parasiticus*", measures ulna 111.5 mm, radius 108.5, tarsus 48.5. A handwritten note with the latter specimen by G. F. van Tets records it as *S. pomarinus*, "TMT is too long for other 2 species". The tarsus (TMT) is at the upper end of the range for New Zealand Arctics (Table 8) but is smaller than measurements of two New Zealand and one Victorian Pomarine Skuas: humerus 103.6 mm, 113.1, —; ulna 110.75, 117.0, 119.0; radius 107.1, 113.6, 115.0; tarsus 54.85, 54.2, 53.5.

Bare parts

Post mortem changes in the colours of bill, tarsus and feet make these characters of little value except with fresh material. Bill colouration is similar in adults of both Long-tailed and Arctic Skuas, the nail being black and the false cere dark but often tinged with shades of brown, olive or grey. In juveniles and immatures of the two species the bill is blue grey and the nail is black. Tarsus colouration is very variable in both species. Most popular works note that the Long-tailed Skua has a blue or blue-grey tarsus (e.g. Peterson *et al.* 1974, Falla *et al.* 1979, Tuck & Heinzel 1980). However, this feature is found only in about 50% of breeding adults, the others having black over a greater or lesser part of the tarsus (Roselaar 1983). In adult Arctic Skuas the tarsus is black. In juveniles of both species the amount of dark colouration on the toes and webs spreads across the feet and up the tarsus, and in the Arctic Skua it also spreads down the tarsus, with increasing age. Thus, in immature Arctic Skuas in their second calendar year 10-70% of the surface of the tarsus is blue grey, this being reduced to 0-10% in birds in their fifth calendar year (Roselaar 1983).

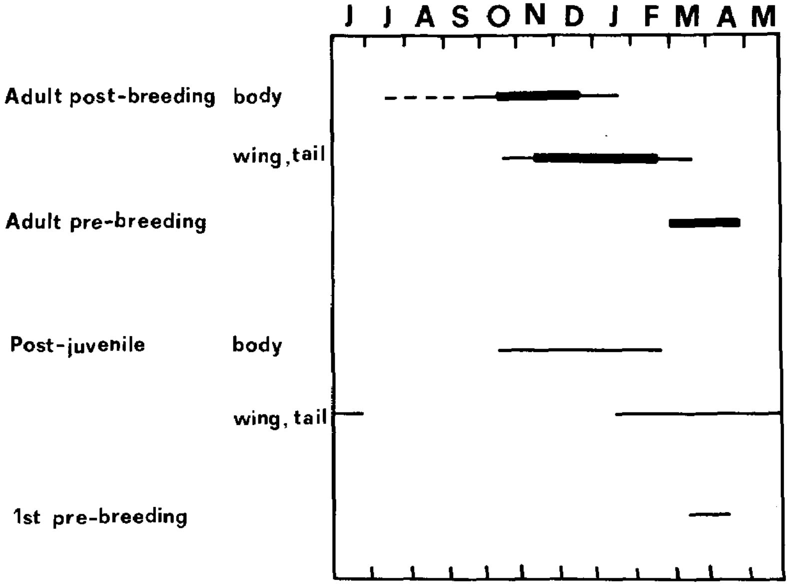
Moult

An outline of the chronology of moults in the Long-tailed Skua is given in Figure 1. However, the timing of moult may be quite variable as Stresemann & Stresemann (1966) recorded five "adults" from Valparaiso, Chile, which had not started primary moult in late November/early December. Two other "adults" collected at the same time had primary scores (see Ginn & Melville 1983) of about 4 and 21. Twelve immature Long-tailed Skuas off southwest Africa in mid-late December had primary scores ranging from 10 to 26 (Lambert 1980).

The adult post-breeding moult is complete. Only a few small body feathers are shed near the breeding grounds, most of the moult occurring in the wintering area. Primaries moult descendantly, and the secondaries probably moult in two series, ascendant and descendant, meeting in the middle of the tract. Body feathers moult in the sequence crown, neck, mantle, chest, flanks, tail-coverts, rest of head, belly and vent, scapulars, back, and rump, but often nearly all parts moult at the same time (Roselaar 1983). The centre rectrices (R1) moult first, then often R6 or R5, R6; thereafter tail moult may be centrifugal or irregular. The upper and under wing-coverts, most scapulars and some lower back and rump feathers may moult only once a year at the same time as the wing. There is a partial prebreeding moult of the head, body (except as noted above) and centre rectrices, the latter taking 30-40 days to become full grown (Roselaar 1983).

The post-juvenile moult is complete and occurs in winter quarters. The first prebreeding moult in spring of the second calendar year (i.e. when about 7 months old) is partial (parts of head, neck and mantle). Thereafter moults are similar to those of adults, but variable amounts of plumage from previous feather generations may be retained, at least up to the third prebreeding moult (Roselaar 1983). Thus, immature birds moulting in winter may have feathers of three generations.

All Long-tailed Skuas collected in New Zealand that I have examined were in active wing moult. Table 9 shows considerable variation in the progress of moult in individual birds collected in January/February, but all appear to be keeping to an "adult" timetable. The specimen collected in September is most exceptional in that it is in active moult at a time when no birds of



(after Roselaar 1983)

FIGURE 1 — Timing of moults in the Long-tailed Skua

TABLE 9 — Moult of primaries and rectrices of Long-tailed Skuas in New Zealand*

	Primaries										Total	Rectrices											
Date	In									Out**	Score	Left											Right
8.1.64	5	5	5	5	5	5	4	1	0	0	35	1	4	0	5	5	5	5	5	5	0	4	1
23.9.81	5	5	5	5	5	5	2	0	0	0	32	0	0	0	0	5	0	0	5	0	0	0	0
3.1.82						0	0	0	0	0***													
22.1.83	5	5	5	4	3	2	0	0	0	0	24	3	0	0	3	5	5	5	5	4	0	0	3
28.1.83	5	5	5	5	4	2	0	0	0	0	26	0	0	0	0	4	0	0	4	0	0	0	0
29/30.1.83	5	5	5	5	5	-	-	0	0	0		0	0	0	0	-	0	0	2	0	0	0	0
29/30.1.83	5	5	5	5	5	5	4	3	1	0	38	4	0	2	4	5	5	5	5	4	2	0	-
29/30.1.83	5	5	5	4	2	-	0	0	0	0		-	0	0	-	5	5	5	5	-	0	0	-
29/30.1.83	5	5	5	5	5	4	3	0	0	0	32	3	0	1	5	5	0	0	4	3	5	5	2
29/30.1.83	5	5	5	5	5	5	-	0	0	0		2	0	1	4	5	-	0	5	4	2	0	-
29/30.1.83	5	5	5	5	5	5	3	1	0	0	34	5	3	5	5	5	0	0	5	5	5	3	5
29/30.1.83	5	5	5	5	5	5	4	2	0	0	36	5	-	-	5	5	5	5	5	5	-	0	5
29/30.1.83	5	5	5	5	5	5	5	3	0	0	38	3	0	2	4	5	5	5	5	4	2	0	5
29/30.1.83	5	5	5	5	5	5	5	4	2	0	41	5	2	4	5	5	5	-	-	5	4	3	5
12.2.83									0	0***													
12.2.83								0	0	0***													

* Scoring system after Ginn & Melville (1983): 0 = old; 5 = fully grown new; 1 - 4 = intermediate stages; - = feather missing

** Outermost (11th) primary is much reduced and is excluded

*** Records from National Museum of New Zealand

any age group should be moulting. The outer primaries of this bird are old and worn, but they are proportionately less worn than those of the birds collected in January. It is possible that this bird had suspended primary moult after replacing the inner six primaries and had resumed moult shortly before it was collected, but I am unaware of any records of suspended moult in skuas, and the condition of the old primaries does not suggest that they had been retained exceptionally long.

Moult in Arctic Skuas is generally similar to that in the Long-tailed Skua, but Roselaar (1983) noted that the centre rectrices moult only once (early in the post-breeding moult). This is, however, not always the case because, in one New Zealand and four Australian specimens of adult Arctic Skuas, the centre rectrices are still growing in April (Table 10) and it is likely that at least some birds moult the centre rectrices twice, as do Long-tailed Skuas.

Plumage

For detailed descriptions of the plumage of Long-tailed and Arctic Skuas, see Roselaar (1983). The descriptions of immatures and winter adults are probably based on relatively small samples, and Roselaar (1983) noted that in the Arctic Skua "Well-fed immatures may be expected to fit much sooner into adult moult cycles than others, and perhaps even fully mature adults may at times return [to the breeding grounds] in partial non-breeding [plumage] after a particularly adverse winter". Presumably the same applies to Long-tailed Skuas.

TABLE 10 — Moult of primaries and rectrices of Arctic Skuas

Date	Primaries In — Out	Total Score	Rectrices Left	Right
	NEW ZEALAND			
15.11.78	2 2 0 0 0 0 0 0 0 0	4		
14.12.59	0 0 0 0 0 0 0 0 0 0	0***		
30.12.77	3 3 3 2 0 0 0 0 0 0*	11		
- . 1.66	1 0 0 0 0 0 0 0 0 0**	1***		
7. 3.53	5 5 5 5 5 5 5 3 0 0	38		
8. 3.69	5 5 5 5 5 5 4 1 0 0*	35		
23. 3.29	5 5 5 3 1 0 0 0 0 0	19***	0 0 0 0 0 5	5 0 0 0 0 0
- . 4.29	5 5 5 5 5 5 3 0 0 0	33***	1 0 0 0 4 5	5 5 0 0 0 1
7. 4.29	5 5 5 5 5 5 5 5 5 5	50	5 5 5 5 5 4	4 5 5 5 5 5
16. 4.31	5 5 5 5 5 5 5 5 4 1	45		
16. 4.31	5 5 5 5 5 5 5 5 5 5	50		
8. 5.66	5 5 5 5 5 5 5 5 5 3	48		
	VICTORIA, AUSTRALIA			
13.11.48	1 1 1 0 0 0 0 0 0 0	3	0 0 0 0 0 1	1 0 0 0 0 0
23.12.81	0 0 0 0 0 0 0 0 0 0	0***	0 0 0 0 0 0	0 0 0 0 0 0
18. 4.84	5 5 5 5 5 5 5 5 5 4	49	5 5 5 5 5 2	3 5 5 5 5 5
18. 4.84	5 5 5 5 5 5 5 5 4 3	47	5 5 5 5 5 3	3 5 5 5 5 5
18. 4.84	5 5 5 5 5 5 5 5 5 3	48	- 4 - 5 5 2	2 5 5 5 4 5
----	5 5 5 5 5 5 2 0 0 0	32	1 5 0 2 5 5	5 5 2 0 5 1
----	5 5 5 5 5 4 1 0 0 0	30	5 1 0 4 5 5	- 4 2 2 5 -
----	5 5 5 5 5 5 5 5 5 4	49	5 5 5 5 5 4	4 5 5 5 5 5

* Records from National Museum of New Zealand
** Specimen New York 744614, after Stresemann & Stresemann (1966)
*** Juveniles

The plumage of the first New Zealand Long-tailed Skua was described by Sibson (1967). The back of this bird is about half in non-breeding plumage, the feathers being dark grey-brown with white spots, tips and bars. The rest of the back is "medium neutral gray"* the features apparently being fairly fresh. A few old, bleached feathers remain on the back and most of the lesser and median coverts are old and worn. The under wing-coverts are of the "adult" type, being uniform grey.

The 1981 East Beach specimen is similar to the previous bird but with slightly more yellow on the neck and is somewhat less advanced in primary and body moult. The back is in almost complete winter plumage, still with a few old "summer" feathers. The lesser and greater coverts are mostly old, the rest of the upperparts being a mixture of old, bleached, worn feathers and new winter plumage. The head and neck are darker than those of the preceding bird. It has "adult" type under wing-coverts.

---

*Colours in "quotation" marks are after Smithe (1975).

The Ninety Mile Beach birds and that from Dargaville are generally similar to the two previous specimens but the back feathers are in a more advanced state of wear. The Dargaville bird has an almost completely uniform "medium neutral gray" back and upperparts, which appear to be the result of abrasion of the white tips of the winter plumage and a general lightening of the plumage, rather than the result of moult. A few old, bleached, abraded feathers remain on the upperparts, while the under wing-coverts are "adult".

Of the Ninety Mile Beach birds, the back was "medium neutral gray" in one and "dark neutral gray" in six and two lacked most of the back feathers. The under wing-coverts were not examined at the time when the birds were picked up, but on recollection several weeks later, I thought that all had 'adult' type feathers.

A photograph of the 1981 bird at Lake Taupo clearly shows a mixture of brown and white barred "juvenile" and uniform grey "adult" under wing-coverts. Unfortunately it is not possible to determine the state of wear and moult of the flight feathers from the photographs.

In all New Zealand specimens examined, the newly grown fresh primaries are "blackish neutral gray". In specimens of adult Long-tailed Skuas collected on the breeding grounds (Alaska, Spitsbergen) and held in the National Museum, Wellington, the back is browner than in the New Zealand birds, tending towards a pale "brownish olive". Whether this difference is due to a continuing change in the colour of the mantle from exposure to sunlight (possibly post mortem?), to the use of borax to preserve the specimens, or to the birds being of different ages is unknown.

The back of Arctic Skuas collected in New Zealand is more "olive brown" than that of the Long-tailed Skuas, and if birds of the same age are compared this difference should be noticeable. However, as the above descriptions indicate, we have to bear in mind that the back colours apparently change throughout the season.

TABLE 11 — Length of centre rectrices* (mm) of Long-tailed and Arctic Skuas (after Roselaar 1983)

Age**	Long-tailed***		Arctic
1st (Juv)	23	(18- 32)	17 (12- 22)
2nd	56	(36- 82)	40 (30- 46)
3rd	88	(60-134)	51 (35- 63)
4th-5th	130	(65-213)	61 (40- 80)
6th & over (Ad)	179	(135-256)	82 (60-105)

* Length given is difference between lengths of centre and outer rectrices, average and range. Length of outer rectrix c.112 mm in Long-tailed, and c.116 in Arctic.

** Age in calendar years. All birds taken in summer.

*** Some shorter measurements of immatures probably caused by retention of non-breeding plumage centre rectrices.

The shape of the tips of the primaries and rectrices are useful in distinguishing between juvenile Long-tailed and Arctic Skuas (Walter 1962). In juvenile Long-tailed the outer primaries and rectrices are rounded, whereas in Arctic they are pointed. However, these characters are not noticeable in juvenile Arctic Skuas collected in New Zealand, owing to abrasion, and are unlikely to be of value except for birds early in the autumn. The centre rectrices are longer in Long-tailed than in Arctic Skuas of the same age (Table 11), but this character is of limited value with broken or abraded feathers. However, when examining New Zealand material, I noticed that the rachis of the centre rectrices of Long-tailed Skuas was more flexible than that of Arctic Skuas and this character could be helpful even when the tips of feathers are missing. In addition, in at least some immature plumages of the Long-tailed Skua the centre rectrices taper into very fine, long projections (Figure 2).

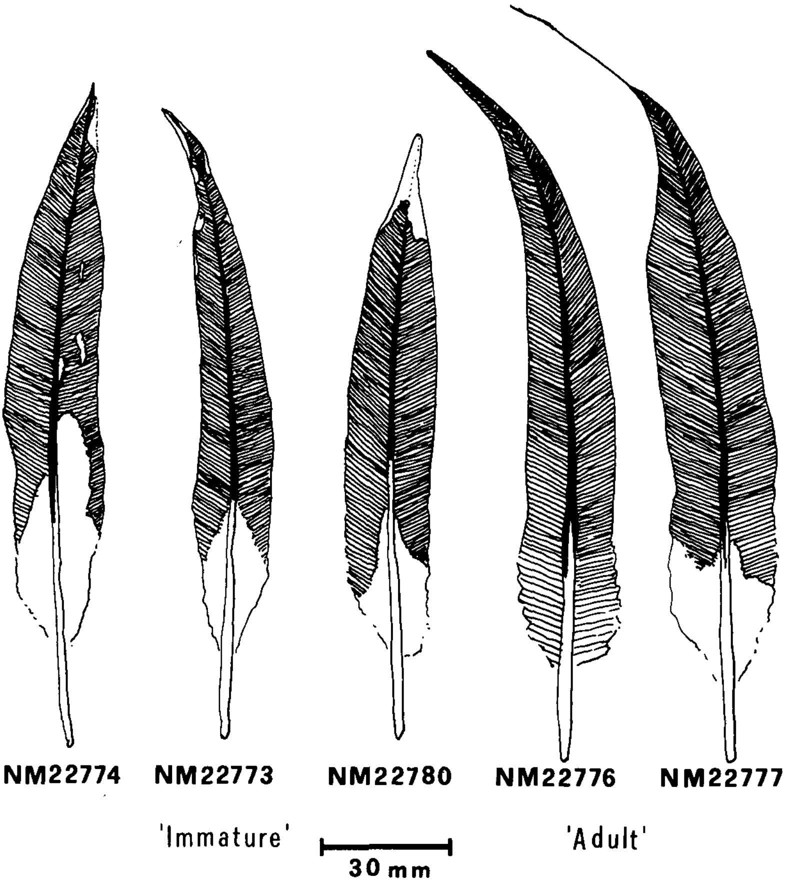


FIGURE 2 — Centre rectrices of Long-tailed Skuas from New Zealand

Long-tailed Skuas collected in New Zealand exhibit two types of centre rectrix colouration: dark brown with white bars/fringes, or very dark grey (Figure 2). Witherby *et al.* (1941) noted that the tail of juvenile Long-tailed Skuas is "as Arctic but usually less white at base and often (but not always) with small buffish-white tips" and that the tail of juvenile Arctics is "brown-black, concealed base white often tinged rufous, outer feathers with very narrow tips, or spots at tips, of buff". Roselaar (1983) also noted that juvenile Long-tailed Skuas have narrow white tips to the rectrices, whereas in juvenile Arctic Skuas the centre rectrices are "usually uniform black". Published information suggests that in immature birds the centre rectrices are similar to those of the adults, but I have been unable to find any reference to the colour of the centre rectrices of adult Long-tailed Skuas in non-breeding plumage. In New Zealand Long-tailed Skuas, seven have "adult" type centre rectrices and eight "juvenile" type. There was considerable variation in the amount of white on the vanes of the "juvenile" feathers, and in the colour of the rachis of both "juvenile" and "adult" feathers — some being all dark, others mostly white. As noted above, all specimens had "adult" under wing-coverts. If the "juvenile" centre rectrices are also found in adult winter plumage, one would expect such feathers in January/February to be fairly fresh, whereas all were fairly worn, as in six birds with "adult" rectrices. There is no obvious explanation for this discrepancy but it is possible that "juvenile" rectrices occur in some immature plumages. This question will remain unresolved until more material is available for examination.

Feather lice

Feather lice (Mallophaga) may be partly or wholly host-specific. When a louse is found only on one host species it can be used to determine the identity of that host. Pilgrim & Palma (1982) listed Mallophaga found on Arctic Skuas in New Zealand. The Long-tailed Skuas from Ninety Mile Beach and Dargaville were examined for Mallophaga, and single species of the genera *Quadraceps* and *Saemundssonia* were collected that were different from lice of the same genera collected from Arctic Skuas. They have yet to be identified as to species (R. L. Palma, pers. comm.). If Mallophaga can be found which are host-specific to the Long-tailed Skua, they could be used to identify otherwise unidentifiable skua material — provided that all skua specimens are stored separately so that they are not contaminated with lice from other species.

Summary

The identification of beach-washed skuas remains difficult as no characters of plumage (except the centre rectrices in breeding-plumage adults), bare parts, standard body measurements or skeletal measurements are known to be definitive. A combination of characters, especially forearm and MTC length, should allow the identification of some specimens, and Mallophaga may allow the identification of some specimens. Beach patrollers are strongly advised to collect all small skuas found on beaches, keep each one separate, and to send them to a museum for further examination and preservation. Eventually enough material may be available for criteria for readily identifying skuas to be worked out.

POSSIBLE ADDITIONAL RECORDS OF LONG-TAILED SKUAS FROM NEW ZEALAND

During the 1983 wreck it became apparent that beach patrollers were likely to misidentify Long-tailed Skuas as Arctic Skuas, the literature being generally unhelpful. This raised the question as to whether all previous records of Arctic Skuas were correct and whether some had been Long-tailed Skuas. I have reviewed all readily available New Zealand material of both species and most of the literature records.

All skins which I have examined in New Zealand collections had been correctly identified. Of ten skeletal specimens of "Arctic" Skuas, however, I had reason to suspect that five may be Long-tailed, but without any definite skeletal character for separating the two species they must remain as "possible" Long-tailed, except for NM15284, which seems a certain Long-tailed (see above). Details of the five birds are as follows:

Reference	Locality	Date	Collector
AM Skel 95.9	Muriwai	12 Apr 1942	Bull, Sibson, Turbott
NM15015	Himitangi Beach	8 Mar 1969	Edlin
NM15284	Himitangi	8 Mar 1969	Edlin
AM Skel 456	Muriwai	21 Nov 1971	Reed
NM17178	Dargaville	11 Dec 1971	Crockett

Early records of skuas from New Zealand are plagued by complications of taxonomy and nomenclatorial changes (see Saunders 1896). Mathews & Iredale (1913) were "inclined to believe that both Arctic and Long-tailed Skuas have occurred in New Zealand waters". The first published record of the Arctic Skua for New Zealand is of one *Lestris parasiticus* collected by Buller at "Wanganui", reported by Hutton (1871), who gave a very brief description. In 1873 Buller published a full description, apparently of the same bird (*Stercorarius parasiticus*), which he noted was shot by himself on 30 April 1864 at Horowhenua. Buller gave the same description in 1888 under the name *Stercorarius crepidatus*. Measurements of this specimen (originally given in inches) are as follows:

Hutton (1871): Total length 393.7 mm, wing 284.5, bill from gape 45.5, tarsus 41.9
Buller (1873): Total length 419 mm, wing 292, bill along edge of lower mandible 43, bill along ridge 30.5, tarsus 40.6, mid toe and claw 38, extent of wings 965, tail 140, bare tibia 12.7

Both authors noted the species as Arctic Skua but the plumage descriptions are inadequate for identification. Finsch (1873) considered the specimen to be *Lestris longicaudus*. Further discussion of this specimen (Buller 1875a, Saunders 1876) culminated in a paper by Buller (1878b) in which he reviewed the four specimens of *Lestris* (=*Stercorarius*) collected up to that time. Figure 2 of that paper depicted the tail feathers of the April 1864 bird, which Buller described as "only partially developed, being encased in a sheath at the base. They extend only about an inch beyond the rest, and are much abraded, having a peculiar filamentous appearance". This description and the generally small measurements all indicate that the bird was a Long-tailed Skua. This specimen was presumably in the collection which Buller sold to the Colonial Museum in 1873, but it was not present when the Museum collection was first catalogued in 1914 and cannot be traced. It is not in the collections of the British Museum (Natural History), the Rothschild Museum, Tring or the American Museum of Natural History (I. C. J. Galbraith, *in litt.*, M. LeCroy, *in litt.*).

The other three early specimens noted by Buller (1875b, 1878a, 1878b) cannot be identified from the published descriptions. These and several other early specimens that were not described (Buller 1879, 1905) cannot be traced.

There is a skua humerus collected on 29 December 1972 by R. J. Scarlett from sand dunes at Te One, Chatham Island (Canterbury Museum Av 30,323). A note with this specimen states "Storrs Olson 18. 12. 1973 suggested that this may be *Stercorarius longicaudus*". The length of this bone (83.2 mm — slightly worn) strongly suggests that it is from a Long-tailed Skua.

Numerous field records of Arctic Skuas published in the *Annual Reports of the Ornithological Society of New Zealand* (1939-1941), *Bulletin of the Ornithological Society of New Zealand* (1942), *New Zealand Bird Notes* (1943-1948) and *Notornis* (1951-present) cannot be assessed as no descriptions were given.

DISTRIBUTION AND HABITS IN THE NON-BREEDING SEASON

The Long-tailed Skua breeds in the far north of Norway, Sweden, Finland, USSR, Alaska, Canada, and Greenland. Its distribution away from the breeding grounds is little known. Vaurie (1965) recorded that it winters in the Pacific "from about 10°S. Lat. to about 50°". Tuck & Heinzel (1980) and Harrison (1983) showed the main Pacific migration route as down the eastern side, but Johnson (1965) suggested that there are also main migration routes through the western and central Pacific. It has been recorded between Valparaiso and Juan Fernandez, Chile, in December and once off Ancon, Peru, in June (Murphy 1936). Tuck & Heinzel (1980) depicted the main Pacific wintering area as off the southwestern tip of South America, even though there do not appear to be any records of the species from that area! Brown *et al.* (1975), who recorded three Long-tailed Skuas in the Atlantic off Santa Cruz, Argentina, did not record any from inshore waters off the Chilean Pacific coast, and it was not recorded by Jehl (1973) in this area in June, although he did see several Arctic Skuas.

King (1967) noted that the Long-tailed Skua "passes rapidly through the Tropical Pacific en route to wintering areas in the South Pacific in September and October, and returns to its breeding grounds in April and May. Recorded regularly but in low numbers at sea in the Central Pacific". Subsequently, King (1970) noted it as a "Rare spring and fall migrant" and recorded only four probable sightings in the period March 1964-June 1965 in an area southeast of Hawaii. Fisher & Lockley (1954) noted that "We can find no record whatsoever of this species from . . . Australia, or the West Pacific south of Japan", but Saunders (1896) recorded a specimen of *Lestris hardyi* (= *S. longicaudus*) from "between Philippines and Sandwich Is.", and there was a probable sight record of one in Sydney Harbour in c. 1930 (Iredale 1940, Hindwood & McGill 1958). Subsequently, there have been several sightings of the species from eastern and southern Australia (Carter 1966, Barton 1978, 1982, Pizzey 1980), in addition to those noted above. There are single records of adults from Micronesia in September (Engbring & Owen 1981) and from Hong Kong in May (Melville 1977), and Greensmith (1975) observed an immature off the Solomon Islands in February. In Japan it is an "offshore passage migrant, in spring mostly in May. Regular but few in number" (Anon 1974). Apparently the species is uncommon in the central and southern Pacific as numerous sea-watch logs do not record it e.g. Jespersen (1933), Fleming (1950), Macdonald & Lawford (1954), Ferdinand (1956), King & Pyle (1957), Morzer-Bruyns (1965), Shuntov (1972), Rogers (1980), but it is noteworthy that it is less ready to approach ships than Arctic and Pomarine Skuas (Rankin & Duffey 1948, Austin & Kuroda 1953), although Harrison (1983) noted that it "attends trawlers". The summer distribution of immature birds is not known, but Cramp & Simmons (1983) noted "certainly some present in North Atlantic", and Kuroda (1955) recorded two "young of the previous year" off Hokkaido in July. Roselaar (1983: 684) inferred that some visit the breeding grounds in their second calendar year, Kampp (1982) recorded a "club" of non-breeding immatures in widely varying plumages at Disko, western Greenland in July, and Andersson (1976) noted the presence of immatures on breeding grounds in northern Sweden.

Most authors consider that, outside the breeding season, the Long-tailed Skua is more pelagic in habits than the Arctic and Pomarine Skuas (e.g. Wynne-Edwards 1935, Cramp & Simmons 1983) and is generally solitary, although groups may be seen on migration (Lambert 1983) and large groups winter around the Benguela Current (Lambert 1980). There are three records of large northward spring movements in the central North Atlantic (Cramp & Simmons 1983), and one of a southerly movement along the coast of Argentina in November after "a tremendous gale" (Wetmore 1926). No large movements have been recorded in the Pacific.

Little is known of the feeding habits of the species in the non-breeding season. Dement'ev & Gladkov (1951) recorded their feeding on berries before autumn departure, Witherby *et al.* (1941) recorded their feeding on marine fish (*Cyclopterus, Liparis*), offal and carrion (see also Kuyken 1970, Harrison 1983), and Sage (1968) recorded one chasing a Wilson's Warbler (*Wilsonia pusilla*) in the Atlantic. During a large movement of Long-tailed Skuas near Buenos Aires, Wetmore (1926) recorded that "At intervals one dropped lightly to the beach near the watermark to pick up a few beetles that had drifted ashore after the storms, and then remained to rest for a few minutes" — cf. W. J. Campbell's observations near Dargaville. Bent (1921) recorded that the species gets much of its food by piracy, and Witherby *et al.* (1941) stated "At sea pursues terns and gulls, but perhaps less frequently than other skuas". Off southwest Africa Lambert (1980) recorded them parasitising Arctic and Common Terns (*Sterna paradisaea* and *S. hirundo*) and Sabine's Gulls (*Xema[Larus]sabini*). Larger species including albatrosses (*Diomedea* spp.), Cape Gannets (*Sula capensis*), and other Long-tailed Skuas were also pursued, quite successfully, when food could be seen protruding from the victim's bill. In the possibly atypical conditions of the Benguela Current fishing grounds, where fish offal was plentiful, Lambert noted Long-tailed Skuas indulging in food piracy more often than Arctic Skuas. Away from the fishing grounds Lambert considered it likely that Long-tailed Skuas usually took free-living organisms from the water surface.

DISCUSSION

The Long-tailed Skua is the least common of the three holarctic-breeding skuas visiting New Zealand, even allowing for the possibility that some earlier specimens of Long-tailed were misidentified as Arctic Skuas. The 1983 wreck was exceptional in that 16 known Long-tailed Skuas and a further 19 probable Long-tailed Skuas were collected. The only other northern skua collected in early 1983 was a juvenile Pomarine from Dargaville on 22 January (W. J. Campbell, NM22783). Very few northern skuas have been collected since the inception of the beached bird patrols in 1935, the maximum being three Arctic Skuas collected in both 1977 and 1978 (C. R. Veitch, *in litt.*, R. G. Powlesland, *in litt.*).

With so little known of the distribution and habits of Long-tailed Skuas in the non-breeding season it is difficult to speculate on the cause of the 1983 wreck. One event does merit consideration. During the summer of 1982 oceanographic and climatological conditions in the central Pacific were unusual and heralded the start of a severe and unusual El Niño, which persisted well into 1983. There was an unusually abrupt swing of the Southern Oscillation, winds along the equator to the west of 180° became westerly in June, and sea-surface temperatures rose. There followed an extended period of very heavy rainfall in the equatorial central Pacific. The movement of warm water towards the west coast of South America resulted in dramatic increases in sea-surface temperatures along the South American coast and a depression of the thermocline (the 20 °C isotherm) throughout the eastern half of the Pacific, which meant that water upwelling along the equator was warmer than before (Cane 1983, Rasmusson & Wallace 1983). In the eastern Pacific, Barber & Chavez (1983) noted a 5- to 20- fold reduction in primary productivity which was associated with "an absolute decrease in growth and reproductive success [of higher trophic levels] caused by disruption of the normal food web".

Schreiber & Schreiber (1983) reported a near-total breeding failure of seabirds on Christmas Island (2°N, 157°W) in November 1982, apparently due to a disappearance of food, mainly flying fish (Exocoetidae) and squid (Ommastrephidae). If food supplies in the central Pacific did change, birds which normally frequent the area may have moved elsewhere, and so Long-tailed Skuas may have wandered further south than usual in search of food. The Dargaville specimen was emaciated and weighed 180 g (on 2 February after refrigerated storage), which is similar to weights of exhausted juveniles in the Netherlands and slightly over 100 g lighter than non-breeding adults, and immatures over two years old, weighed in June/July (Roselaar 1983). Although no other unusual birds were associated with the Long-tailed Skuas in New Zealand, the appearance of Long-tailed Skuas in eastern Australia was associated with other warm-water species, e.g. White Tern (*Gygis alba*) and the first and second Australian records of White-necked Petrel (*Pterodroma externa cervicalis*) (D. Eades, *in litt.*).

The Pomarine Skua also winters in the central Pacific, where King (1967) recorded it as being "common from December through April", although Cramp & Simmons (1983) show it wintering only along the western and eastern seaboards, as well as off the northern coast of New Guinea (e.g. Morzer-Bruyns 1965) and in Australasian waters, whereas the Arctic Skua is unrecorded from the central Pacific (King 1967). The fact that these species were not found wrecked in association with the Long-tailed Skuas suggests that they may have different food preferences in winter or that they were not in the area from where the Long-tailed Skuas came. Arctic Skuas are commonly seen harrying terns in New Zealand (e.g. Oliver 1955, Fleming 1958, Edgar 1961), as well as scavenging (Hindwood 1955), whereas Pomarine Skuas feed mainly on fish during the non-breeding season (Cramp & Simmons 1983).

ACKNOWLEDGEMENTS

I am very grateful to all beach patrollers and collectors who provided the material for this paper. Study of museum material was greatly facilitated by J. A. Bartle (National Museum of New Zealand, Wellington), I. C. J. Galbraith (British Museum, Natural History), B. J. Gill (Auckland Institute and Museum), B. Gillies (National Museum of Victoria, Melbourne), and G. A. Tunnicliffe (Canterbury Museum, Christchurch). C. R. Veitch, M. Kearns and R. G. Powlesland made available information from the OSNZ Beach Patrol Scheme. I wish to thank R. L. Palma for examining skuas for Mallophaga, R. B. Sibson for drawing my attention to the 1982/83 El Niño, Gudrun Matijevic and A. J. Holcombe for help with translations and J. A. Bartle for help and encouragement throughout. W. J. Campbell, D. Eades, B. D. Heather, M. LeCroy, J. de Korte, J. L. McKean, C. S. Roselaar and R. N. Thomas provided much useful information and/or commented helpfully on a draft of this paper and Christine Ambler very kindly typed the tables.

LITERATURE CITED

ANDERSSON, M. 1976. Population ecology of the Long-tailed Skua (*Stercorarius longicaudus* VIEILL.) J. Anim. Ecol. 45: 537-559.
ANON. 1974. Check-list of Japanese birds. Fifth Rev. ed. Tokyo: Gakken.
AUSTIN, O. L.; KURODA, N. 1953. The birds of Japan: their status and distribution. Bull. Mus. Comp. Zool. 109: 279-637.
BALDWIN, S. P.; OBERHOLSER, H. C.; WORLEY, L. G. 1931. Measurements of birds. Sci. Publ. Cleveland Mus. Nat. Hist. 2: 1-165.
BARBER, R. T.; CHAVEZ, F. P. 1983. Biological consequences of El Niño. Science 222: 1203-1210.
BARTON, D. 1978. Birds seen at sea off southern NSW and eastern Victoria. Aust. Seabird Group Newsl. 10: 14-19.
BARTON, D. 1982. Notes on skuas and jaegers in the Western Tasman Sea. Emu 82: 56-59.
BENT, A. C. 1921. Life histories of North American gulls and terns. US Nat. Mus. Bull. 113.
BROOKS, A. 1939. Migrations of the skua family. Ibis 1939, 14th ser., 3: 324-328.
BROWN, R. G. B.; COOKE, F.; KINNEAR, P. K.; MILL, E. L. 1975. Summer seabird distributions in Drake Passage, the Chilean fjords and off southern South America. Ibis 117: 339-356.
BULLER, W. L. 1873. A history of the birds of New Zealand. London: J. van Voorst.
BULLER, W. L. 1875a. On the ornithology of New Zealand. Trans. NZ Inst. 7: 197-211.
BULLER, W. L. 1875b. On some additions to the collection of birds in the Colonial Museum. Trans. NZ Inst. 7: 224-225.
BULLER, W. L. 1878a. Notes on the ornithology of New Zealand. Trans. NZ Inst. 10: 191-201.
BULLER, W. L. 1878b. Remarks on a species of *Lestris*, inhabiting our seas. Trans. NZ Inst. 11: 355-359.
BULLER, W. L. 1879. Additions to lists of species, and notices of rare occurrences, since the publication of 'The Birds of New Zealand'. Trans. NZ Inst. 11: 361-366.
BULLER, W. L. 1888. A history of the birds of New Zealand. 2nd. ed. London: the author.
BULLER, W. L. 1905. Supplement to the 'Birds of New Zealand'. London: the author.
CANE, M. A. 1983. Oceanographic events during El Niño. Science 222: 1189-1195.
CARTER, M. J. 1966. An occurrence of the Long-tailed Skua, *Stercorarius longicaudus*, in Port Phillip Bay, Victoria. Emu 66: 69-70.
CRAMP, S.; SIMMONS, K. E. L. (eds). 1983. The birds of the Western Palearctic. Vol. III. Oxford University Press.
DEMENT'EV, G. P.; GLADKOV, N. A. 1951 (trans. 1969). The Birds of the Soviet Union. Vol. 3. Jerusalem: Israel Programme for Scientific Translations.
DE ROO, A.; VAN DAMME, B. 1970. A first record of the Long-tailed Skua, *Stercorarius longicaudus* VIEILLOT, from the Ethiopian Region (Aves: Stercorariidae). Rev. Zool. Bot. Afr. 82: 157-162.
EDGAR, A. T. 1961. Some observations on White-fronted Terns and skuas. Notornis 9: 120-121.
ENGBRING, J.; OWEN, R. P. 1981. New bird records for Micronesia. Micronesica 17: 186-192.
FALLA, R. A. 1936. Arctic birds as migrants in NZ. Rec. Auckland Inst. Mus. 2: 3-14.
FALLA, R. A.; SIBSON, R. B.; TURBOTT, E. G. 1979. The new guide to the birds of New Zealand. Auckland: Collins.
FERDINAND, L. 1956. Oceanic bird life. Pages 224-236 *in* BROW, A. F.; GREVE, Sv.; MIELCHE, H.; SPÄRK, R. The Galathea deep sea expedition 1950-1952. London: Allen & Unwin.
FINSCH, O. 1873. Remarks on some birds of New Zealand. Trans. NZ Inst. 5: 209.
FISHER, J.; LOCKLEY, R. M. 1954. Sea-birds. London: Collins.
FLEMING, C. A. 1950. Some South Pacific sea-bird logs. Emu 49: 169-188.
FLEMING, C. A. 1958. Arctic Skua landing on beach. Notornis 7: 236.
GINN, H. B.; MELVILLE, D. S. 1983. Moult in birds. BTO Guide 19. Tring: British Trust for Ornithology.
GODFREY, W. E. 1966. The birds of Canada. National Museum of Canada Bull. 203. Biological Series No. 73.
GREENSMITH, A. 1975. Some notes on Melanesian sea birds. Sunbird 6: 77-89.
HARRISON, P. 1983. Seabirds — an identification guide. Beckenham: Croom Helm.
HINDWOOD, K. A. 1955. Sea-birds and sewage. Emu 55: 212-216.
HINDWOOD, K. A.; McGILL, A. R. 1958. The birds of Sydney (County of Cumberland), New South Wales. Royal Zool. Soc. NSW.
HUTTON, F. W. 1871. Catalogue of the birds of New Zealand with diagnoses of the species. Wellington: Geological Survey of New Zealand.
IREDALE, T. 1940. Australian skuas. Emu 40: 177-180.
JEHL, J. R. 1973. The distribution of marine birds in Chilean waters in winter. Auk 90: 114-135.
JESPERSEN, P. 1933. Observations on the oceanic birds of the Pacific and adjacent waters. Vidensk. Medd. fra Dansk naturh. Foren., Copenhagen 94: 187-221.
JOHNSON, A. W. 1965. The birds of Chile and adjacent regions of Argentina, Bolivia and Peru. Vol. 1. Buenos Aires: Platt.

KAMPP, K. 1982. Notes on the Long-tailed Skua *Stercorarius longicaudus* in West Greenland. Dansk Orn. Foren. Tidsskr. 76: 129-135.
KING, J. E.; PYLE, R. L. 1957. Observations on sea birds in the tropical Pacific. Condor 59: 27-39.
KING, W. B. 1967. Preliminary Smithsonian Identification Manual. Seabirds of the Tropical Pacific Ocean. Washington.
KING, W. B. 1970. The Trade Wind Zone oceanography pilot study. Part VII. Observations of sea birds March 1964 to June 1965. U.S. Fish. Wildl. Serv. Spec. Sci. Rep. Fish. 586.
KURODA, N. 1955. Observations on pelagic birds of the northwest Pacific. Condor 57: 290-300.
KUYKEN, E. 1970. De Kleinste Jager (*Stercorarius longicaudus*) in België, met een beschrijving van de eerste Augustusvangst, 1969. Gerfaut 60: 188-197.
LAMBERT, K. 1980. Ein Überwinterungsgebiet der Falkenraubmowe, *Stercorarius longicaudus* Vieill. 1819, vor Südwest- und Südafrika entdeckt. Beitr. Vogelkd. 26: 199-212.
LAMBERT, K. 1983. Seabirds off NW Africa in spring 1983. Seabird Group Newsl. 39: 4-7.
MACDONALD, J. D.; LAWFORD, P. A. 1954. Sight records of birds in the Pacific: compiled from the bird log kept during the recent cruises of HMS Challenger. Emu 54: 7-28.
MANNING, T. H. 1964. Geographical and sexual variation in the Long-tailed Jaeger *Stercorarius longicaudus* Vieillot. Biol. Pap. Univ. Alaska 7: 1-16.
MATHEWS, G. M.; IREDALE, T. 1913. A reference list of the birds of New Zealand. Part 1. Ibis 1913, 10th. ser., 1: 201-263.
MELVILLE, D. 1977. New Laridae records from Hong Kong. Bull. Brit. Ornithol. Club 97: 34-37.
MÖRZER-BRUYNS, W. F. J. 1965. Birds seen during west to east trans-Pacific crossing along equatorial countercurrent around latitude 7°N in the autumn of 1960. Sea Swallow 17: 57-66.
MURPHY, R. C. 1936. Oceanic birds of South America. Vol. 2. New York: Am. Mus. Nat. Hist.
OLIVER, W. R. B. 1955. New Zealand birds. 2nd. ed. Wellington: Reed.
PETERSON, R.; MOUNTFORT, G.; HOLLOM, P. A. D. 1965. A field guide to the birds of Britain and Europe. 2nd. ed. London: Collins.
PILGRIM, R. L. C.; PALMA, R. L. 1982. A list of the chewing lice (Insecta: Mallophaga) from birds in New Zealand. Notornis Suppl. Vol. 29 & Nat. Mus. NZ Misc. Ser. 6. 32 pp.
PIZZEY, G. 1980. A field guide to the birds of Australia. Sydney: Collins.
POWLESLAND, R. G. 1983. Seabirds found dead on New Zealand beaches in 1981. Notornis 30: 125-135.
RANKIN, N. M.; DUFFEY, E. A. G. 1948. A study of the bird life of the North Atlantic. British Birds 41, Supplement: 1-42.
RASMUSSON, E. M.; WALLACE, J. M. 1983. Meteorological aspects of the El Niño/Southern Oscillation. Science 222: 1195-1202.
ROGERS, A. E. F. 1980. Seabirds observed between Sydney and Buenos Aires. Notornis 27: 69-78.
ROSELAAR, C. S. 1983. Family Stercorariidae skuas. Pages 652-697 *in* CRAMP, S.; SIMMONS, K. E. L.
SAGE, B. L. 1968. Ornithological transects in the North Atlantic. Ibis 110: 1-16.
SAUNDERS, H. 1876. On the *Stercorarinae* or skua gulls. Proc. Zool. Soc., Lond. 1876: 330.
SAUNDERS, H. 1896. Catalogue of the Gaviae in the collection of the British Museum. Trustees of the British Museum.
SCHREIBER, R. W.; SCHREIBER, E. A. 1983. Reproductive failure of marine birds on Christmas Island, fall 1982. Tropical Ocean-Atmosphere Newsl. 16: 10-12.
SERVENTY, D. L.; SERVENTY, V.;WARHAM, J. 1971. The handbook of Australian sea-birds. Sydney: Reed.
SHUNTOV, V. P. 1972 (trans. 1974). Seabirds and the biological structure of the ocean. Washington: US Dept. Commerce.
SIBSON, R. B. 1967. Long-tailed Skua ashore at Muriwai. Notornis 14: 79-80.
SIBSON, R. B. in press. Small skua at Taupo. Notornis.
SMITHE, F. B. 1975. Naturalist's color guide. New York: Am. Mus. Nat. Hist.
STRESEMANN, E.; STRESEMANN, V. 1966. Die Mauser der Vogel. J. Orn. 107: Sonderheft.
TEN KATE, C.,G. 1953. Over de osteologische verschilpunten tussen *Stercorarius longicaudus* en *parasiticus*. Limosa 26: 116-119.
TUCK, G. S.; HEINZEL, H. 1980. A field guide to the seabirds of Australia and the world. Sydney: Collins.
VAURIE, C. 1965. The birds of the Palearctic fauna. Non-passeriformes. London: Witherby.
WALTER, H. 1962. Vergleichende Untersuchungen an den Raubmöwen *Stercorarius parasiticus* und *longicaudus*. J. Orn. 103: 166-179.
WETMORE, A. 1926. Observations on the birds of Argentina, Paraguay, Uruguay, and Chile. US Nat. Mus. Bull. 133: 1-434.
WILLET, G.; HOWARD, H. 1934. Characters differentiating certain species of *Stercorarius*. Condor 36: 158-160.
WITHERBY, H. F.; JOURDAIN, F. C. R.; TICEHURST, N. F.; TUCKER, B. W. 1941. The handbook of British birds. Vol. 5. London: Witherby.
WYNNE-EDWARDS, V.C. 1935. On the habits and distribution of birds on the North Atlantic. Proc. Boston Soc. Nat. Hist. 40: 233-346.

DAVID S. MELVILLE, *c/o WWF Hong Kong, GPO Box 12721, Hong Kong*

THE MINERAL CONTENT OF THE FAECES OF PUKEKO *Porphyrio p. melanotus*

by R. A. FORDHAM

ABSTRACT

In coastal Manawatu pasture, faecal pellets of the Pukeko (*Porphyrio p. melanotus*) vary in weight through the year and on average disintegrate in about 16 days (range 7-29). The seasonal concentrations of 11 minerals in the faeces are discussed briefly in relation to soil type and the topdressing regime. The addition of faecal minerals to the pasture is estimated per hectare through the year and per bird for autumn. The amounts deposited fall with increasing distance from the edge next to swamp and are largest in autumn when the population is highest.

INTRODUCTION

Pukeko live in lowland swamp but between late summer and mid-winter form conspicuous feeding flocks in adjacent farm land. Although grass and crops may be damaged by such flocks (Guthrie-Smith 1953, Oliver 1955, Carroll 1966, McKenzie 1967) positive effects could be that they induce plant growth, capture insect pests (Oliver 1955), and return minerals to the soil in their faeces.

The mineral content of faeces, however, has not been measured for any indigenous New Zealand bird, except another rail, the Takahe (*Notornis mantelli*), in a single month (Mills *et al.* 1980). The primary aim of this study therefore was to determine the seasonal content of minerals in Pukeko faeces. A secondary aim was to estimate where and in what amounts these minerals are deposited on pasture. The main observations were made at Pukepuke Lagoon (described in Fordham 1983), which supported a Pukeko population that has been intensively studied (Craig 1979, 1980a, 1980b). A second study area at Tiakitahuna (40° 24'S, 175° 30'E) c. 20.3 km east of Pukepuke Lagoon, consisting of crop and pastoral land surrounding a swamp, provided supplementary observations.

METHODS

Between August 1971 and May 1974, I collected 400 faecal pellets from the Hay and Rough paddocks at Pukepuke Lagoon (Fordham 1983, Fig. 1), counting all the faecal matter lying within a circle of 10 cm diameter as one pellet. The freshly voided pellets (of shiny appearance and uneroded shape) were oven dried, ground in a hammer mill for 10 s and sealed individually in polythene sachets. From each of 200 sachets, a subsample of 0.140 g was extracted and the dry matter percentages of nitrogen and phosphorus were determined simultaneously after a modified Kjeldahl digest (Williams & Twine 1967). The contents of 190 sachets were combined by season to make up 18 samples (each of 2.5 g). These were ashed, and the levels of sodium, potassium, magnesium, calcium, aluminium, molybdenum, manganese, iron, and copper were determined by atomic absorption spectrophotometry.

NOTORNIS 32: 74-79 (1985)

In addition, I collected monthly samples, totalling 1000 fresh faeces, between December 1976 and November 1977 at Pukepuke Lagoon and Tiakitahuna, to estimate the dry weights of pellets. To monitor the rate at which faecal pellets break down physically, 96 fresh faeces were marked with pegs in the Hay paddock, Pukepuke Lagoon, and I inspected them weekly to record their disintegration in the four arbitrary categories of intact, slightly broken, largely broken, and scattered. To measure the distribution of faeces in pasture at Pukepuke Lagoon, I set up in the Hay paddock belt transects 115 m long through eight zones (Fordham 1983), each 12.5 m wide, that were parallel to, and extended a total of 100 m from, the edge of the pasture next to the lagoon. I did the transects once or twice monthly between September 1972 and August 1976 by walking slowly through each zone, counting all faecal pellets in the effective field of view (a central strip c. 3 m wide totalling 0.0345 ha, that is, 24% of each zone).

RESULTS

Weight and mineral content of faeces

The faeces were voided as coherent cylinders c. 8 mm in diameter and c. 60 mm long (maximum > 120 mm) in small piles or curved lines. The pellet diameter was affected by the plant constituents, and pellet length depended on the plant constituents and the bird's walking speed. Table 1 shows the dry weights by season. At Tiakitahuna, the faeces were heavier in spring and summer than in autumn and winter, the extremes being in spring and winter, and the seasonal mean weights differed significantly by t-test ($p < 0.05$). At Pukepuke Lagoon, a low summer population (Fordham 1983) produced few faeces, but the pattern of weights over the other three seasons was the same as at Tiakitahuna, and the seasons differed significantly by t-test ($p < 0.001$).

The seasonal concentrations in faeces of 11 minerals are given in Table 2. The concentrations of both N and P were highest in spring and lowest in autumn, and the differences between the main seasonal levels were significant by t-test ($p < 0.01$). The broad pattern of other elements was of relatively high concentrations in winter, or autumn (Al), and low levels in summer, spring (Na) or autumn (K,Mo). Significant differences (by t-test, p at least <0.05) between seasons of highest and lowest concentrations were obtained for Na, Ca, Al, Mo, Fe and Cu.

TABLE 1 — Seasonal dry weights (g) of fresh faecal pellets collected from pasture at Pukepuke Lagoon and Tiakitahuna, Dec 1976-Nov 1977

	Pukepuke Lagoon			Tiakitahuna		
	n	$\bar{x}$	(±SE)	n	$\bar{x}$	(±SE)
Summer (Dec-Feb)	-			100	0.437	(0.022)
Autumn (Mar-May)	200	0.444	(0.012)	100	0.367	(0.017)
Winter (Jun-Aug)	200	0.338	(0.012)	100	0.319	(0.012)
Spring (Sep-Nov)	200	0.523	(0.020)	100	0.513	(0.029)
Total	-			400	0.409	(0.011)

TABLE 2 — Seasonal concentrations of some minerals in dry matter samples[a] of fresh faeces, Pukepuke Lagoon, 1971-1974

		Na %	K %	Mg %	Ca %	N %	P %	Al µg/g	Mo µg/g	Mn µg/g	Fe µg/g	Cu µg/g
Autumn	$\bar{x}$	0.930	2.258	0.086	1.728	1.937	0.384	1003	0.7	225	7487	5.9
(Mar-May)	±S.E.	(0.258)	(0.327)	(0.008)	(0.208)	(0.071)	(0.017)	(19)	(0.09)	(54)	(678)	(0.55)
Winter	$\bar{x}$	1.000	3.428	0.084	1.953	2.424	0.400	674	1.5	272	11845	8.7
(Jun-Aug)	±S.E.	(0.114)	(0.579)	(0.005)	(0.081)	(0.096)	(0.021)	(99)	(0.16)	(43)	(1555)	(2.28)
Spring	$\bar{x}$	0.705	3.045	0.082	1.470	2.767	0.509	751	1.1	208	8434	3.3
(Sep-Nov)	±S.E.	(0.003)	(0.442)	(0.004)	(0.122)	(0.102)	(0.044)	(108)	(0.34)	(9)	(1057)	(0.55)
Summer	$\bar{x}$	0.896	2.398	0.084	1.194	2.252	0.388	420	0.8	138	2987	2.9
(Dec-Feb)	±S.E.	(0.152)	(0.247)	(0.004)	(0.229)	(0.104)	(0.020)	(85)	(0.02)	(44)	(498)	(0.61)
Year	$\bar{x}$	0.886	2.732	0.084	1.572	2.345	0.414	712	1.0	207	7416	5.1
	±S.E.	(0.084)	(0.212)	(0.003)	(0.109)	(0.051)	(0.015)	(63)	(0.11)	(22)	(881)	(0.75)

[a] Except for N and P faeces were combined seasonally into 2.5 g samples: autumn (n = 5, 45 faeces); winter (n = 4 49 faeces); spring (n = 4, 51 faeces); summer (n = 5, 45 faeces). For N and P the sample for each season = 50 separate faecal pellets.

Distribution and disintegration of faeces

Faecal counts from 68 transects were pooled for each zone to provide an index of faecal distribution in the Hay paddock in 1972-1976. Faeces declined in frequency outwards from the pasture edge with 59.9% (n = 1663) dropped in the first two zones (0-25 m from the edge). Only 15.7% of faeces were dropped beyond zone 4 (>50 m from the edge) and 3.1% beyond zone 6 (>75 m from the edge). Because Pukeko began to use the neighbouring Rough paddock after 1972, progressively fewer faeces were left in the Hay paddock. But although fewer were dropped than between September 1971 and August 1972, when I had made weekly transects only through zones 1-4, the overall distributional gradient was generally consistent in each year and season. Between 1972 and 1976, the mean densities per hectare of faeces in zones 1-8 of the Hay paddock were respectively 272, 153, 92, 81, 40, 50, 10 and 12; overall mean for all zones, 89. During autumn (March-May), when the population was at its annual peak (Fordham 1983), the mean density of faeces for zones 1-2 alone was 496/ha and for all eight zones 217/ha.

The maximum time taken for freshly voided pellets to disintegrate and become no longer recognisable was 15.7 ± 0.73 days (range 7-29 days). Breakdown took longer in winter (18.2 ± 1.49, n = 30) and spring (17.3 ± 1.08, n = 36) than in summer (7.6 ± 0.62, n = 8) and autumn (12.8 ± 0.95, n = 22). Apart from winter and spring, which were not different by t-test, seasonal means were all significantly different ($p < 0.001$).

Deposition of minerals on the pasture

Table 3 shows the mean deposition (g/ha) of minerals in the Hay paddock, Pukepuke Lagoon, through each season, based on the mean faecal weights and content and the density of faeces in different zones of the pasture. For the table, the mean dry weight of summer faeces was estimated to be 0.484 g (the mean of the spring and autumn values) because at Tiakitahuna summer faeces weighed, on average, only 0.003 g (0.682%) less than the mean of the spring and autumn weights (Table 1). The seasonal pattern of minerals for zones 1-2 and for all 8 zones comprised a peak in autumn followed by a low in spring, and a summer value estimated at higher than those in winter or spring. On average K, Ca, and N were present in amounts > 1 g/ha; Na, P and Fe in amounts between 0.1 and 1 g/ha; Mg, Al, and Mn in amounts between 0.001 and 0.1 g/ha; and Mo and Cu only as traces < 0.001 g/ha.

To estimate the contribution per bird to the minerals of the pasture for one season (autumn), I used the data in Tables 1 & 2 and observations of the rate of defecation. The average daily rate of defecation by two captive Pukeko kept for 6 days on pasture in April 1972 was 48.7 pellets (range 42-58), equivalent to c. 2.9 m of faeces per bird. Allowing for age and sex differences in body weight and the age and sex composition of the Pukepuke Lagoon flock (Craig 1974), a flock of 50 birds in the autumn peak population would constitute a biomass of c. 46 kg of Pukeko dispersing daily between swamp and pasture. The total amount of minerals defecated by such a flock for the 92 days of autumn (March-May) could be in the order of Na 925 g, K 2245 g, Mg 86 g, Ca 720 g, N 1927 g, P 382 g, Al 100 g, Mo 0.07 g, Mn 22 g, Fe 745 g, and Cu 0.059 g. Some of this load, of course, would fall in the adjacent swamp, not on the pasture, but the amount of faecal deposition in the swamp has not been measured.

DISCUSSION

The concentrations of minerals in Pukeko faeces result partly from the stocks of minerals in the plants they eat and in the water and soil (Kear 1963, Wilkinson & Lowrey 1973) and partly from the birds' metabolism. At Pukepuke Lagoon the sandy soils are imperfectly drained, and free water may lie on the surface in winter and spring. The soils are low in clay and organic matter, slightly acid, and high in Ca and N, medium in P, and very low in K. Copper, Co, and Se may be deficient (Cowie *et al.* 1967). The high concentrations of K, Ca, and P in the faeces were undoubtedly influenced by the fertiliser potassic-superphosphate (15% potassium chloride and 85% calcium hydrogen phosphate and calcium sulphate). This fertiliser was applied at the rate of 250 kg/ha to the Hay paddock in November to promote hay growth through late spring and summer and at the rate of 188 kg/ha to the Rough paddock in March or April to boost spring pastures. Trace elements were not applied, although lambs were dosed directly with selenium (P. Barber, pers. comm.). The relatively high concentration of Na in faeces was probably the result of spray from the sea (3.2 km to the west) being continually received by swamp and pasture plants. The pattern of high winter and low summer concentrations in the faeces of minerals such as Mn, Fe and Cu may reflect relatively more ingestion by the birds of soil in winter, as occurs in domestic stock (M.A.

TABLE 3 — Estimates of the mean seasonal deposition (g/ha) of some minerals present in pukeko faecal pellets in the Hay paddock bordering Pukepuke Lagoon, 1972-1974
t (trace) < 0.001 g/ha

	Distance (m) from pasture edge	*Na*	*K*	*Mg*	*Ca*	*N*	P	Al	Mo	Mn	Fe	Cu
Autumn	0-25	2.048	4.972	0.189	3.805	4.266	0.846	0.221	t	0.050	1.649	0.001
(Mar-May)	0-100	0.896	2.176	0.083	1.665	1.866	0.370	0.097	t	0.022	0.721	t
Winter	0-25	0.352	1.205	0.030	0.687	0.852	0.141	0.024	t	0.010	0.416	t
(Jun-Aug)	0-100	0.105	0.359	0.009	0.205	0.254	0.042	0.007	t	0.003	0.124	t
Spring	0-25	0.118	0.510	0.014	0.246	0.299	0.085	0.013	t	0.003	0.141	t
(Sep-Nov)	0-100	0.074	0.319	0.009	0.154	0.289	0.053	0.008	t	0.002	0.088	t
Summer	0-25	0.807	2.159	0.076	1.075	2.027	0.349	0.038	t	0.012	0.269	t
(Dec-Feb)	0-100	0.312	0.836	0.029	0.417	0.785	0.135	0.015	t	0.005	0.104	t
Annual	0-25	0.840	2.589	0.080	1.490	2.222	0.392	0.067	t	0.020	0.703	t
Mean	0-100	0.352	1.087	0.033	0.625	0.933	0.165	0.028	t	0.008	0.295	t

Turner, pers. comm.), through particles splashed on to plants or swallowed directly. Compared with Takahe faeces in late winter (Mills *et al.* 1980), the concentration of Mg in Pukeko winter faeces was low but the levels of Na, K, Ca, N and P were much higher.

There is no other work on the faecal minerals of any indigenous New Zealand bird with which to compare the present results. The study by Stewart *et al.* (1974) of Pukeko near the Tiwai Point aluminium smelter concerned only the level of fluorine in bones and other tissues.

The distribution and density of faeces in the pastures broadly reflected that of the birds (Fordham 1983), except that the birds were scored more often next to the swamp because in zone 1 of the pasture they mostly used a 2 m strip along the edge, whereas the standard transect for counting faeces was centred 7 m from the edge. Therefore the numbers of faeces in zone 1 was underestimated.

The disintegration of faeces did not appear, from direct evidence, to be influenced strongly by stock numbers or water levels.

The estimates of minerals deposited per hectare on pasture are conservative because the transects underemphasised faecal density in zone 1. The estimates were influenced mainly by seasonal changes in faecal (i.e. bird) numbers, the seasonal variation in size and content of faeces having comparatively little effect. The estimates of minerals contributed by a flock of 50 birds in autumn are likely to be maxima, however, because the captives may have had a higher rate of defecation than they would when feeding on a natural mixed diet of swamp and pasture plants. Reid (1974) found that captive Takahe voided more faeces (about 8 m/day) on a less nutritious diet of grass or tussock than on a more nutritious one of poultry pellets and grass. Pukeko vary their use of habitats and their diet with the season (Wright 1978, Fordham 1983), and so their rate of defecation in autumn is not likely to be the same in other seasons.

The conclusion is that, although Pukeko are one of the main vertebrate agents of mineral interchange between the swamp and adjoining pasture at Pukepuke Lagoon, their faeces are short-lived and contribute little to the overall mineral supply of the pasture.

ACKNOWLEDGEMENTS

Field work was eased by the co-operation of Peter and Pat Barber, who owned the pastures, and by Tom Caithness and Bill Pengelly of the Wildlife Service Jim Dunlop and Pieter Nes, DSIR, arranged the chemical analyses, and Maggie Atkinson assisted in the field and laboratory. Ted Roberts, Brian Springett, Eric Spurr, and Max Turner commented helpfully on the manuscript.

REFERENCES

CARROLL, A.L.K. 1966. Food habits of Pukeko (*Porphyrio melanotus* Temminck). Notornis 13:133-141.

COWIE, J.D.; FITZGERALD, P.; OWERS, W. 1967. Soils of the Manawatu-Rangitikei Sand Country. Soil Bureau Bulletin 29, Wellington: Govt. Printer.

CRAIG, J.L. 1974. The social organisation of the Pukeko *Porphyrio porphyrio melanotus* Temminck, 1820. PhD thesis, Massey University.

CRAIG, J.L. 1979. Habitat variation in the social organisation of a communal gallinule, the Pukeko, *Porphyrio porphyrio melanotus*. Behav. Ecol. Sociobiol. 5: 331-358.

CRAIG, J.L. 1980a. Pair and group breeding behaviour of a communal gallinule, the Pukeko, *Porphyrio p. melanotus*. Anim. Behav. 28:593-603.

CRAIG, J.L. 1980b. Breeding success of a communal gallinule. Behav. Ecol. Sociobiol. 6:289-295.

FORDHAM, R.A. 1983. Seasonal dispersion and activity of the Pukeko *Porphyrio p. melanotus* (Rallidae) in swamp and pasture. NZ J. Ecol. 6:133-142.

GUTHRIE-SMITH, H. 1953. Tutira. The story of a New Zealand sheep station. Edinburgh: William Blackwood & Sons Ltd. 3rd ed. 444 pp.

KEAR, J. 1963. *The agricultural importance of wild goose droppings. Wildfowl* 14:722-777.

MILLS, J.A.; LEE, W.G.; MARK, A.F.; LAVERS, R.B. 1980. Winter use by Takahe (*Notornis mantelli*) of the summer-green fern (*Hypolepis millefolium*) in relation to its annual cycle of carbohydrates and minerals. NZ J. Ecol. 3:131-137.

McKENZIE, H.R. 1967. *Food of the Pukeko. Notornis* 14:41-42.

OLIVER, W.R.B. 1955. New Zealand birds. Wellington: Reed 661 pp.

REID, B. 1974. Faeces of Takahe (*Notornis mantelli*): A general discussion relating the quantity of faeces to the type of food and to the estimated energy requirements of the bird. Notornis 21:306-311.

STEWART, D.J.; MANLEY, T.R.; WHITE, D.A.; HARRISON, D.L.; STRINGER, E.A. 1974. Natural fluorine levels in the Bluff area, New Zealand. 1. Concentrations in wildlife and domestic animals. NZ J. Sci. 17:105-113.

WILKINSON, S.R.; LOWREY, R.W. 1973. Cycling of mineral nutrients in pasture ecosystems. *In* Butler, G.W. and Bailey, R.W. (Eds) *Chemistry and biochemistry of herbage. Vol.* 2, pp. 247-315. London. A.P. 455 pp.

WILLIAMS, C.H.; TWINE, J.R. 1967. Determination of nitrogen, sulphur, phosphorus, potassium, sodium, calcium and magnesium in plant material by automatic analysis. Div. Plant Ind. Tech. Paper 24. CSIRO.

WRIGHT, J.D. 1978. The time budget and feeding ecology of the Pukeko *Porphyrio porhyrio melanotus*Temminck, 1820. *MSc Thesis, Massey University.*

R. A. FORDHAM, *Department of Botany and Zoology, Massey University, Palmerston North.*

*

SHORT NOTE

An Oystercatcher in Vanuatu

I was visiting Vanuatu on 29 September 1983, doing conservation work on behalf of the South Pacific Regional Environment Programme and the International Council for Bird Preservation, when I was surprised to observe an oystercatcher, a bird not previously recorded for that country.

On the waterfront at Vila, I noticed the characteristic piping calls and saw the bird circling low overhead before it landed on the grassed area by the sea wall opposite the Post Office. It remained on the ground long enough for me to examine it with 8x30 binoculars from about 50 metres before it flew again. The pattern of black and white, both on the ground and in the air, was indistinguishable from that of the South Island Pied Oystercatcher (*Haematopus ostralegus finschi*). The white of the breast ended in a sharp line forward of the wing flexure, the lower two-thirds of the back was white and the white wing-bar was prominent. Bill and leg colour appeared to be slightly paler than the deep orange expected on an adult bird, but this feature is difficult to assess on a lone bird.

Appearing particularly agitated, the oystercatcher circled several times and settled very briefly on the flat roof of one of the waterfront buildings before flying across the harbour towards Iririki Island. It was attracting some interest from local people, and those that I spoke to said that they had never seen a "pijin" like that there before.

The origin of this bird is debatable, the two most likely sources being New Zealand and Australia. The Australian Pied Oystercatcher (*H. ostralegus longirostris*) is distributed over much of the coast of that country but is quite sedentary, has a smaller population than the New Zealand subspecies and is found mainly in the southeast (Blakers *et al.* 1984). Moreover, it does not have as much white on the back as was seen on this bird (A. E. Baker, pers. comm.). This feature leads to the conclusion that it was a South Island Pied Oystercatcher.

An extension of range northwards is not surprising, given the dramatic increase in population over the last 30 years (Hay 1983), but 2000 km is further than expected considering the lack of records from intermediate localities. No records have been obtained from either New Caledonia or the Kermadecs, although Schodde *et al.* (1983) reported unidentified pied oystercatchers as occasional non-breeding vagrants on Norfolk Island. The first oystercatchers seen on that island (30 birds in December 1960) may have been South Island ones (Wakelin 1968) and it is probable that more recent records are also of this subspecies. Closer to Australia, on Lord Howe Island, B. D. Heather (pers. comm.) has observed an oystercatcher which was indistinguishable from *H. ostralegus finschi.* This bird was seen on the airport tarmac there on 13 September 1982 after not being there on the two previous days. It remained at least until 17 September.

It is possible, though unproven, that an individual as far out of its range as Vanuatu may be the result of an immature bird on reverse migration, particularly as it and the Lord Howe Island bird were seen at the time of year when birds in New Zealand were migrating south for breeding. The evidence for this phenomenon has been reviewed by Diamond (1982), who concluded that it is relatively common in some species and is a result of "mirror-image" navigational errors, in which a migrating bird takes a correct bearing from a north-south axis but travels on the wrong side of that axis. In other words, a confusion of left and right orientation occurs. In this case the "error" would be a mirror image in relation to the east-west axis but there appears to be no logical objection to that possibility. If oystercatchers begin their navigation by orienting to the coast, a simple left-right error at the start could carry them north instead of south. The lack of such records is not surprising, given the small land area available for them to end up at.

An alternative explanation suggested by Diamond is that some birds migrate in the reverse direction as a result of initially being blown off course while on normal passage. On becoming lost they return along their path to reorientate. In the north of New Zealand, it would be easy for a bird to miss land on the return path and continue north-westwards beyond North Cape. The evidence for this behaviour is meagre, however, and 2000 km is an extreme distance for a bird to fly in order to "reorientate".

Whatever the mechanism whereby oystercatchers arrive so far from their normal range, such records are symptomatic of a burgeoning population and should be monitored to see whether more permanent range extensions result.

LITERATURE CITED

BLAKERS, M.; DAVIES, S. J. J. F.; REILLY, P. N. 1984. *Royal Australasian Ornithologists Union.* Melbourne University Press.
DIAMOND, J. M. 1982. Mirror-image navigational errors in migrating birds. Nature 295: 277-278.
HAY, J. R. 1983. Shorebirds of the Miranda coastline. Tane 29: 15-30.
SCHODDE, R.; FULLAGAR, P.; HERMES, N. 1983. A review of Norfolk Island birds: past and present. Australian National Parks and Wildlife Service Spec. Pub. 8. 119 pp.
WAKELIN, H. 1968. Some notes on the birds of Norfolk Island. Notornis 15: 156-176.

J. R. HAY

SHORT NOTE

High Altitude Records of Pukeko in the Southern Alps

Mount Aspiring National Park

On 21 February 1984, Mr G. P. Paltridge brought to the Canterbury Museum some fresh bird remains that he had found at a height of 1350 m, 0.75 km south-east of Rabbit Pass in the head of the East Branch of the Matukituki River, Mount Aspiring National Park. I identified the remains as Pukeko *(Porphyrio porphyrio melanotus).*

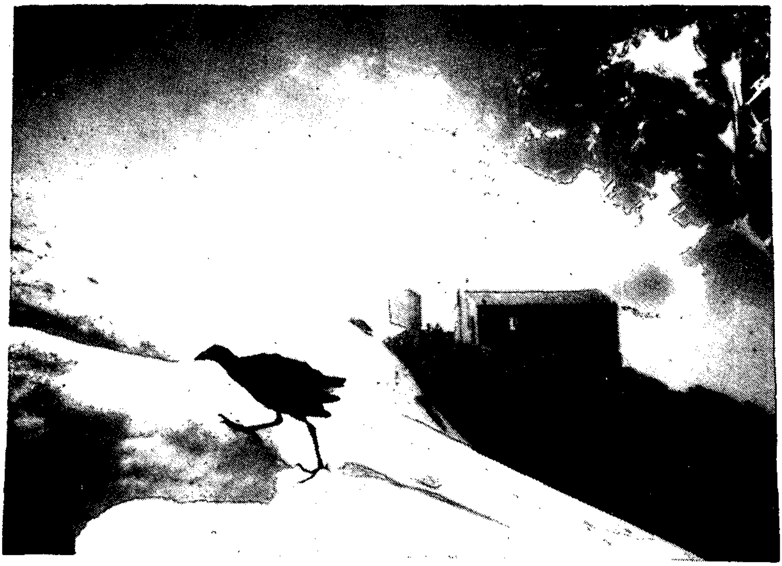
Mr Paltridge noted the absence of swamps over the route tramped by him and his companion, Mr J. C. Smith, up the Wilkin River and its South Branch, across Rabbit Pass, and into the headwaters (East Branch and Kitchener Stream) of the Matukituki River.

The black bill tip, plumage and some external measurements confirmed that the Pukeko was a juvenile.

Child (1981), in a survey of the bird life of the Park, reported Pukeko in the lower Okuru River, about 40 km in a direct line north-east of Rabbit Pass.

Mount Cook National Park

On 5 February 1984, Mr D. McNulty, a guide in the Mount Cook National Park, observed (from c. 1030 to 1130h) a live Pukeko at 2350 m



A Pukeko at 2350 m near the Tasman Saddle hut, Mount Cook National Park, 5 February 1984

Photo D. McNulty

near the Tasman Saddle hut. The day was fine with a southerly wind and patches of mist. Over the two days that preceded this sighting the weather in the Park had been misty with moderate south-easterly winds.

Mr McNulty saw three Pukeko at the end of January 1984 at 550 m, about 48 km from the Tasman Saddle hut in the Glentanner swamp. On 29 February 1984, Mr R. Slater put to flight a Pukeko at 750 m in the Mount Cook Village. There have been no other recent reports of Pukeko at high altitudes in the Park (J. Atkinson, pers. comm).

J. Atkinson (pers. comm.) has reported that on average 5-8 Pukeko are seen regularly in Glentanner swamp and they are known to breed there. Green (1883) observed 'numerous swamphens' on Birch Hill Station in Lagoon Stream Swamp. This is at c. 610 m. Brodrick (1880-1931), while surveying the road line at the head of Lake Pukaki [c. 485 m], made the following diary entry on 24 October 1888 ". . . there are scores of dead swamphens all along the edge of the swamps. I suppose killed by the heavy snow last winter."

Douglas, in his monograph *Birds of South Westland* (c. 1899) cited by Pascoe (1957 p. 235), commented that Pukeko ". . . can cross the main range, but many must perish on the journey as I have often found them dead on glacier and snow field." According to Carroll (1969) Pukeko in New Zealand rarely live at high altitudes; they are most abundant from 1200 ft [366 m] to sea level. Carroll (1969) reported a Pukeko banded in February 1967 and recovered in May 1967 112 miles [180 km] from its liberation point. It seems reasonable to speculate therefore that Pukeko occupying habitat at higher altitudes than usual in the vicinity of the main divide are likely to be blown off course into localities well above their usual altitudinal range. It is possible that the Rabbit Pass juvenile Pukeko may have been carried by a bird of prey, although the corpse showed no obvious signs of this. I have twice observed live juvenile Pukeko snatched off the ground and carried about 40 m by an Australasian Harrier *(Circus approximans).*

I am grateful to Graeme Paltridge and John Atkinson for allowing me to report their observations.

LITERATURE CITED

BRODRICK, T. N. MS Diaries 1880-1931. Wellington: Alexander Turnbull Library.
CARROLL, A. L. K. 1969. The Pukeko *(Porphyrio melanotus)* in New Zealand. Notornis 16: 101-120.
CHILD, P. 1981. Birdlife of Mount Aspiring National Park. National Park Scientific Series No. 4. Wellington: Department of Lands and Survey.
DOUGLAS, C. E. c. 1899. Cited by J. Pascoe (1957) Mr. Explorer Douglas. Wellington: A. H. & A. W. Reed.
GREEN, W. S. 1883. The High Alps of New Zealand. London: McMillan & Company.

GEOFFREY A. TUNNICLIFFE, *Canterbury Museum, Rolleston Avenue, Christchurch 1*

LETTER

The Editor,

Henderson Island

Sir,

Since the publication of our account of Henderson Island in *Notornis* 30: 233-252, Nelson Dyett, who established the radio and meteorological station on Pitcairn Island during World War II and has kept in touch with the island ever since, has provided further information which deserves to be placed on record, together with some additions and corrections.

It appears that the island was visited between 12 April and 24 May 1944 by a surveying party of five from the "PAN" Expedition under the late Flight Lieutenant A. M. Fletcher, together with six Pitcairners, to appraise its suitability for an airstrip. According to a report in the National Archives, Wellington, they found that it was difficult to land and that the island was covered with impenetrable scrub up to 30 ft high and was short of water. They cut and pegged 13¼ miles of survey lines behind the main landing place and another 3½ miles long the coast before the project was abandoned. The most interesting information about the natural history is that the largest trees were tunina with boles up to 30 ins in diameter (which is 75 cm, not 500 cm as reported in our account). There were also cabbage, pandanus, highwhite, jesmy, punney, sharkwood and occasional sandalwood trees on the plateau, and miro and tow, used by the Pitcairners for carving, along the northern coastal strip, with a few coconuts at the landing places.

In our account it should be noted that the castaways from the whaler Essex arrived in 1819, not 1820, that the subsequent naval observations are taken from ship's Remark Books at the Hydrographic Department, Taunton (a rich and unexploited source of such information), and that the figures for Oeno and Ducie Islands have been transposed in Table I. A full review of other information about the island has now been published by F. R. Fosberg, M. H. H. Sachet and D. R. Stoddart in *Atoll Research Bulletin* 272, although it may be remarked that since several visitors have reported the presence of shells and corals on the plateau the island may have been uplifted more recently than they suggest.

While it has been announced that settlement on the island will not be permitted, we understand that agitation for it continues and that, in addition to Pitcairners in search of wood, the island is currently being visited by at least one yacht annually, and probably a tourist ship in the future, with no sort of supervision. Clearly more satisfactory arrangements are needed both for the support of the Pitcairners, who have suffered several medical emergencies recently, and for the protection of the wildlife and environment of the rest of the Pitcairn group. It seems increasingly doubtful whether much can now be expected from Britain, where such places now appear increasingly remote, so that much may depend on people living nearer to the area.

W. R. P. BOURNE, *Department of Zoology, The University, Aberdeen,* UK.;
A. C. F. DAVID, *Hydrographic Department, Taunton,* UK.