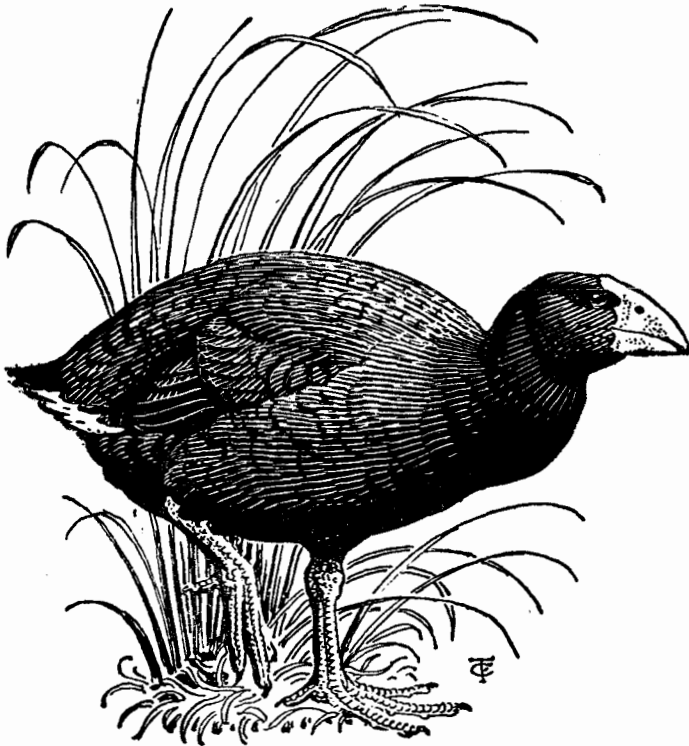


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THE CATTLE EGRET IN NEW ZEALAND, 1978-1980

By B. D. HEATHER

ABSTRACT

Late-August censuses gave minimum New Zealand totals of 266 Cattle Egrets (*Bubulcus ibis*) in 1978, 624 in 1979, and 771 in 1980. This rising trend ceased in 1981 and 1982. The three years' records are given for each region, and the late-August distribution is mapped. Arrival of birds was conspicuous in late April and early May and probably continued into June. A bird banded as a nestling in northern New South Wales was recovered, and a second banded bird was seen. Arrival was widespread, mainly in the west, and by June most birds had moved to traditional farms. The main departure period seemed to be mid-October to mid-November, but many birds remained to December. A few overwintered each year and passed through breeding plumage.

In New Zealand, the birds are very shy of humans, even though they associate with various gregarious farm animals, mainly cattle and sheep. In the New Zealand winter, the main observed food of the egrets is earthworms. Differences of plumage from the nominate race and the development of breeding plumage are discussed.

Because of the interest of OSNZ members in investigating the number and distribution of the Cattle Egret (*Bubulcus ibis coromandus*) in New Zealand and the success of the 1977 study (Heather 1978), further national counts were made in 1978, 1979 and 1980. In all years, a late-August weekend was used for the counts, as in 1977. By late August, most egrets are settled and in fewer flocks than earlier

TABLE 1 — Numbers of Cattle Egrets in New Zealand, 1977-1980, from counts made in late August

	1977	1978	1979	1980
Northland	25	30	57	91
Auckland	4	9	22	18
S.Auck/Waikato	97	67	178	157
Bay of Plenty	7	3	9	0
Volcanic Plateau	0	0	0	0
Taranaki/Wanganui	35	8	24	31
Gisborne	5	17	26	26
Hawkes Bay	1	0	22	4
Manawatu	15	18	41	72
W.Wellington	0	0	2	5
Wairarapa	7	0	0	0
North I. totals	196	152	381	404
Marlborough	22	6	21	32
Nelson	20	34	44	55
West Coast	20	15	57	25
Canterbury	14	20	76	167
Otago	0	14	16	55
Southland	21	25	29	33
South I. totals	97	114	243	367
NZ Totals	293	266	624	771

and further movement does not occur for another month. In addition, notes were kept in many regions of the birds' arrival and dispersal and, whenever possible, their departure, overwintering, plumage changes, associated animals, and general behaviour.

Table 1 gives the results of the late-August counts by regions, including 1977 figures for comparison. Whenever bad weather affected counts in some regions, consistent numbers seen before and after the count weekend are used. The totals are minimum because in several places where new flocks were found, farmers reported that birds had been present in previous years. In 1977 ibises and other egrets were also counted, but they were not in 1978-80, when information was enough to show that no unusual influx or change of numbers occurred. Therefore, changes in Cattle Egret numbers were independent of the movements of other species.

The sharply rising trend of numbers up to 1977 ceased in 1978, birds returning to some localities in slightly higher numbers, to some in lower numbers, and to a few not at all, the overall 1978 total being slightly lower than that of 1977. In 1979, the rising trend resumed dramatically to a number more than twice those of the previous two years. In 1980, the trend continued with well over 100 more birds than in 1979. The reasons for these annual changes are not known but must be related to breeding or climatic events in Australia, where the birds breed and most disperse after breeding.

Although nationally co-ordinated counts were not made in 1981 and 1982, enough is known to show that, in 1981, the rising trend ceased again and in 1982, numbers fell sharply. Prominent localities with winter counts available for both years are, for 1981 and 1982 respectively and with 1980 numbers in brackets, Rangiriri 81-94, 84, (125), Awaiti 28, 15, (21?), Foxton 67, 22, (67), Grovetown 38, 19, (32), Appleby 2, 2, (17), Taumutu 48, 28, (91), Clandeboye 17, 6, (19). Other figures are Parakai in 1982, 30 (18) and Gisborne in 1981, 11 (22).

REGIONAL RECORDS

These records are given in detail because more can be taken from them than mere population numbers and because they give a base against which future events can be measured — for example, flock sites that are minor now may become traditional wintering and even breeding sites.

NORTHLAND

The site near Awanui continued to be important, and the Dargaville district emerged as a second major locality, the birds concentrating at Ruawai in July-October.

1978

Te Paki, up to 20 reported by farm manager in early April and 11 seen with cattle on 4 April; all had left by 22 April. Parengarenga, 2

briefly in early April, according to farm manager. Waihopo (Houhora), 5 in roadside paddock on 11 April. Kerikeri Inlet, 2 on farm paddocks 11-17 April; one, 30 April to 7 May.

Awanui: One from 30 March to 25 April, once in a sheep pen with domestic fowls; number built up to 25 by late May and decreased from 1 June (e.g. 12 on 11 June, 10 on 2 July, 14 on 6 July - 26 Aug). Sometimes with sheep, usually with cattle. At high tide on 6 July, they were in a field with no stock but with 60 Pied Stilts, 100 Red-billed Gulls, and 15 Caspian Terns. On 23 Aug, they flew from paddock to perch on a dead tree with Royal Spoonbills and White-faced Herons. On 4 Nov, 14 still; on 5 Nov, 5 present, in breeding plumage, two of them bowing as if in courtship ritual.

Dargaville: Awakino Point, 3 on 7 June, 7 on 10 June, when they left. Ruawai, on farmland east and west of Wairoa River, 3 from 4 April to 7 June; increased to 16 throughout Aug.

1979

Aupori peninsula, two singles in Aug. Hokianga: Waihou Valley, Rangiahua, 4 in late April, 7 on 6 May, 14 in June, none reported thereafter; Rawene, 2 for 2 weeks in April; Waima, 4 on 10 July.

Awanui: Six arrived in late April, moved several miles to Waipapakauri for about 10 days, and returned to Unahi, where 20 were present on 28 May. The flock stayed in this area, except briefly in July. At Unahi, 23-25 on 26 Aug and until early Oct, when the flock increased, by farmer account, shortly before departure later in Oct.

Dargaville: Two, later 4, in April. Parore district, 7 on 16 May. Rehutai, 1 in May. Arapaoa, 4 in April. Marohemo, 2 in April. All these birds probably congregated to form the flock at Ruawai, which began with 2 in April-May, built up to 32 by 26 Aug and c.40 on 28 Sep and also in late Oct. Time of departure not known.

1980

A few scattered sightings: Cape Karikari, 1 on 26 April; Aurere, near Doubtless Bay, 3 in May; Wainui, near Whangaroa Bay, 1 in May; Kerikeri, 2 in May, 1 in June; Waipu, 6 in early June; One Tree Point, Whangarei Harb, 2, May-Sep.

Awanui: Flock built up from 4 in April to 12 in June, 30 in July and Aug, 39 on 10 Nov; 5, in breeding plumage, on 15 Nov; none seen thereafter.

Dargaville: Baylys Beach, 1 dead on 5 April, 3 (live) on 25 April; Taingaehe, Pouto Pen, 4 on 20 April, 5 on 27 April; Matakoho, N. Kaipara, 2 in May; Awakino Point, 3 on 30 April, 7 on 23 Aug. Ruawai, 52+ on 23 Aug; by farmer accounts, birds left in early Nov.

(A. T. Edgar, W. J. Campbell, M. Hows)

AUCKLAND

Parakai (Parkhurst): As in 1977, this was the only site, apart from one freshly dead on Muriwai Beach on 26 May 1979.

1978: Eight on 15 July and through to 24 Dec.

1979: 16 on 25 April and, several days later, 6 more several kilometres away. These two flocks remained, always apart, until 20 Dec.

1980: One on 6 Jan and 27 Feb, presumably oversummering; 14 on 25 April and 19 May; 18 in late Aug.

(S. M. Reed)

SOUTH AUCKLAND/WAIKATO

Prominent developments were the continued growth of flocks at the Rangiriri site, which were the largest flocks in New Zealand every year, and the emergence of a new site in the Piako district and a minor one at Karaka.

1978

The bird that oversummered in Pokeno Valley was last seen on 10 April (D. A. Lawrie). Seagrove, near Karaka, south Manukau Harb, 1 on 23 July. Pukekohe, 1 on 24 May flying south. Lake Whangape, Waikato, 3 on 28 May.

Aka Aka: One on 14 May, the only sighting at this favoured locality of 1977. The few birds that returned to 1977 localities presumably moved on to join the bigger groups at Rangiriri. None seen at Lake Ngaroto, which was favoured in 1977.

Rangiriri: On 21 March, 3 at Henderson's farm; 23 on 28 May, but Mr Henderson reported 38, some since early April. On 4 June, three flocks of c.10, 26, and 7; 54+ on 15 July. Up to early July, most were on the Henderson farm, as in 1977, but thereafter all were together at Te Onetea Road, where there were 61-62 later in July, 67 on 27 Aug, and 50 nearby on 7 Oct. Many had left by 11 Oct, but 25+ were still there on 4-5 Nov and 6 on 18 Nov.

1979

New centres in this year of greater numbers were Karaka in south Manukau and Pipiroa near the Piako estuary, southern Firth of Thames; birds seen at or south of Miranda and near Waitoa (Te Aroha) may have been from the Pipiroa flock.

Miranda, 1 on 20 Jan and through to 3 June, 3 on 17 June, 4 on 3 July and through to at least late Aug. Meremere, 3 in late May, 4-5 on 8 July. Lake Whangape, 9 on 28 Aug. Te Kowhai, west of Hamilton, 1 on 28 Aug. Raglan, 1 on 22 Dec (oversummering?). Makomako, Aotea Harbour, 1 on 15 June, 2 later. Jory Rd, Ohaupo, 2, 15 Aug to 4 Nov. Lake Ngaroto, 3 in early June.

Karaka: Seven from at least July to late Oct; 1 stayed on for first week of Nov. Nearby, 7 flying east at Pokeno on 7 May and one at Wairoa estuary, Clevedon, on 30 April.

Pipiroa: Three on 29 Dec 1978, 4 on 7 Jan, 7 on 17 Jan to 15 March; 12 on 17 June; 27 on 28 Aug; 30 in Oct; 31 on 6 Nov. At least 7 of the Jan birds apparently overwintered in the district.

Aka Aka: 12-13 on 29 April, 14 on 5 May, 21 on 31 May, but thereafter down to 4 because main cattle herd was removed. Presumably most birds moved to Rangiriri. Nine on 25 Aug.

Rangiriri: H. Henderson reported first birds seen on his farm on 23 April; number rose to over 80 by last week of May. The flock at nearby Te Onetea Road was 16 on 25 April and 28 on 6 May. By June, flocks were 32 at Onetea and 86 at Henderson's. These flocks, some 10 km apart, came together for July and Aug; counts of 131 on 8 July and 119 on 25 Aug. None found in the district after 26 Oct.

1980

Pukekohe sewage ponds, 2 on 14 April. South of Kawhia Harb, 2 near Te Anga, 19 April, and 1 at Kiritihere, 20 April. Meremere, 5 on 11 Feb. Lake Ngatoro, 3 on 25 April. Lake Whangape, 8 on 28 May, 9 on 28 Aug. Jory Rd, Ohaupo, 1 on 3 May, 2 on 21 May. 3 on 31 May, 3 on 24 Aug, 4 on 1 Sep.

Karaka: Two arrived on 21 April and 2 more on 29 April. They left at the start of the duck-shooting season on 1 May. One at Mangere on 13 May and 2 at Manurewa on 2 May may have been some of these birds. Karaka, 1 from June to late Aug (J. Urquhart).

Pipiroa: Nine on 21 Jan, 3 on 31 Jan, 7+ on 3 Feb, 12 on 3 May. By July, they had moved west to near Waitakaruru; 28 from July to Aug. One at Kaiaua 4 April to 17 May.

Rangiriri: Reported to arrive in ones and twos from April onwards, later moving west across Waikato River to Huntly West Road. On 26 April, 13 at Te Onetea Road and 16 at Henderson's. On 3 May, 61 in groups of 26, 2 and 33. On 2 June, the groups were 23 and 100. On 24 Aug, 125 in flocks of 107 and 18. 106+ at Huntly West Road on 5 Oct. None seen on air search on 18 Nov.

Band recovery: A bird washed ashore dying on the morning tide of 4 May 1980, on Taharoa Beach south of Kawhia Harbour, had been banded as a chick by J. Willows on 24 Dec 1979 at a colony NW of Grafton, NSW; band no. 100-25054.

(B. Brown, JH & BH Seddon, *et al.*)

BAY OF PLENTY

Awaiti Wetland Reserve: Fields adjacent to this reserve remained the only known site in the Bay of Plenty and Volcanic Plateau regions.

1978: Three on 26-27 Aug, which had been there for at least several weeks. Seen up to 24 Sep but not found on 28 Oct.

1979: Eight on 11 Aug; 9 on 25 Aug, last seen 20 Sep.

1980: 11, up to 15 on 7 June; 21 on 22 June.

(P. C. Latham)

GISBORNE/WAIROA

The regular flock occurred on fields near the Waipaoa River, some 20 km from Gisborne.

- 1978: Five first seen in May, rising after several weeks to 8 and then by ones and twos to 17 in July/Aug.
 1979: Seven appeared on or about 20 April; up to 14 by 1 June and 26 by 1 July and through to at least late Aug.
 1980: On 23-24 Aug, 22 at usual site; also 1 at Tolaga Bay and, near Wairoa, 1 at Whakaki Lagoon and 2 at Awamate.

(A. Blackburn, J. C. Henley)

HAWKES BAY

No birds were recorded in 1978. In 1979 and 1980, the main localities were certain farms at Meeanee and Farndon, near Clive, but some confusing local movement occurred, especially to fields adjacent to the Ahuriri estuary at Westshore, and late-Aug counts were hindered by heavy rains and flooding.

- 1979: Two on 25 April at Horseshoe Lake, Patangata, east of Waipawa, with feral domestic geese. Meeanee, 10-12, May to July and from time to time up to Oct. Puketapu, west of Napier, 2 on 25 Aug. Ahuriri, 2 on 6 May, 14 on 30 Aug. Farndon, 3 on 25 Aug, 15 on 9 and 23 Oct, 11 on 9 Nov. Waipukurau (A. H. Gollop), 3 in July and on 21 Sep, 2 in Oct.
 1980: Even fewer birds. Three c.14 km west of Dannevirke on 30 May; gone by 1 June; Otape Road, Dannevirke, 1 on 25 April (J. Drake). Lake Hurimoana, 2 on 25 May. Farndon, 2 on 18 April, changing to a nearby farm where farmer had known them for two years; 4 from early July to at least 18 Oct. No further sightings until 1 on 7 March 1981 at Ahuriri.

(K. V. Todd, B. R. Keeley, M. Craven)

WAIRARAPA

This district of fine Cattle Egret habitat was ignored by the egrets, except in passing.

- 1978: Two on northern shore of Lake Wairarapa on 8 April.
 1979: One at Pirinoa on 20 April; found dead on 27 April. One at Monk's farm, north end of L. Wairarapa, a favoured place in 1977, on 22-23 April and on nearby farm on 29 April; did not stay. Three flying over flood gates at south end of the lake on 11 May.
 1980: One at Pirinoa on 3 May; 1 nearby on 3 June; 1 Lake Ferry on 6 Aug, 1 on 16 Nov, east side of L. Wairarapa, outside shearers' quarters where an OSNZ wader-study party was staying.

(D. Sim, B. D. Heather)

TARANAKI

Despite its abundant well-watered pasture and its prominence as a landfall, Taranaki has not been favoured by the egrets as a wintering place, except for regular small flocks at Waitara and Nukumarū, one or two birds regularly on a farm near Normanby, and an elusive flock in the Patea district.

1978

North Taranaki: Waitara River mouth, 1 on 6 May.

South Taranaki: Between Manaia and Kapuni, 4 in May. Normanby, 2 from May to mid-Nov. Nukumarū (Lake Waikato), the two that overwintered were presumably joined by 4 more as 6 were present on 27-28 Aug.

1979

North Taranaki: A spectacular influx began with 1 at Cape Egmont lighthouse on 17 April and continued as a flurry of reports up to 6 May of at least 50 birds spread along northern and western coastal Taranaki from Awakino to Warea and inland south of Waitara to Tikorangi and Tarurutangi. On 24 April, one even hit the vessel *Pacific Installer* in Port Taranaki (skin in Taranaki Museum). Localities were Awakino, Pukearuhe, Urenui, Waitara, Bell Block, New Plymouth, Oakura, Cape Egmont, Pungarehu, and Warea. Mostly ones and twos, but several groups of 3 and 4 were about Waitara, 7 were at Awakino, and 13 were at Tikorangi.

By mid-May, most birds had apparently moved on, apart from a temporary concentration of 12 at Toko, east of Stratford, on 22 May, down to 7 on 23 May, and a flock of 9 on the northern outskirts of Waitara. This Waitara flock remained to mid-Sep, increased to 12 by 19 Sep, and went by 23 Sep.

South Taranaki: One beside Opunake-Stratford road in last week of April. Maxwell, 3 in roadside field on 21 Aug, possibly from the Nukumarū flock. Nukumarū, 15 on 2 June, 28 Aug and 5 Sep (site not visited before 2 June). According to farm staff I. & J. Coombe, all left between 10 and 18 Nov after several absences lasting several days each.

1980

North Taranaki: Waitara, 7 on 15 April. Onaero (Urenui), 1 with White-faced Herons on 9 Jan; 6 on 27 April. Okau (Tongaporutu), 1 on 15 May.

South Taranaki: Normanby, 1 up to Nov. Mokoia, 3 in roadside field, 6 July. Nukumarū, first bird returned 29 March, 4 on 6 April, 12 on 9 April (I. & J. Coombe); no further observations made until 31 on 31 Aug.

(R. W. Wheeler, L. C. Edlin, B. D. Heather)

MANAWATU/WEST WELLINGTON

The birds tended to change from being in small flocks in widely spaced localities, mainly south of Palmerston North, to a concentration in the Foxton district, especially the first of the string of small dune lakes in farmland north of Foxton Beach. A farm at the southern end of Lake Horowhenua had 2-5 birds each year on the same fields with the same herds. Note the clear sequence of build-up and departure at Foxton No. 1 in 1980.

1978

Longburn (Hamilton's Line), 13 on 20 July, 16 from 23 July to at least 29 Aug; 13 went about 10 Nov; 3 still there on 12 Nov, none on 3 Dec.

Foxton: No. 1 lake, 1 on 6 Aug; 6 km further north, 2 on 27 Aug. Manawatu River estuary, 2 on 17 Dec.

1979

Lake Pukepuke, 3 on 4 May, 5 on 7 May. Marton district, 1 on 9 June. Lake Koitiata, Santoft, 6 on 25 Aug. Tiakatahuna (W of Palmerston), 1 on 20 June. Lake Horowhenua, none seen 13 & 20 April, although reported by farmer; 2 on 24 May and through to at least 25 Aug. Opiki, 4 on 25 Aug. Wellington airport, 1 on 17 April and for most of May.

Foxton: No. 1 lake, none on 13 March and 17 April (no May visits); 49 on 24 June, 31 on 15 July and 12 & 25 Aug; 25 on 29 Oct, 19 on 11 Nov. Manawatu estuary, 3 on 3 Feb, 1 on 11 Feb and 17 & 20 April, 4 on 5 May, 4 on 31 Dec. Flooded pasture south of Foxton, 1 on 13 & 20 May, 2 on 2-3 June, 4 on 11 June. These estuary and floodwater birds may well have been from the nearby No. 1 lake flock.

1980

Awahuri (Oroua River), near Palmerston North, 10 on 10 Aug. These probably moved to join the Foxton flock, which rose by 10 at this time. Moutoa Land & Survey block, between Foxton and Shannon, 5 on 24 Aug. Lake Horowhenua, none in April, 5 on 29 June and 24 Aug, 11 on 30 Nov, 12 on 1 Dec.

Foxton: No. 1 lake, none on 13 April, 4 on 20 April, 13 on 26 April, 20 on 27 April, 44 on 18 May, 57 on 20 July, 67 on 24 Aug, c.70 on 28 Sep, 60 on 12 Oct, 12 on 20 & 27 Nov. Then none until 5 on 10 May 1981. Manawatu estuary, 1 on 1 Jan and 20 April.

(L. J. Davies *et al.*)

NELSON

The two regular sites continued to be at Takaka, where the flock moved among farms between the township and the coast, mainly on the Rotatai flat, and at Appleby, near Nelson, where birds tended to favour the Waimea estuary early in the season and move later to nearby farmland.

1978

Takaka, 12 in May, 14 on 26-27 Aug. Appleby, 1 on 20 March, 6 on 6 April and in early May on Waimea estuary, and 6-7 all May on nearby fields; 20 on 23 June and through to 15 Nov.

1979

Big River, southern Westhaven Inlet, 3 on 19 April. Takaka, 18 on 25 Aug. Motueka, 1 on 20-24 April. Riwaka, 2 on 25 Aug. Appleby, 6 on 2 May, 11 on 18 June, 24 on 26 Aug, last seen 11 Nov.

1980

Many of the May dates coincide with observers passing through to and from Farewell Spit; these birds may have been new migrants or have been moving through from other regions.

Farewell Spit lighthouse, 1 with house cow on 16 May, stayed one day only. Pakawau, 4 on 12 May, 6 on 17-19 May. Takaka, 3 in mid-April, 19 by early May, 22 by 18 May, 31 on 23-24 Aug. Riwaka, 5 on 11 May, 6 on 19 May, 5 on 23-24 Aug. Motueka, 1 on 19 May. Appleby, 5 on 18 May, 17 on 23-24 Aug. Ruby Bay, 1 on 19 May. Mapua, 9 on 26 Aug. Rabbit I., 14 on 26 Aug. Wakefield, 2 on 23-24 Aug.

(J. M. Hawkins)

WEST COAST

This long narrow region with its complex pattern of high ridges and valley flats, forest, farmland, and lakes, cannot be fully watched all season. It was often the landfall for many egrets, most of which did not stay. Unlike most regions, the birds remained in widely spaced small flocks, but as usual most localities were regular, even after an absence of one or more years.

1978

Few 1977 localities had egrets back. Rotomanu, only 1 on 9 April. Matai (Grey River), 2 seen at end of June only. On 26-27 Aug, 15 birds only — 8 at Karamea, 6 in Kokatahi/Kowhitirangi district near Hokitika, and 1 at Okarito.

1979

At the same time as in Taranaki, a small but spectacular influx occurred in the second half of April. The observations of C. Burridge and others at Punakaiki were notable: At 5 p.m. on 16 April, 8 birds arrived on the Burridge farm. They were joined by a ninth on 22 April and 10 more early on 23 April. Late on 23 April, the number fell to 5, and to 1 by 26 April. Meanwhile, 10 at Barrytown on 25 April and 5 on 27 April and 7 on 29 April at Coal Creek may have been Punakaiki birds or further migrants.

Other early records by R. Weston, who was travelling through at the time, were of 6 at Ross, 3 near Harihari and 14 at Whataroa on 27 April and of 6 at Manukaiuia River and 8 at Paringa on 26 April.

Moana, near Rotomanu, 9 on 15 April. Camerons, south of Greymouth, 4 on 18 April.

Karamea, 9 on 25 Aug. Westport, 2 on 14 July. Barrytown, 10 on 25-30 April, c.20 on 7 May; none thereafter. Coal Creek, 8 on 5 Aug, 6 on 25 Aug. Matai, 8 throughout Aug. Rotomanu, 13 on 25 Aug. Arahura Valley, 11 throughout Aug, 2 on 2 Dec. Kokatahi/Kowhitirangi, 5 and 2 on 25 Aug, 8 on 11 Oct. Harihari, 3 on 25 Aug. Flocks counted in late Aug had been together most of winter, but some numbers were down.

1980

After an early influx in the second half of April and the first week of May, numbers diminished, and by the census in late Aug few could be found.

Early reports: Westport, 2 on 20 April. Punakaiki, 2 on 19 April. Greymouth district: Matai, 1 on 3 May; Rotomanu, 2 on 19 April; Kotuku, 2 on 19 April; Lake Kangaroo, 11 on 20 April. Hokitika district: Humphreys, 2 on 10 May; Hokitika, 9 in late March; Kowhitirangi, c.20 on 21 April; Totara River, 9 on 26 April; Mikonui River, 4, and also 3 at Shearer Swamp, 26 April. Whataroa, 1 on 19 April. Franz Josef (Potters Creek), 1 on 4 May. Fox Glacier to Jacob River, 4 in early May.

Later reports: Karamea, 12 on 24 Aug. Westport, 1 on 19 Aug. Coal Creek, 4 all Nov up to 22 Nov. Rotomanu, 4 on 23 Aug. Kowhitirangi, 8 on 25 Aug.

(S. C. Lauder)

MARLBOROUGH

The main site at Grovetown, near Blenheim, continued to be favoured, whereas Kaikoura, the other site in 1977, was rather neglected except early in the season.

1978: Grovetown, 6 on 11 June and through to early Oct. Kaikoura, 1 only, 16 June to 4 July.

1979: Grovetown, 3 on 8 May, 20+ on 18 June, 16 on 25 Aug, 4 on 2 Oct, 1 on 4 Nov. Kaikoura, rapid build-up in May, 5 to 7 to 8 by 22 May, 9 on 8 June, 5 from 25 Aug to 20 Oct.

1980: Linkwater, 3 on 7 April, none on 11 May. Grovetown, 15 in mid-April, 18 on 18 May, 32 on 23-24 Aug, 29 on 3 Nov, 16 on 6 Nov, 11 on 10 Nov, 5 on 25 Nov. None thereafter until 23 on 16 May 1981. Grassmere, 2 on 6 April. Kaikoura, 8 on 11 May, 2 on 31 May.

(P. Jenkins, J. A. Cowie, R. N. Holdaway, D. Bate)

CANTERBURY

Although the small flock at Waikuku persisted, the main flock at Taumutu, on the western side of Lake Ellesmere, continued to increase until it rivalled the Rangiriri flock in the Waikato. The Taumutu birds were often hard to count accurately, except late in the

day while herds were being milked. Many but not all were sometimes seen on the lake shore, and single birds and small parties were sometimes reported as much as 15 km away at Selwyn River and South-bridge. New centres of congregation developed in the Ashburton district at Ashburton Forks and on two farms at Eiffelton and in the Timaru district of South Canterbury at Clandeboye and Kingsdown.

1978

Waikuku: One, then 3, in April; 3 through to early Oct.

Taumutu: 13 from April to 1 July, when 15 present; 17 on 19 Aug and through to at least early Oct.

1979

Waikuku: None on 31 March and 1 April, 1 on 6 April, 4 on 27 April, 12 on 10 June, 15 on 7 July & 25 Aug, 12 on 29 Sep, none on 25 Oct.

Taumutu: None on 31 March, 1 and 27 April; 31 on 22 May, 40 in early June and probably through to mid-Sep; 17-18 on 25 Oct, last seen mid-Nov.

Ashburton: Ashburton Forks, c.30 km inland, two flocks of 9 and 14 on same farm, 10-16 May. Thereafter only the 14 remained, until 29 June. Eiffelton, farm east of township, 4 on 17 May, 8 on 18 May, 9 on 19 May through to 8 Aug, 10 from 13 Aug to 17 Oct, when very restless; not seen after 21 Oct. Eiffelton, farm south of township, 14 on 1 July and through to late Oct, number then fluctuating between 4 and 14, last seen 6 on 15 Nov.

Geraldine-Winchester highway, 3 on 25 Aug; according to farmer, 2 each winter for previous 3 years.

1980

Christchurch, Bromley sewage farm, 5 on 7 & 15 May. Haldon station, Lake Benmore, 2 on 13 May. Rakaia River mouth, 2 on 12 May. Kaiapoi, 1 on 23 Aug.

Waikuku: One on 18 April and 2 May, 3 on 11 May, 6 on 18 May, 7 on 23 & 30 May, 8 on 23 Aug and through to at least mid-Oct.

Taumutu: None on 18 April, 2 on 20 April and 17 nearby near Leeston, 1 at Prebbleton on 17 May, 70 in one flock on 27 May, c.80 in three flocks on 3 June, 91 on many occasions from June to Oct, including 23 Aug; 35 on 15 Nov. Not seen again until 18-19 in mid-Jan 1981; then not seen in Feb 1981.

Ashburton: Scattered sightings of varying numbers, flocks not settling except at Hinds and Eiffelton. Three on 30 March, 2 on 1 April, c.17 on 6 April, 8 following a plough on 2 July; all in different localities. On 16 Aug, 5 and 11 near Hinds, and on 23 Aug two flocks of 5 near Hinds, 11 at Eiffelton, and 3 at Rangitata Huts.

South Canterbury (Timaru district): Washdyke, 3 on 23 Aug. Otipua,

8 on 23 Aug. Clandeboye, 19 on 23 Aug; went in late Oct but 3 nearby on 20 Nov. Kingsdown, 13 on 23 Aug, 24 on 21 Nov, 16 on 27 Nov. According to farmer, 11 had been present in 1979.

(P. M. Sagar, W. Mawson, M. Lane, P. A. G. Howell *et al.*)

OTAGO

Two favoured localities developed, one about Berwick and the southern Taieri Plain, the other east and south of Balclutha; perhaps a third, in the Oamaru district.

1978

Waitopeka, south of Balclutha, 1 in late Aug. Chaslunds, 3 in May-June.

1979

Owaka, 3 on 25 Aug. Berwick, reported by farmer to be present all of June; 12 on 2 July, 13 on 3 July, 11 on 18 Aug, 13 on 25 Aug, 14 on 6 Sep, 13 on 13 Dec. Balclutha, small flocks of up to 9 in several midwinter weeks when birds had been flooded out of Berwick district; none found on 25-26 Aug.

1980

Otago Peninsula, 1 at Harrington Point on 12 April. Oamaru, 28 on 23 Aug. Two, 23 km north of Oamaru on 7 Sep. Maheno, south of Oamaru, 3 in July and Aug. Balclutha: Stirling, 9 on 15 Jan, 12 on 29 March; Kaitangata, 9 on 23 Aug; Paretai, 4 on 23 Aug. Owaka, 8 on 23 Aug.

Central Otago, 1-2 reported at Edievale in early May; Alexandra, 6 at Earnsclough on 14 June, 1 on 21 June (ground now frosted); farmer said 2 arrived on 22 May and 4 on 9-10 June.

(M. R. Foord, P. Child)

SOUTHLAND

Little set pattern was discernible from year to year in that birds tended to return to same general areas rather than precise farms. Notable stragglers on arrival were birds at Puysegur Point lighthouse, Stewart Island hotel, and the Penrod oil rig well away south of land. One wonders how many perish at sea, missing their landfall.

1978

Haldane estuary, 2 on 24-25 Nov; according to farmer, 3 present most of winter. Ones and twos reported between 2 and 15 May at Glencoe (Hedgehope), Kennington, Waimahaka, Tuatapere, and Invercargill (near Kew Hospital).

On 26-27 Aug, 11 at Gummies Bush (Riverton), 2 at the borstal farm (Invercargill), 5 in Seward Downs/Gorge Road district, 1 in Maitaia district, and 3 at Wyndham. In Sep, 20 arrived at Edendale, confirmed on 27 Sep. Te Anau, 5 on 4 Dec.

Penrod oil rig: One bird sent ashore in poor state from the rig, which

was some 280 km south-east of Stewart Island, on 13 April; it had been on the rig for 3 days before capture. A year before, on 30 April 1977, a bird was sent ashore very weak from the rig, then some 120 km offshore. Both birds died.

1979

On 25-26 Aug, 4 at Gummies Bush, 1 at Balfour, 17 at Wyndham, and 7 at Invercargill. Arrival dates and other information not recorded.

1980

Strong influx recorded in second half of April: Mataura Island, 1 on 9 April; Wyndham, 7 on 13 April; Otatara, 1 on 17 April, 3 on 4 May; Ohai, 2 on 24 April; Lorneville, 3 on 26 April; Charlton (Gore), 13 on 26 April; Te Anau, 5 on 26 April, 7 on 27 April, up to 13 from then to 26 May; Manapouri, 3 on 28 April; Tuatapere, 11 on 1 May.

On 27-28 Aug, 21 at Wyndham, 6 at Gorge Road, and 6 at Otatara.

Puyssegur Point lighthouse farm, Preservation Inlet: One on 16 April (seen to shelter under a cow when attacked by a NZ falcon). In this same place in 1973, one was present in last week of April and first week of May (P. Daniels).

Stewart Island (Halfmoon Bay), 9 on 16 April (1 dead), 7 in May, favouring lawns about the hotel and post office. Three seen at similar time in last two years (R. Thomas, ranger).

(R. R. Sutton, K. Morrison)

MOVEMENTS

Distribution

Figures 1-3 show where the birds were in late August of the three years. For the most part, they were in the same localities as in 1977 (and previous years), merely the numbers changing. The attachment of the egrets to traditional places was strong and no less remarkable than the development of such traditions in little more than a decade of migration. Usually the birds returned to the same farm or neighbouring farms year after year, sometimes after an absence of one or two years during years of lower numbers. Even when a locality was abandoned as an all-winter site, some birds returned to it early in the season, sometimes for just a few days. Yet most districts had huge areas of apparently equally suitable agricultural land available, which the birds ignored except in passing on first arrival. For example, in all the rich dairy-farming land of the Waikato, the birds have remained faithful to a few farms in the Rangiriri district, and in the equally rich farmland of Taranaki, which was a prominent landfall for them, only a few stayed on at Waitara, Normanby and Nukumarau.

Some changes did occur, however, in distribution after 1977. One was the break with tradition that saw Aka Aka abandoned as a regular site in Waikato and several sites near Palmerston North abandoned in favour of the Foxton district. Another was the growth

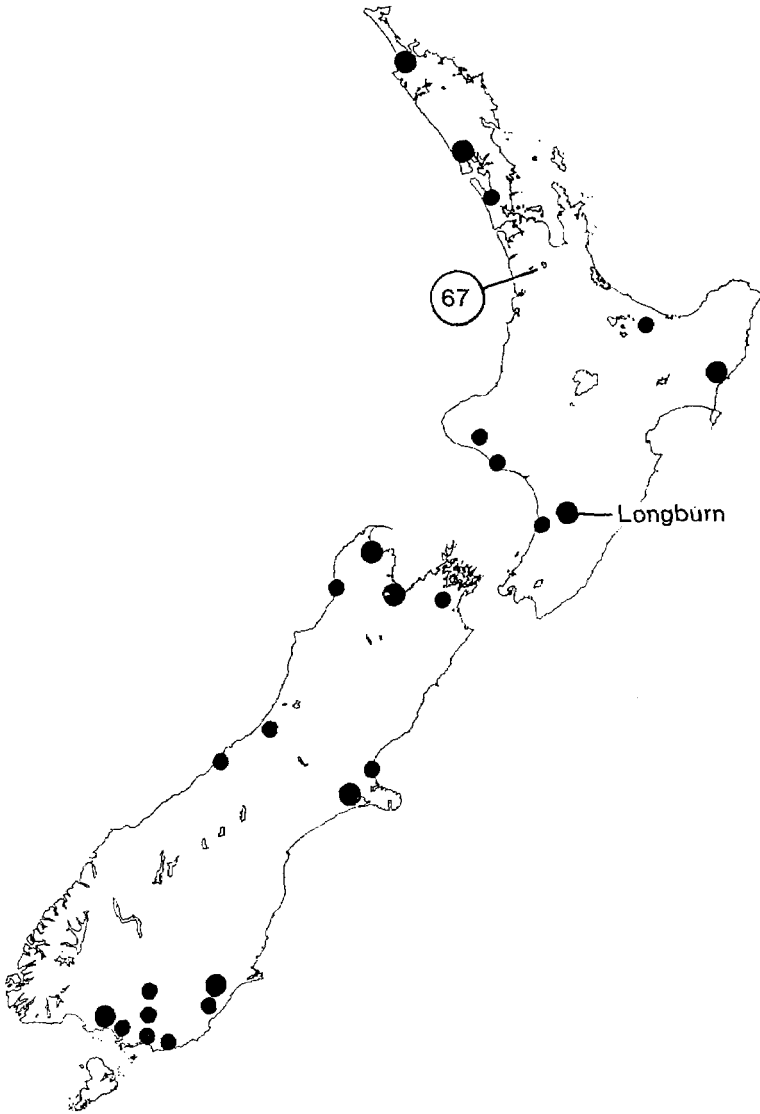


FIGURE 1 — Distribution of Cattle Egrets in late August 1978. Key as in Fig. 2.

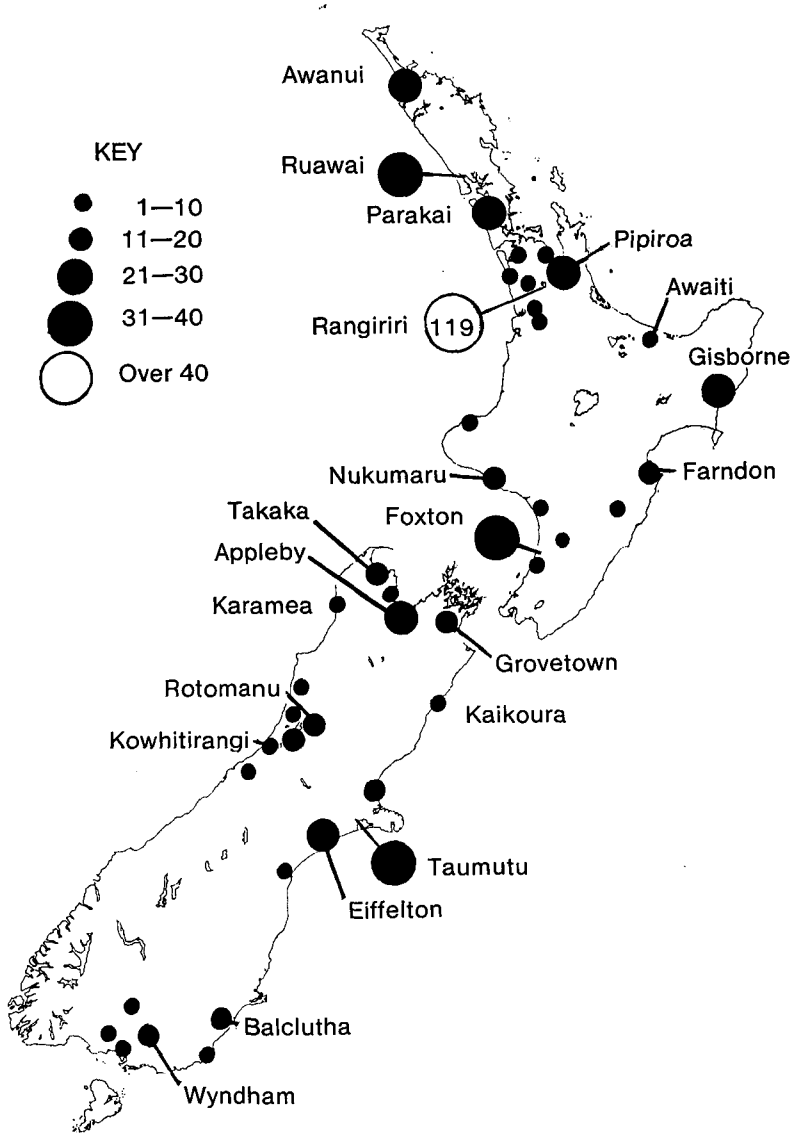


FIGURE 2 — Distribution of Cattle Egrets in late August 1979

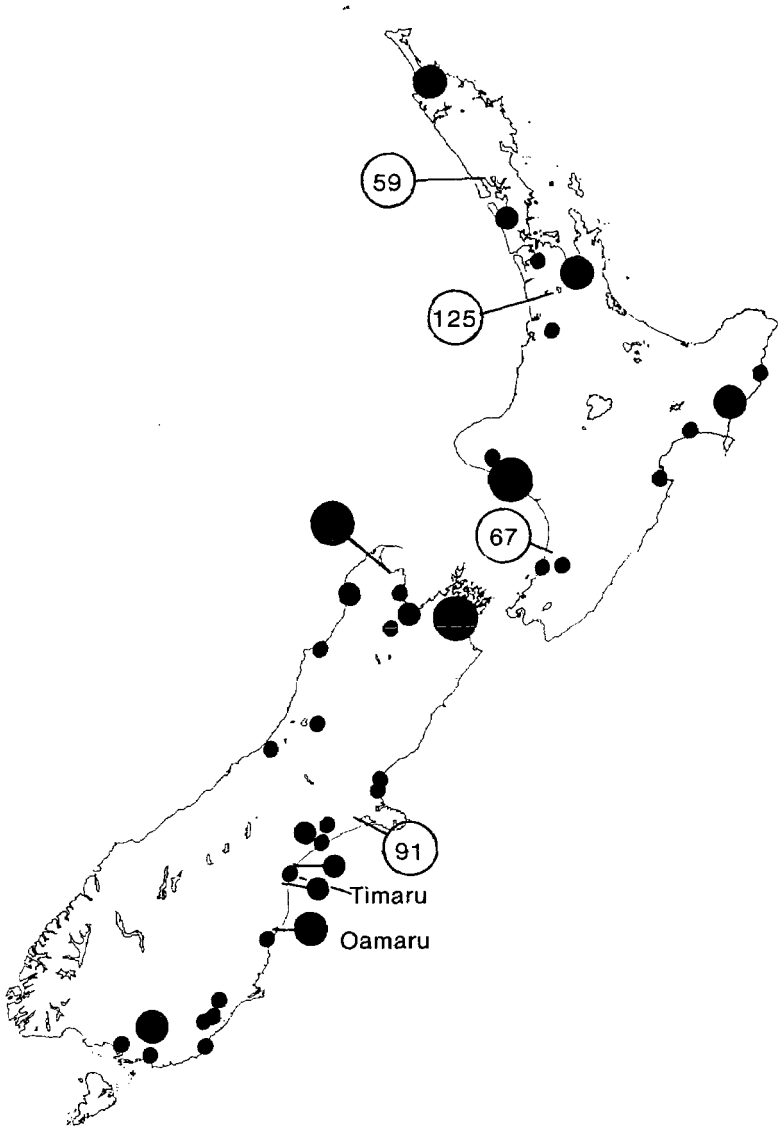


FIGURE 3 — Distribution of Cattle Egrets in late August 1980. Key as in Fig. 2

of numbers in the eastern South Island with important new sites near Ashburton, Timaru, Oamaru and Berwick/Balclutha, whereas the eastern North Island apart from Gisborne, in spite of its agricultural landscape, continued to be largely ignored. In Southland and on the West Coast, the egrets continued to be in widely spaced small flocks, but elsewhere the demands for the company of others of the species and for traditional places seemed to outweigh the wide choice of habitat.

Migration

Whereas in 1977 we could only assume (Heather 1978: 226) that the egrets were migrating from and to Australia, migration is now certain. The birds have a regular pattern of arrival and departure, coinciding with movements in eastern Australia (Morris 1979), arrival especially being prominent, widespread on the west, and in places where the birds do not stay, including some unexpected places such as far to sea south of New Zealand. A bird with a bright metal band was seen for several days in Southland in early April 1981, and no birds have been banded in New Zealand. Several were beach-wrecked on western coasts in the arrival period, including one that had been banded as a chick in New South Wales 4 months earlier. The birds then gradually assembled in traditional wintering places, where they remained for some 4 months. Although most had gone by mid-November, a surprising number stayed through to December, and some overwintered in New Zealand each year. Breeding in New Zealand is not known and there is no evidence to suggest that it has occurred.

Arrival times

Figures 4 and 5 show the recorded dates of arrival of Cattle Egrets in 1979 and 1980, divided into April and early May. Although the first birds arrived in late March and the first half of April (e.g. South Taranaki and Marlborough 1980), the obvious influx occurred in the second half of April and the first week of May. See especially Taranaki and West Coast in 1979 and Southland in 1980. Two of the three beach-washed birds were found fresh on 5 April (Dargaville) and 4 May (Kawhia). Landfall seemed to be haphazard and to occur anywhere on western coasts from Aupori Peninsula in the far north to Ross in southern Westland, except in Fiordland, where birds presumably flew over the forested ranges and landed at the first pasture they met, from Te Anau, Tuatapere and Puysegur Point to Stewart Island, stragglers being perhaps lost at sea south of Stewart Island. April birds seemed to arrive piecemeal, in ones and twos and small parties rather than as major flocks.

On arrival, many birds spent several weeks at or near the places of arrival and then moved on, as happened in North Taranaki in 1979. Some, however, must have moved promptly to familiar ground because April birds were sometimes recorded in eastern localities (e.g. Gisborne and Wairarapa 1979, Marlborough 1980 and Canterbury in all three years). Even though the early influx was sometimes con-

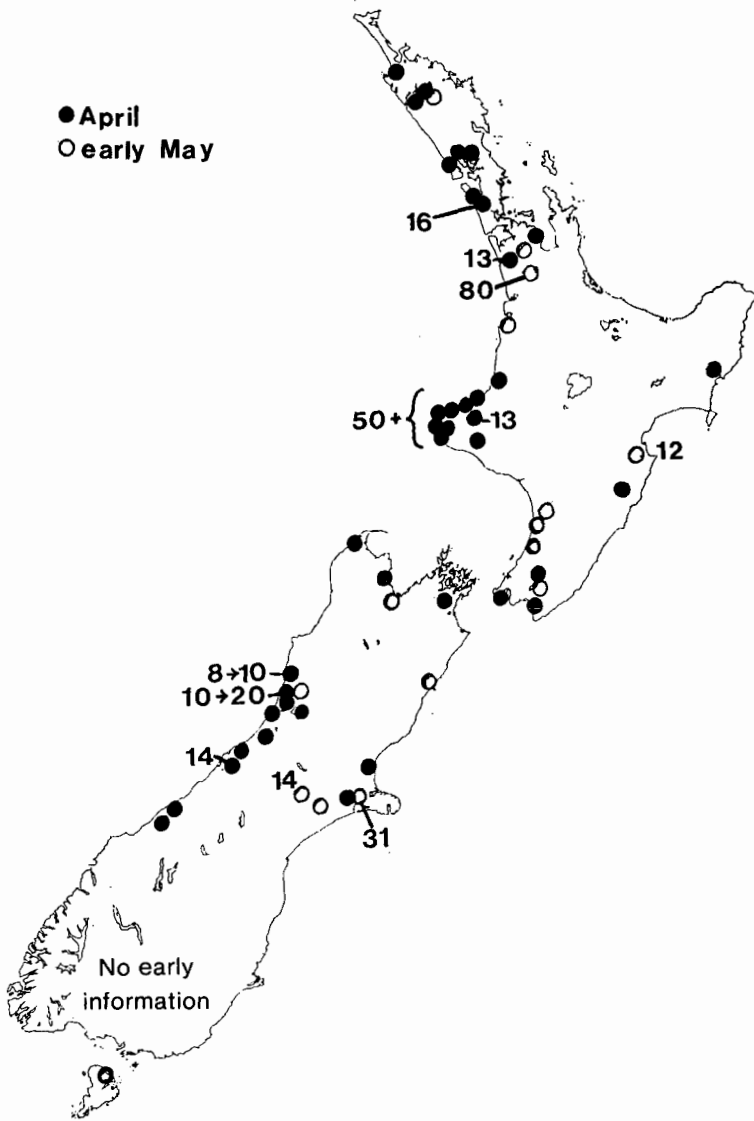


FIGURE 4 — Recorded places of arrival, April and early May 1979. Numbers are less than 10 unless given

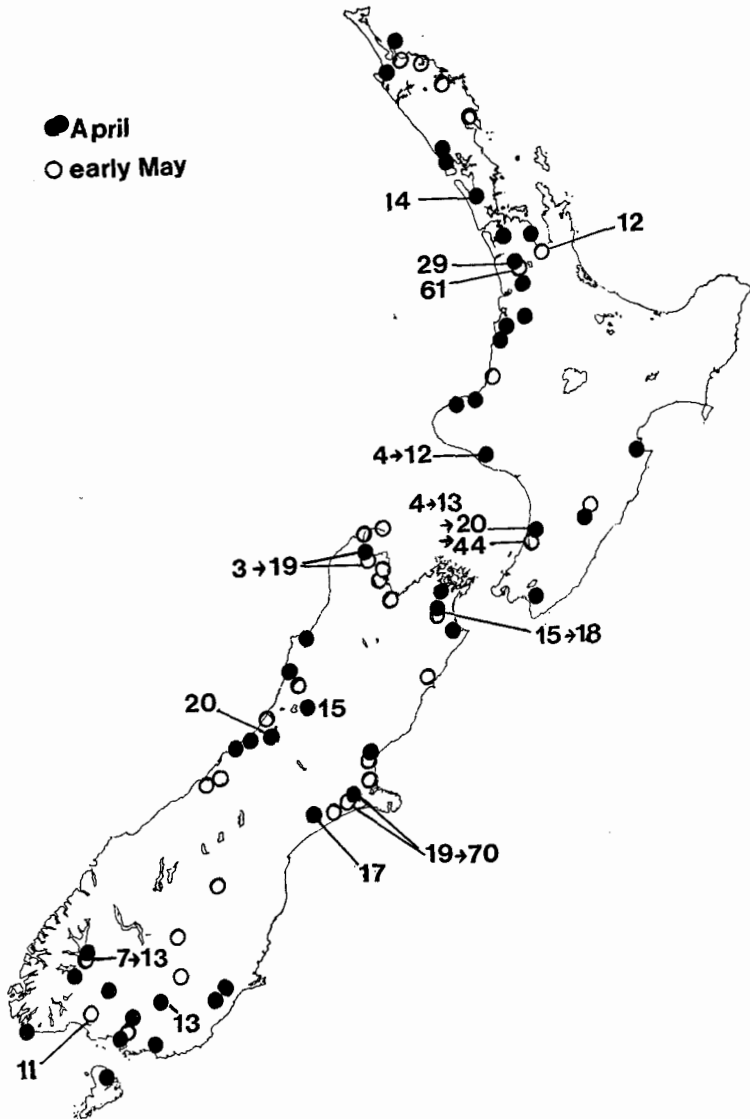


FIGURE 5 — Recorded places of arrival, April and early May 1980. Numbers are less than 10 unless given

spicuous, the numbers involved were far short of the numbers that did arrive, and so birds probably kept arriving throughout May and into June. Numbers kept rising at traditional localities until at least early June and often much later (e.g. Rangiriri in 1979 and 1980), and the third fresh beach-washed bird was found (Muriwai) on 26 May.

The records show that at first most birds were widely scattered and moving about, and so changes in numbers during May and June may have been due to a continued arrival of immigrants, to movement within New Zealand, or to both. This uncertainty obscures the full period of migration from Australia.

Departure

Enthusiasm for recording the egret flocks often waned after the late-August count weekends, and so the period of departure, which lacks the drama of arrival, cannot be clearly defined. In some places, the flocks remained more or less unchanged through winter and into spring from a peak in late May (e.g. Awanui 1978, Waitara 1979) or even in late April (e.g. Parakai 1979). However, in most major sites in most years, the flocks did not reach full size until well into June or even in July. As in 1977, July-September flocks were stable, minor fluctuations being attributable to some local wandering and to the difficulty of counting large flocks of egrets feeding among cattle or sheep, often among clumps of rushes and in hollows and ditches. Sometimes, flocks diminished or disappeared as early as September (e.g. Waitara 1979) but sometimes northern flocks increased in October (e.g. Awanui and Dargaville 1980, Pipiroa 1979), and so early movements may not have been migratory, especially as few birds were in breeding plumage by late September.

Table 2 shows localities where times of departure were noted with fair or full accuracy. It confirms the impressions of 1977 (Heather 1978) that departure was piecemeal and largely from mid-October to mid-November. This seems to accord well with the time of northward passage through inland New South Wales, given by Morris (1979) as "during October-November," and it would allow ample time for breeding in northern New South Wales and southern Queensland (see also Pratt 1979).

In two places where on-the-spot observers kept notes (Nukumaru and Eiffelton 1979), the birds showed the premigratory restlessness (*Zugunruhe*) typical of migratory birds, the whole flock disappearing for days on end, reappearing, and disappearing again, several times. Thus, when observers visit a site on a weekend in the likely departure period and see no birds, the birds may or may not have gone. For example, the last 12 birds at Foxton No. 1 lake in 1980 were last seen on 27 Nov, but at Lake Horowhenua, some 20 km further south, where 5 birds had wintered, the number rose to 11 on 30 Nov and 12 on 1 Dec. These may have been some of the same birds.

TABLE 2 — Recorded times of departure. None was seen after each final date

Place	Midwinter number	Final dates
Awanui 1978	14	14 still on 4 Nov 5 still on 5 Nov
1980	30	39 on 10 Nov 5 on 15 Nov
Rangiriri 1978	67	25+ still on 5 Nov 6 still on 18 Nov
Waitara 1979	9	12 on 19 Sept; all gone on 23 Sept
Nukumarū 1979	15	All left between 10 & 18 Nov
Longburn 1978	16	13 still on 10 Nov; left before Dec
Foxton No.1 1979	31	25 still on 29 Oct 19 still on 11 Nov
1980	60	Down to 12 between 12 Oct & 20 Nov
Appleby 1978	20	All last seen 15 Nov
1979	24	All last seen 11 Nov
Eiffelton 1979		
Farm (a)	10	All left 21 Oct
Farm (b)	14	14 up to 4 Nov 6 still on 15 Nov
Taumutu 1979	36	Dropped during Sept & Oct. Last left by mid-Nov
1980	91 max	35 still on 15 Nov
Grovetown 1980	32	29 on 3 Nov 16 on 6 Nov 11 on 10 Nov 5 on 25 Nov

Oversummering

Even less clear was the fate of birds still in New Zealand in late November and in December. It is tempting to assume that these birds were immature and migrated late, joining Australian breeding colonies without breeding. Many may well have done so because few were recorded in January-February. However, this simple picture is spoilt by some flocks that remained undiminished well into December at a few sites that were traditional and so could not have been occupied by immature birds only. For example, at Parakai the flock of 8 in 1978 was still there on 24 December and the flock of 22 in 1979 was still there on 20 December, and yet 1 in Jan/Feb 1980 was the only bird seen until late April each year. In Otago, the Berwick flock of 13 was seen up to 13 Dec and 9 were near Balclutha in mid-January. At Taumutu, 18-19 were seen once in mid-January, but these could have been non-breeding remnants of the 1980 flock of 91 birds.

In 1977/78 only three egrets were known positively to have oversummered and few were seen after mid-November. Although the number seen after mid-November was greater each successive year, very few were seen in Jan/Feb, and so few may really have oversummered. The three districts where summer birds were seen most were South Auckland/Waikato (Miranda, Pipiroa, Meremere, Raglan), Foxton (Manawatu River estuary), and Ellesmere (Taumutu). These are the districts where breeding has most been expected but where none is known to have occurred. As far as I am aware, all birds that oversummered went through a period of breeding plumage.

An earlier record of summering was given to D. A. Lawrie and A. Habraken by Mr Spicer, a farmer near Rangiriri, Waikato, of three birds in breeding plumage that stayed with his sheep throughout the summer of 1976/77.

BEHAVIOUR

In New Zealand, the egrets are notoriously hard to approach, even by car, and the following statement by Baker (1929) about them in India is inconceivable to us: "They are extraordinarily tame, allowing people to pass within a few feet without moving and then merely flapping lazily away or stalking solemnly off for a few yards before recommencing to feed." Perhaps higher populations of people and egrets than in New Zealand encourage such behaviour. Because of the birds' volatile nature, attempts to study their behaviour have often been frustrated and we can only make a few generalisations here.

The Cattle Egret's association with cattle and other animals is in New Zealand conventional rather than necessary. They associate loosely with cattle of any breed, both dairy and beef stock; almost as often with sheep, both with and without lambs; and are also recorded with pigs, farm deer, domestic geese, and even poultry. They often feed among these animals, moving about the fields with them, but they seldom really follow individual animals, looking for disturbed insects,

and they are just as likely to be on adjacent paddocks without stock. They are often on wet pasture among White-faced Herons (*Ardea novaehollandiae*), Black-backed Gulls (*Larus dominicanus*) and Black-billed Gulls (*L. bulleri*) and, by casual association, Spur-winged Plovers (*Vanellus miles*), Pied Stilts (*Himantopus h. leucocephalus*), and sometimes Pukekos (*Porphyrio p. melanotus*) and Black Swans (*Cygnus atratus*). On one occasion near Ashburton, eight were seen following the plough, together with Black-backed Gulls. If a lake or estuary is near a favoured farm, the birds sometimes resort to its margins, as at Lakes Whangape, Waikato (Nukumaru), Horowhenua and Ellesmere and estuaries at Napier and Foxton. The attachment to individual farms or neighbouring farms from year to year has remained a strong characteristic, and locality seems to be more important to most birds even than cattle or other animals.

South African studies have made clear that the Cattle Egret adapts readily to whatever food is locally and seasonally abundant and that its diet reflects what is available rather than any overall preferences. For example, in south-western Cape Province (Siegfried 1971b), insects were the main food, especially grasshoppers and caterpillars, and these were also fed to nestlings; but in the wet season (April to October), earthworms were the main food. In New Zealand, whenever I have been able to watch egrets feeding (lower North Island), they have been taking earthworms from damp pasture and especially in hollows and ditches. However, this is not likely to be universal, especially in dry conditions, and they will take whatever invertebrates are available, and sometimes even mice, frogs and small birds.

Some unusual feeding was noted by Marion Lane on several farms near Eiffelton in the Ashburton district. On one farm, five egrets associated with free-ranging farm geese and fowls (both with white plumage) and often fed together. Geese, fowls and egrets would start the day by gathering at two large grain-storage silos, feeding on the loose barley grain on the ground around the silos. During the day they would move about the farm together, and late in the day they would return to feed at the silos, before going to roost.

On another farm, eight egrets were regularly seen pecking at bales of lucerne hay and pea straw stored in the paddock. Whenever bales were being fed out to the sheep, the egrets would come with the sheep, often riding on their backs. As soon as the straw was dropped, the egrets would be among it, scratching at and shaking it, searching for the peas.

In the Canterbury winter, few invertebrates were likely to be in this plant material, but, as usual, the egrets were too unapproachable for their food to be seen with absolute certainty. This apparent feeding on grain and seed may have been acquired from the egrets' associate animals; if so, it is remarkable in that I am not aware of any mention in literature of vegetable matter in the Cattle Egret diet (Palmer 1962, Skead 1966, Siegfried 1971b, 1973, Cramp & Simmons 1977).

PLUMAGE

Racial differences

The Cattle Egret consists of two races. The nominate race, *B. i. ibis*, of Africa, south-western Europe and east to the Persian Gulf and the Caspian Sea, has during this century colonised South and North America, where it is now widespread; it has also been introduced in Hawaii. The eastern race, *B. i. coromandus*, of Asia from Pakistan east to southern Korea and Japan and south to Malaysia and the Philippines, has since the 1940s colonised northern and, later, eastern Australia, from where the New Zealand birds come.

There is a sizeable body of literature on the plumage and moult of the race *ibis*, largely from southern Africa, but little on *coromandus*. Without a good range of study skins, however, or studies of trapped and captive birds like those done in southern Africa, we cannot learn much about the plumage and moult of the birds in New Zealand.

Differences in breeding plumage between the two races are well known. In *ibis*, breeding colour is confined to plumes of the crown, chest and mantle (incorrectly shown as "breeding plumage" of *coromandus* in plate 17 of Falla *et al.* 1979) and is pale ginger-buff. In *coromandus*, however, the breeding colour is much brighter and richer (orange-buff, Baker 1929, Ali & Ripley 1968; more golden or rusty, Vaurie 1965) and more extensive, including the cheeks and throat. In the field the whole head, neck, breast and back look bright rusty orange. This is the plumage which many birds acquire, though often not with full intensity, before they leave New Zealand to breed, and which is seen best on some of the birds that oversummer. In the colonies, a few egrets breed in plumage with very little colour (Pratt 1979: 355), presumably young birds.

Differences in non-breeding plumage have not been described, the literature implying that the two races are alike, apart from measurements. As far as can be told from field observation, however, some differences do seem to exist and may deserve closer study. In *B. i. ibis*, adults of both sexes have a "permanent buffy wash on the head (Siegfried 1971a), expressed by Cramp & Simmons (1977) as "feathers of crown paler than breeding." In addition, males have creamy buff on chest and centre of mantle (e.g. Witherby *et al.* 1943), whereas females are white. Juveniles are like the adult female but their crown also is white, becoming slightly tinged cinnamon at 10 weeks and with a distinct brown forehead and crown at about 5 months (Siegfried 1971a).

In *B. i. coromandus*, as seen in the field in New Zealand, we have not been able to distinguish male from female or juvenile from adult. No birds have a coloured wash on chest and mantle until breeding-plumage colour starts to appear in spring, and so the sexes are alike. On arrival and after shedding any remaining breeding plumage, *all* birds seem to have pure-white heads. Whenever I have

been able to see birds closely and by telescope, this has been so. However, within a month of arrival, that is, by late May, some birds (and by late June probably all birds) have acquired a pale yellowish or straw-coloured wash on forehead and forecrown. This wash is not easily seen with binoculars, except at very close quarters. It is not a patch on the "crown," as described for *ibis*, but is a narrow band from the base of the upper mandible tapering on to the forecrown.

For example, all 13 birds at Kaikoura and Waikuku in late May 1979 had pure-white heads, whereas of two at Lake Horowhenua several days later, one had the forehead-forecrown wash and the other had only a few yellowish feathers in centre forehead; these are traditional wintering sites and so the birds cannot all have been juveniles. In late June 1980, all five birds at Lake Horowhenua had the same forehead-forecrown wash, and on 29 Aug 1978, all 16 near Palmerston North had it, the colour varying in intensity from bird to bird. Thus, all birds seem to follow the same pattern and we cannot tell juvenile from adult.

Another point of interest is that I have yet to see the yellowish upper leg and soles of feet described by all authorities for *ibis* and shown prominently in plate 37 of Cramp & Simmons (1977). Baker (1929, also quoted by Ali & Ripley 1968) said the same of *coromandus* in India. All the birds I have seen closely, some very closely, have had wholly greenish-grey legs, sometimes paler about the 'knees,' and slate-grey feet with black claws.

Visible changes

The only records of normal moult are those of A. Habraken, who on 21/1/80 saw, in a flock of nine that had oversummered at Pipiroa, mid-primary moult in all seven birds that still had some breeding colour and a second-primary gap in one of two all-white birds. At Rangiriri on 26/4/80, he saw some primary moult in only one of 29 birds.

The occasional reports of birds in non-breeding plumage having pinkish bills may perhaps be explained as a rush of blood to the bill, as in the following incident. While M. D. Dennison and BDH were watching two feeding egrets, one of which had a normal yellow bill and one a pinkish-yellow bill, the yellow-billed bird stopped and preened vigorously for several minutes. During the preening, its bill changed to purplish yellow, almost pink. When last seen, perched on a gate, both birds still had pinkish bills. Their yellow facial skin was not affected.

On arrival in late April and May, few birds, no more than 5%, still have traces of breeding colour. During mid-August to early September, colour begins to appear on some 10% of birds, and a few of these develop quite extensive but weak colour. By late September, about half the birds in the flocks are partly coloured, but only a few

are strongly coloured. Thereafter, colour intensifies rapidly in the most advanced birds, but up to half the birds in some flocks remain white throughout October. At this stage, however, with birds starting to depart piecemeal, not necessarily only those in good colour, the proportions of birds in various plumages have little meaning. In November, most remaining birds are well coloured, but a few are still white. The lower photograph on page 114 of Moon (1979) shows part of a flock in flight with birds in a wide range of colour intensity.

In 1979, Juliette Urquhart kept notes on general changes in plumage colour of the seven egrets at Karaka, from July to early November, when the birds left. On 4 Sep, the first colour was seen, a wash on the breast of one bird; by 23 Sep, three birds had breast colour. On 2 Oct, one had a ginger wash on the whole head, the breast and the back, three had coloured wash on breast and back, and three were white, apart from the strip over the bill. By 16 Oct, one was brilliant and with full plumes, four were coloured on head, breast and back, but not brightly, and two were pale. They were still the same on 28 Oct, shortly before departure. The sequence of colour development seemed to be breast, back, and head.

Siegfried (1971a) noted that, in *ibis*, the young growing plumes differ in colour from the older more advanced plumes. "When the plumes first break from their sheaths they are white, only later during their growth do they assume their characteristic buffy colour." This difference may explain the observed rapid intensifying of colour that begins as only a pale ginger wash and why, although many were extensively coloured, so few birds were brilliantly coloured before they left. Relevant here is my observation on 29/8/78 of two in a flock of 16 all-white birds that had prominent breast plumes in sheath protruding as white spikes from among the normal breast feathers. The bases of these plumes were bright blood-red.

THE FUTURE

After small casual beginnings in the mid-1960s, the migration of Cattle Egrets to winter in New Zealand, first noted in 1973, has been a regular event, the numbers growing rapidly to a peak of nearly 800 birds in 1980. This dramatic development of a new migratory habit has not been a steady rise of numbers, however, numbers falling somewhat in 1978, 1981 and 1982. As these fluctuations cannot be related to weather or food supply in New Zealand, it is unfortunate that no general account is available of breeding success and dispersal in eastern Australia for the years of our study. We should continue to record Cattle Egret numbers for publication in the annual Classified Summarised Notes, especially numbers in late August, for comparison with our 1977-1980 figures and in case a comparison with events in Australia does become possible.

Despite expectations, the egrets are not known to have bred in New Zealand, but oversummering birds should be watched in case

some do breed, as two pairs are known to have done in South Australia in 1971 (Parker *et al.* 1979). The birds seem to treat New Zealand as a normal part of their dispersal range from the colonies in south-eastern Queensland and north-eastern New South Wales, which, to judge by the recoveries (late April-September) reported in *Corella* and the annotations in Parker *et al.* (1979), includes New South Wales, Victoria, Tasmania, and South Australia.

Many aspects of the Cattle Egret are worthy of detailed study in New Zealand, for example, non-breeding plumages, moult, plumage changes of overwintering birds, foods and feeding habits, day-to-day habits of flocks, including roosting and behaviour in relation to associate animals.

ACKNOWLEDGEMENTS

I should like to thank the many members of OSNZ whose efforts and enthusiasm made this project as successful as it has been. I hope their interest in Cattle Egrets will not diminish and that we shall learn more, not less, now that nationally co-ordinated counts have been discontinued.

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THE ANNUAL CYCLE OF THE SOOTY SHEARWATER *Puffinus griseus* AT THE SNARES ISLANDS, NEW ZEALAND¹

By JOHN WARHAM, GRAHAM J. WILSON and BRUCE R. KEELEY

ABSTRACT

A study of the Sooty Shearwater was made at the Snares Islands during four summers. The work is based partly on the activities of 31-45 marked pairs in burrows and partly on more general observations. These large, powerful shearwaters (weight 819 g) return in late September and, after a 'scratching-out' period of about a month, part of the population leaves on a prelaying exodus which lasts about two weeks. Laying reaches a peak from 20 to 24 November and incubation takes 53 days, most eggs hatching from 11 to 16 January. No precise nestling periods were obtained, but adults depart on migration from the end of March and most leave by the third week of April. Most chicks leave during the last weeks of April and the first week of May.

Surface-laid eggs are plentiful. They tend to be smaller and narrower than burrow-laid ones and, on average, are laid three days later than those underground. During incubation the male takes the first stint on the egg after the female's brief initial one. Thereafter the stints are of similar length, averaging about 9.4 days for both sexes. Samples of chick weights for their first 40 days are given as well as weights of 500 chicks at the time of banding just before their first flights. Flooding of burrows is the chief overt cause of chick mortality. Differences in timing of breeding at Whero Island and The Snares are discussed. In general, the timing seems to be similar throughout the birds' range from Australasia to the Falklands and Tierra del Fuego, but precise information is very sparse.

INTRODUCTION

The Sooty Shearwater or New Zealand Muttonbird (*Puffinus griseus*) breeds from the Three Kings Islands at 34°S, 172°E to Macquarie Island at 55°S, 159°E. Some still try to breed on headlands of mainland New Zealand despite the attentions of feral cats, stoats and other predators. The chief breeding places, however, are the many islands around Stewart Island and on the Snares Islands. Sooty Shearwaters also nest in small numbers on eight islands off New South Wales and three around Tasmania (Lane & White, in press), often

¹University of Canterbury Snares Islands Expeditions, Paper No. 22.

in association with Short-tailed and/or Wedge-tailed Shearwaters, *P. tenuirostris* and *P. pacificus*. There are also important, though little known, breeding places in southern South America and some also nest at the Falkland Islands.

These are powerful petrels about 500 mm long, wingspan c. 1050 mm, and weighing 819.1 ± 76 g ($n = 299$) at the Snares Islands — bills and claws and, if hand-held, struggle persistently and on release often desert their egg permanently. They are highly sociable often desert their egg often permanently. They are highly sociable summer breeders, laying one egg in a chamber dug at the end of a tunnel in the ground, less often in a rock crevice. As with other petrels, pair-bonds and burrows tend to be retained from year to year.

Sooty Shearwaters are notable transequatorial migrants, and most spend the southern winter in the cool offshore waters of the North Atlantic and North Pacific Oceans.

Detailed biological work on the species was carried out by L. E. Richdale on Whero Islet off the north-east corner of Stewart Island at 47°S, 168°E between 1940 and 1957. His classic account (Richdale 1963) was based on observations of about 500 banded adults and dealt mainly with the post-egg stage of the annual cycle.

Our work at The Snares (48°S, 166°E) was undertaken during four expeditions — 17 January to 13 February 1967, 14 November 1968 to 23 February 1969, 20 November 1969 to 19 February 1970, and 18 November 1970 to 11 March 1971. Further information was collected for us during the 1971/73, 1974/75 and 1976/77 expeditions, particularly by D. S. and C. J. Horning, and these have helped to fill some of the gaps in our observations. Our study covered mainly the early part of the breeding cycle and so largely complements that of Richdale.

METHODS

The shearwater tunnels may be 2-3 metres long, often twisting to avoid tree roots. The occupants are seldom visible from outside and many cannot be reached with the aid of a bent wire. Furthermore, fitting of observation panels to nests (Warham 1966: 193-200) is usually impracticable because of the depths of the chambers and the thick roots. To facilitate inspections, the shorter straighter burrows were selected, and so in this respect ours was a biased sample. Numbered pegs identified the 31-45 burrows in the study.

Study birds were marked with stainless steel leg bands, as were others banded in the hope of recovery overseas. Temporary paint marks on foreheads allowed some individual birds to be identified without handling — their legs were seldom visible. We have no evidence of band loss. Attentiveness at nests was gauged by direct observation of the marked birds and from displacements of fine wire fences set across burrow entrances.

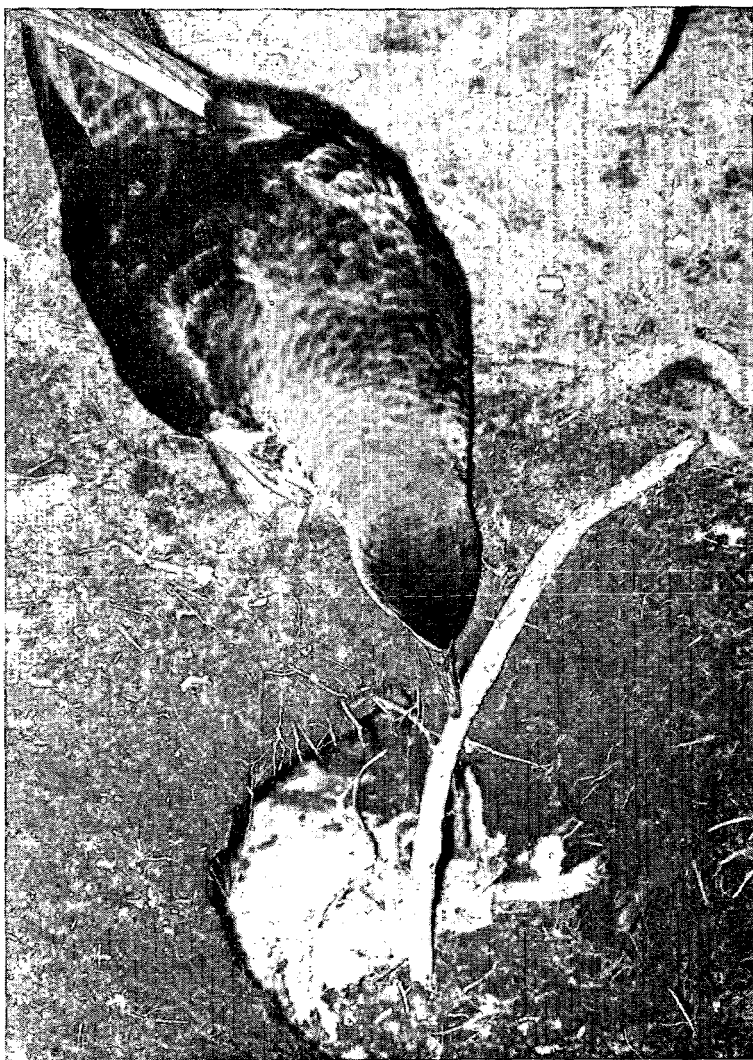


FIGURE 1 — Sooty Shearwater carrying nesting material into burrow.
Photo: John Warham

The shearwaters were sexed by cloacal examination around the time of laying (Serventy 1956) and sometimes by palpating shelled eggs in females but, to reduce nesting failure, examinations and handling were kept to a minimum. Measurements were made with vernier calipers and weights with spring balances, those below 200 g being accurate to ± 1 g, those above 200 g to ± 10 g. Where appropriate, measurements are given ± 1 standard deviation.

THE HABITAT

The Snares consist of Main or North East Island (280 ha) and Broughton Island (48 ha), both with many offlying stacks and islets, and a group of large almost unvegetated rocks known as the Western Chain — for maps see Warham (1967) or Fineran (1969). Main and Broughton Islands are granitic, mostly covered in deep peat and well vegetated. There are no man-introduced vertebrates.

These islands lie in the west-wind zone and experience frequent gales, rain and mists. Only for 1972 do our meteorological data cover a complete year. The 1481 mm of rain that then fell was fairly evenly distributed throughout that year while the mean monthly temperatures ranged from 6.9 °C in June to 13.5 °C in February.

Main and Broughton Islands are largely covered with a forest of *Olearia lyallii* with some admixture, particularly on Broughton, of the tree *Senecio stewartiae*. Both produce almost closed canopies at about 6 m. Outside the tree zone the peat supports lush meadows of tussock grasses, notably the broad-leaved *Poa tennantiana*. Mostly peripheral to these meadows, but interdigitating with them to some extent, are meadows of a narrow-leaved grass *Poa astonii*, which tends to grow in larger stools to 1.5 m high. Another important floral element is *Hebe elliptica*, a tough-stemmed salt-resistant bush growing to about 3 m high and forming dense thickets in some places outside the forest zone. The Snares Islands flora has been described by Fineran (1964, 1969); its geology and soils by Fleming *et al.* (1953), and its birds by Warham (1967) and Horning & Horning (1974).

The Sooty Shearwater is by far the most numerous vertebrate on these islands in the summer. We estimated that they had nearly 3 600 000 burrows on Main and Broughton Islands, which, at an occupation rate of 75%, represents a population of about 2 750 000 pairs (Warham & Wilson 1982).

The birds' effects on the vegetation are very marked. The extensive burrowing honeycombs the peat and undermines the vegetation so that the trees are predisposed to uprooting. Trees with an initial lean become progressively inclined over the years and during severe gales many fall, opening the canopy. Particularly widespread wind-blows occurred twice between 1967 and 1973.

Petrel trampling deters seedlings from becoming established in the forest: they survive mainly where burrow densities are low or

where young plants are protected by logs. The forest floor is bared of dead leaves and small twigs because these are carried underground to line the nest chambers (Fig. 1) and the forest floor comes to 'resemble an extensive poultry run' (Fineran 1964). Among the tussocks these effects are less obvious, though here too there is little leaf litter and the tussock pedestals tend to become unstable owing to the burrowing. Other petrels, e.g. *Pterodroma inexpectata* are also involved, particularly among *Poa astonii*.

Active cropping of the ground vegetation by the shearwaters, which tear off beakfuls of leaves for nest linings, also inhibits plant growth. Presumably seedling trees receive similar treatment.

THE ANNUAL CYCLE

The annual cycle of a typical breeding pair is summarised in Fig. 2. The records of the 1971/73 expedition show that the bulk of the shearwaters returned in the last two weeks of September (Horning & Horning 1974). There was a decline in numbers ashore from late October to mid-November, marking an exodus lasting about 14 days, followed immediately by egg laying. Between 1968 and 1970, two-thirds of the eggs appeared between 20 and 24 November. Incubation took 53 days and two-thirds of the eggs hatched between 11 and 16 January, mean date 13 January. Chick rearing continued until about the third week of April in 1972, by which time the adults had left. Most chicks departed between the last week of April and the first week of May.

From late April to mid-September these shearwaters are mostly absent from New Zealand seas while undertaking their contra-nuptial migrations to the North Pacific Ocean, crossing the Equator in both directions in high-speed flights. They moult on their wintering grounds in the northern summer.

Two recoveries show that Snares Island birds participate in this movement. Z-5609, a male banded on 25 November 1968 and whose partner laid an egg in one of our burrows that summer, which they failed to hatch, died on a Japanese fishing line on 30 March 1970 at 49°09'N, 175°50'W. It had not been recorded ashore in the 1969/70 season, although it could easily have been overlooked that year and have left early, perhaps once again as a failed breeder. Z-6848, an adult of unknown status, banded on 13 January 1969, died in a Japanese net on 23 August 1969 at 48°45'N, 175°50'W. Both recoveries were south of the central sector of the Aleutian Chain, an area well known for its concentrations of shearwaters (Shuntov 1974).

The prebreeding component of the shearwater population is omitted from Fig. 2. We learnt little about these birds as it was not until 1972 that any chicks were banded. Of 500 fledglings marked that year, at least one was ashore at 3 years old and 13 were resighted in the 1976/77 summer, when 5 years old. None was known to be breeding. Richdale (1963: 76) found one 9-year-old nesting, not

necessarily for the first time. With the better known Short-tailed Shearwater, a few 2-year-olds appear on land for about a month, more 3-year-olds stay for about two months, many 4-year-olds for three months (from egg laying onwards) and the prebreeders 5 to 8 years old arrive with the breeders but leave about a month before them (Serventy *et al.* 1971). By analogy, we would have expected a steady increase in the numbers of prebreeding Sooty Shearwaters until about the end of February with a considerable decline in March as they left on their northwards migration.

We have no information on failed breeders but Richdale (1936: 106) found that these birds usually stopped coming ashore soon after their egg or chick was lost.

Sep.	← a	
Oct.		CLEANING OUT BURROWS
Nov.	← b	PARTIAL EXODUS
		EGGS LAID
Dec.	← c	INCUBATION
Jan.		EGGS HATCH
Feb.		CHICKS
Mar.		REARED
Apr.		PARENTS DEPART
	← d	CHICKS DEPART
May	← e	NO BIRDS
Jun.		ON
Jul.		BREEDING
Aug.		GROUND

FIGURE 2 — The annual cycle of breeding Sooty Shearwaters at The Snares. a — first birds return (8 Sep.); b — first egg laid (16 Nov.); c — last egg laid (2 Dec.); d — last adult seen (1 May); e — last chick seen (25 May)

THE PRELAYING PERIOD

Our information suggests that for most breeding birds approximately eight weeks elapse between arrival about 25 September and the appearance of the egg about 23 November.

The re-occupation was followed in 1972. On 8 September some burrows were found to have been scratched out. On the evening of 11 September a group of about 50 shearwaters was seen overhead; none was seen on the 12th but 'hundreds' on the 15th and 'thousands' on 18 and 19 September, although none had yet been sighted on the ground. By 22 September about 10% of the burrows had been excavated and by the next day most of those on the east coast south of the Biological Station had been dug out. By 28 September the Hornings estimated that only about 1% of the burrows showed no sign of use.

During this re-occupation period many birds stayed in their burrows by day, when some sang briefly. Others could be stimulated to do so by a footfall, but many returned to sea before dawn and the departure chorus was 'deafening.'

A pre-egg stage of nearly two months (Fig. 2) is much longer than the one month estimated by Richdale (1963: 14) but very similar to the length of this stage in *P. tenuirostris*, another transequatorial migrant which makes its first landfall in the last week of September and has a peak of laying from 19 to 21 November (Serventy *et al.* 1971).

Sooty Shearwater activity, as gauged by numbers overhead in the evenings and by singing volume, declined around the beginning of November, although birds were suddenly very numerous on the dark night of 6 November 1972, three days before a new moon. On 14 November that year the Hornings recorded that the muttonbirds had been strangely silent for about two weeks. On the 17th they were back in strength, landing early in the evening, and by the 23rd the Hornings collected 11 surface-laid eggs from a limited area of ground.

Likewise in 1968 we noted a low level of calling and activity on 15 November, a little more on the 16th, a marked increase on the 17th and still more on the 18th when the first egg for that year was found.

Such prelaying exoduses have been reported for a wide range of procellariiforms (Warham 1964). Often the males tend to remain behind but with some species, of which the Short-tailed Shearwater is the best known example, both breeders and prebreeders dramatically desert the nesting islands to return equally abruptly about three weeks later to lay immediately (Serventy *et al.* 1971).

EGG LAYING

Females carrying eggs and with swollen cloacae were handled on the night of 15 November 1968 but the earliest egg seen was on

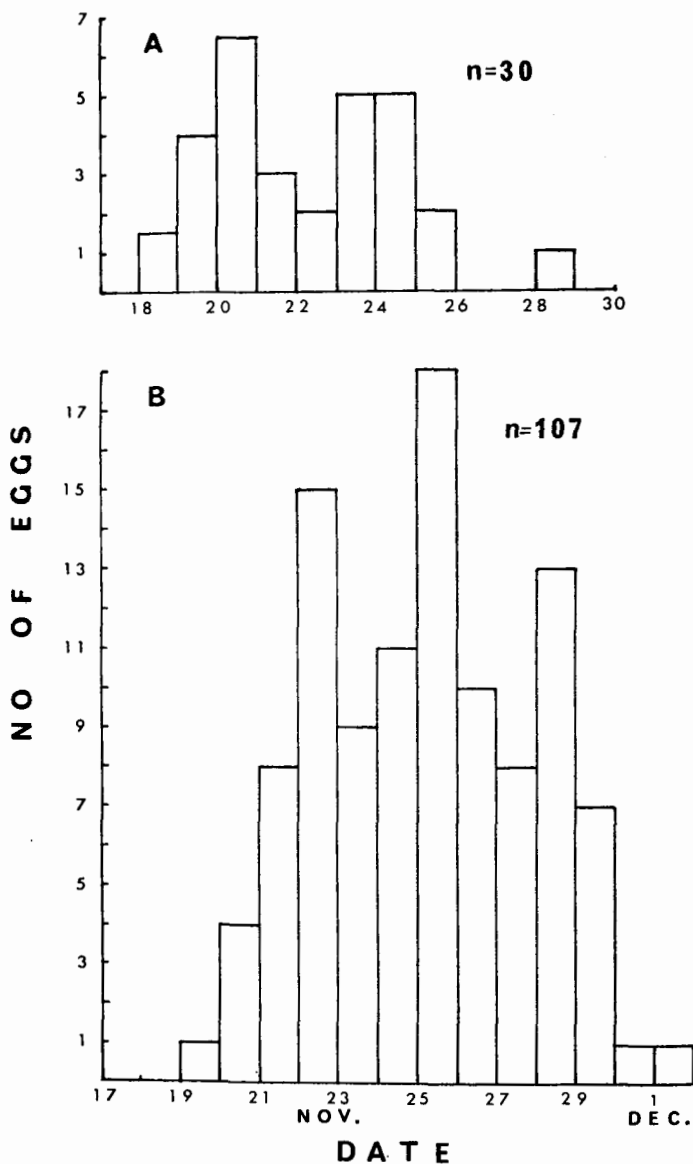


FIGURE 3 — Progress of laying of Sooty Shearwater eggs; A, in burrows; B, on the surface, in 1969 and 1970

17 November 1972. As the last-known laying date was the night of 1/2 December, eggs appeared over at least 18 days. Doubtless there were some earlier and later layings and one bird with a palpable egg was caught on the night of 9 December 1968.

Figure 3A shows the dates of laying of 30 eggs in study nests in 1969 and 1970. In 1969, four burrows already held eggs when we arrived, and their dates of laying have been calculated by subtracting 52.7 days of incubation from their hatching dates (see below). To reduce desertion the nests were examined only once daily, in the morning, and it was assumed that the eggs were laid the previous midnight. The 13 eggs in 1969 were laid on a mean date of 22.7 November and the 17 in 1970 on 21.9 November. The mean date for the whole sample is 22.3 ± 2.4 November, with 66% being laid between 20 and 25 November.

Many eggs were laid on the surface and abandoned and could remain untouched for days before being discovered by gulls or buried by other shearwaters. Such eggs were very obvious on the bare floor of the forest. Fig. 3B shows the dates of laying of 107 surface eggs collected in 1970. They were laid in a 3160 m² low-density area (73 burrows/m²) and in a 2860 m² high-density area (106 burrows/m²), both being within the *Olearia* forest.

The mean dates of laying in the areas of low (25.1 November) and high burrow density (25.3 November) were almost identical, and the mean for the whole sample of 25.23 ± 2.80 November was nearly three days later than the mean for the 30 burrow-laid eggs in 1969 and 1970 of 22.27 ± 2.39 November. The difference is highly significant ($t = 4.870$ and $P < 0.001$), suggesting that birds that laid on the surface did so later than those laying in burrows.

We found no surface eggs in the few areas where the soil was waterlogged or shallow and unburrowed: the birds laid on the surface only where there were occupied burrows. On the other hand we found that such birds were not attracted preferentially to places where nests were most concentrated because in the low-density area 1.84 eggs/m² appeared and in the high-density area 1.92/m² — an insignificant difference of only 4% as against a 45% increase in burrow density.

If the areas we sampled were typical of the 147 ha of forest on Main Island, then some 27 000 eggs were surface-laid there in 1970. Surface eggs were also laid among the tussock but were difficult to find and we did not count them. There is little information on surface-egg numbers for other shearwaters populations. Richdale (1963) recorded the phenomenon in *P. griseus* at Whero Island, but not its extent. Warham (1960) collected 14 eggs of *P. tenuirostris* from 2508 m² of tussock (0.56/100 m²) burrowed at a similar density to our low density area at The Snares.

We believe that some of these surface eggs of *P. griseus* were viable as four out of five showed signs of development after artificial

incubation for 72 hours by Snares Crested Penguins (*Eudyptes robustus*). However, in the only other study we know of to check the viability of surface eggs, Naarding (1980) found that those of *P. tenuirostris* were sterile, whether incubated in an incubator or when exchanged for burrow eggs and incubated naturally. Only on two occasions did we see adult shearwaters incubating surface eggs by day and both soon deserted.

Richdale (1963: 17) calculated that the peak of laying at Taieri Island, Otago, occurred about 29 November in 1943 and, assuming an incubation period of 56 days, found that this agreed with his hatching dates from Whero Island. Using our more precise figure of 53 days' incubation, the mean laying date for Whero Island would be 26 November, some four days later than burrow-laid eggs at The Snares.

EGG SIZE AND SHAPE

In Table 1 the dimensions and shapes of freshly-laid Sooty Shearwater eggs measured at The Snares are summarised. Figures for the statistic length \times breadth squared (both measured in cm) are also given because these provide a useful check on egg size because weight $= k LB^2$, where k is a constant for the species. In the three samples weighed the mean values of k were 0.548, 0.548 and 0.551. Also listed is the mean shape index, $B/L \times 100$, a measure of the roundness of the egg, a sphere having an index of 100. P values are from standard error tests. The eggs were collected throughout the laying period but the burrow eggs did not come from the same nests in 1968/69 and 1969/70 nor was sampling restricted to particular areas.

The table also includes Richdale's figures for Whero Island (Richdale 1963: 19), where few eggs were laid on the surface. He pointed out that if their mean breadth was significantly narrower than those of eggs from burrows, surface layers were probably young birds. Serventy (1967) showed that eggs of Short-tailed Shearwaters breeding for the first time were longer and narrower than those laid by older birds, that mean breadth increased up to the sixth or seventh breeding season and that, in a sample of 52 surface eggs, the mean breadth was significantly less than the mean of a random sample from the burrows. He concluded that the surface eggs were very probably laid by young inexperienced birds.

Our figures for 1968/69 did not fit this pattern, neither mean lengths nor mean breadths being significantly different in the two samples. Rather, the surface eggs averaged slightly larger (higher LB^2), although they were a little longer (lower shape index).

The 1969/70 data conformed with Serventy's findings. The burrow eggs were on average significantly broader, larger and heavier than those from the surface, suggesting that the average breeding experience of those laying on the surface that year was less than that of those with burrows. Maybe the difference between the 1968/69 and 1969/70 samples reflected a changed age-composition in the surface-

TABLE 1 — Dimensions of surface and burrow laid Sooty Shearwater eggs.
 (coefficients of variation in parentheses)
P values show results of tests for differences between means for surface and burrow eggs.

Year	Where laid	n	Length ± 1 S.D. (cm)	Breadth ± 1 S.D. (cm)	LB ² ± 1 S.D.	n	Weight ± 1 S.D. (g)	Mean Shape Index
1968/69	Surface	50	7.69 ± 0.50 (3.94)	4.91 ± 0.17 (3.42)	185.7 ± 14.3 (7.69)	50	101.76 ± 7.99 (7.85)	63.90
	Burrow	55	7.60 ± 0.59 (5.18) n.s.	4.92 ± 0.17 (3.42) n.s.	184.1 ± 17.2 (9.53) n.s.	-	-	64.68
	<u>P</u>							-
1969/70	Surface	81	7.68 ± 0.50 (3.91)	4.88 ± 0.17 (3.48)	185.2 ± 14.8 (8.10)	74	100.38 ± 7.80 (7.77)	63.50
	Burrow	77	7.70 ± 0.29 (3.83) n.s.	5.00 ± 0.13 (2.52) n.s.	192.5 ± 12.7 (6.65) n.s.	52	105.88 ± 7.40 (6.99) <0.001	64.92
	<u>P</u>							-
1972	Surface	100	7.62 ± 0.28 (3.72)	4.95 ± 0.31 (6.33)	185.9 ± 28.4 (15.30)	-	-	64.68
Richdale (1963: 19)	Burrow	72	7.74 ± 0.29 (3.75)	4.83 ± 0.18 (3.73)	180.57	25	95	62.40

layers sampled in those years, the 1969/70 eggs being significantly broader ($P < 0.001$) and bigger ($P < 0.001$), which may mean that there were more old birds or better food in the 1969/70 season.

The mean dimensions of the three samples of surface eggs are not statistically different, but the 1972 eggs were rather variable in breadth. This was unexpected as all were laid before 27 November and the youngest birds, the most likely group to lay very narrow eggs, would be expected to be among the last to lay.

Eggs measured by Richdale were smaller (low LB²) and more elongated (low shape index) than ours. His mean weight of 95 g also seems low but it was based on 25 fresh eggs, not those of his larger sample of 72. If we applied a k value of 0.549, an egg of his mean dimensions would weigh 99 g.

INCUBATION

The roles of the sexes during incubation were difficult to unravel owing to the bird's sensitivity to disturbance. To reduce desertions we examined study burrows every other day and so our data are few and rather imprecise.

Some females left before dawn on the night they laid but others spent one or even two days with their egg before leaving the male to incubate. From 10 nests inspected every two days in 1968/69 the mean length of 32 incubation spans was found to be 9.4 days. Only two of these (3 ± 1 and 4 ± 1 days respectively) were less than eight days long. While some changeovers may have been missed by not making daily inspections, the lack of any two-day stints implies that unrecorded short spells did not occur. Eleven stints by banded males averaged 9.45 ± 1.3 days and 12 by banded females 9.58 ± 2.7 days, and so the lengths of stint by the partners were similar. Changeovers took place at night and only twice were two birds together by day.

We saw little temporary desertion. Eggs left uncovered usually failed to hatch. Several incubating birds fled their burrows during daytime checks. Their partners often resumed incubation one or two nights later, and it seemed that desertion was most likely when the on-duty partner's relief was overdue. Only one temporarily deserted egg hatched: the desertion occurred one week before hatching and lasted one day only. It should not be concluded that Sooty Shearwater eggs are not resistant to chilling: failure to hatch re-incubated eggs seemed to be largely due to the reluctance of the deserting partner to resume duty.

Our meagre data suggest that a typical female put in two, and her mate three long stints, with either in charge of the egg at hatching.

During the 1969/70 and 1970/71 seasons the time between laying and hatching at nine nests, determined to within one day, was 51.5 days for one egg, 52.5 days for five eggs, 53 days for two eggs and 54.5 days for one egg. The mean incubation period was 52.7 days.

HATCHING

Hatching success in the study burrows was low. In 1970 checks were made once daily and 58% of the 19 eggs laid hatched, but in 1971 when checks were made twice daily to get more precise information, only 33% of the 18 eggs laid hatched. These losses were certainly abnormal, a consequence of the disturbance necessary to establish that hatching had occurred. Without better techniques such losses seem inevitable and the effects of disturbance have also been experienced with supposedly insensitive petrels: in the Manx Shearwater (*P. puffinus*), Harris (1966) found that hatching success fell from 78% to 59% owing to handling.

In 1971 the mean date of hatching for seven eggs whose laying dates were known to within eight hours was 14.4 January and the mean date of hatching of 28 eggs laid in 1967, 1970, 1971 and 1972, most of whose dates of laying were known only ± 1 day, was 12.9 January, range 7-18 January. Some eggs doubtless hatched before and after these dates.

We had no evidence that the spread of hatching varied between years, nor did Richdale (1963: 24) find differences between seasons from 257 hatching dates collected over five years. Yet his mean date of hatching was 24.1 January ± 4.2 days, range 16 January to 4 February, some 11 days later than we found at the Snares Islands only some 175 km to the south. This difference is greater than the apparent 4.6 day difference in laying dates between the Snares birds and those calculated for Taieri and Whero Islands. Richdale also thought that a Sooty Shearwater chick he found at The Snares on 13 January 1948 was an early hatching, whereas it was born at the peak of the hatching period found by us.

Seven eggs were closely followed from the time the first crack in the shell appeared. After this, one chick took 5 days, three took 4 days and three took 3 days to break free, the mean time being 3.7 days. From a sample of ten chicks the time elapsing between hatching and loss of egg tooth varied from 5 to 23 days with a mean of 16 days.

THE CHICK

We were unable to follow growth in detail for comparison with the very full particulars provided by Richdale (1963: 26-55) but some new information on the early stages was obtained, partly because we could sex our parent birds, which Richdale did not do.

In 1969 nine chicks were weighed daily from the day they hatched until late February. Table 2 shows the attentiveness of parents for the first 15 days for comparison with Richdale's Table 24 (1963: 47). Our birds showed a greater tendency to stay with their chick by day than his did, for his parents were rarely present after the third

day. A parent was with most of our chicks up to their fifth day and lone parents even stayed ashore with 16- and 21-day-old chicks.

Table 2 also shows the frequency with which the nine chicks were fed. Presumably they had also been given a meal before our first weighing, as found by Richdale. All were fed almost nightly during their first five days and after day 1 received meals, on average, on at least eight of their first 14 days. The incidence of fasting increased as they grew. (The longest time that a chick went without food was seven days.)

The six chicks still alive when weighing ceased at 40 days had not reached the weight plateau that Richdale reported in about the 7th week. Nevertheless, four were above the mean adult weight of 819 g by the time they were 38 days old.

As Richdale found, some 20-30-day-old chicks received gargantuan

TABLE 2 — Attentiveness of Sooty Shearwater parents with chicks 1-15 days old*

Age of chick (days)	Nest no.								
	1	2	3	4	5	6	7	8	9
1	A	A	A	A	A	A	A	A	A
2	NF	F A	F A	F A	F A	F	F A	F	F A
3	F	F A	F A	F A	F	F	?	?A	F A
4	F A	F A	NF	NF	?A	F	F A	F A	F A
5	F A	F A	F A	F A	F A	F A	NF	F	F
6	?A	F	?	NF	F	NF	F A	NF	NF
7	F A	NF	?	F	?	NF	NF	F A	F
8	NF	F	?	F	F A	F A	NF	NF A	F
9	F	NF	F A	NF	NF	NF	F	F	NF
10	F	NF	NF	F	F	NF	NF	F A	NF
11	F	F	?	F	?	F	F	F A	F A
12	F	F	F A	NF	NF	NF	NF	F	NF
13	F	NF	NF A	?	NF	NF	F	F	F A
14	NF	NF	F	?	F	F	F	NF	NF
15	NF	F	NF	?	NF	F	NF	F	F

* c.f. Richdale 1963, Table 24: 47.

F = chick fed since previous day. NF = chick not fed since previous day.

A = adult present by day. ? = not determined if chick fed.

TABLE 3 — Weights of Sooty Shearwater chicks at weekly intervals according to age.

Age (days)	Richdale's 'heavy' chicks ¹			The Snares 1969		
	n	wt (g)	Range (g)	n	wt (g)	Range (g)
1st to 7th	50	115	70-187	42	128	55-240
8th to 14th	54	202	95-321	42	247	130-445
15th to 21st	215	367	147-670	41	380	220-555
22nd to 28th	231	561	245-915	42	515	260-750
29th to 35th	231	617	310-915	39	645	380-880

¹ From Richdale 1963, Table 12.

meals, almost doubling their weight overnight. One 26-day-old chick increased from 460 to 705 g overnight and a 29-day-old from 360 to 715 g. Our chicks grew rather faster during their first 40 days than Richdale's 'heavy' chicks at Whero Island — Table 3.

Table 4 shows the results of day and night inspections of two nests for the chicks' first 36 days of life. At both nests the male was on duty with the newly hatched chick. Thereafter, although either parent came in after dark, there was a tendency for the same bird to visit for two nights in succession. The female at nest 8 was present by day on days 3 and 4 and by night from day 2 to day 6 inclusive. Here and at some other nests the alternate-shift system of incubation seemed to be carried over into the early part of chick rearing, as suggested for *P. tenuirostris* (Serventy 1967: 171). At nest 8 there was some overlapping of parental visits on the night of day 9. Nearly all visits occurred before midnight.

ADULT DEPARTURE

Richdale (1963: 51) established that adult Sooty Shearwaters leave the nesting colonies before their chicks. On average, 58 'heavy' chicks, the only ones that he thought likely to survive, were deserted for 11.9 days, 25 'light' chicks for 21.0 days, the total range being 0-27 days.

We were unable to follow marked chicks but the Hornings' notes for 1972 suggest that by 10 April most adults had left; on that date only about 200 birds took off from a rock used nightly by many thousands earlier in the season. After 29 April no shearwaters were seen overhead at dusk and on 30 April the take-off rocks were almost deserted. The last adult identified that season was seen on 1 May

(not 17 May as stated in Horning & Horning, 1974). This was a bird banded on 17 January 1967.

CHICK DEPARTURE

In 1972 chicks with wisps of down were first seen on the ground on 21 April and such sightings soon became common at night. Chick weighing started on 15 April with birds still in burrows and continued until 7 May with mostly birds from the surface — Table 5. On that date the last 14 chicks were banded after much searching and it appeared that most chicks had gone. Yet some still remained, for many

TABLE 4 — Roles of the sexes in early care of the Sooty Shearwater chick.

Chick's age (days)	Nest 6		Nest 8		Chick's age (days)	Nest 6		Nest 8	
	Day	Night	Day	Night		Day	Night	Day	Night
1	♂	♂	♂	?	19	-	-	-	-
2	-	-*	-	♀	20	-	-	-	♂
3	-	-*	♀	♀	21	-	-	-	♀
4	-	♀	♀	♀	22	-	-*	-	-
5	♀	♀	-	♀	23	-	-	-	-
6	-	-	-	♀	24	-	♀	-	-*
7	-	♀	♀	?	25	-	-*	-	-
8	♀	♀	♀	?*	26	-	-	-	-
9	-	-	-	♂	27	-	-*	-	-
10	-	?	♀	♂	28	-	-	-	-
11	-	?*	♂	?*	29	-	♂	-	-
12	-	-	-	-*	30	-	-	-	-
13	-	♂	-	-	31	-	?*	-	-
14	-	♂	-	♂	32	-	-*	-	♀
15	-	-*	-	-	33	-	♂	-	-*
16	-	-	-	-	34	-	♂	-	-
17	-	♂	-	♀	35	-	-	-	-
18	-	-*	-	-*	36	-	-	-	-*

♂ = male parent with chick; ♀ = female parent with chick; - = no parent with chick; ? = nest not inspected; * = chick fed but no parent seen.

were dead on the ground on 13 May after a heavy rain storm. The last chick seen on 25 May was fat and healthy.

We were unable to follow marked chicks from birth and so gained no precise data on nestling periods. Richdale (1963: 53) gave a mean nestling period of 97 days, range 86-106 days. That period added to our mean hatching date of 14 January gives a mean fledging date of 21 April, range 10 to 30 April. Our chicks seem to have left later than this, perhaps at dates comparable to those at Whero where chick departure peaked on 2 May, range 19 April to 12 May, but our information is not good enough for certainty.

Departure was a gradual process, unlike the hectic pre-dawn exoduses of the adults at the height of the breeding season. Sometimes, in the early morning before dawn, quite large numbers of chicks were spread out across the tussock slopes beating their wings. There was little jostling for position and departure was orderly and rather cryptic. Occasionally chicks still with down on their bodies were seen to land and so not all fledglings got away on their first flight.

Each of the 500 chicks banded at the end of 1972 season was weighed — Table 5. The April chicks were identified by their residual down. Some were caught on the surface, but the earlier samples were mainly of birds from burrows and probably not yet ready to leave and hence weighing more than they would at departure. The samples in May, whose mean weights varied little from night to night, probably included few birds not within two or three days of leaving. Most were now down-free and so a few late adults could have been included in error, although the last known adult was identified on 1 May.

The grand mean for the 500 chicks was 746 ± 176 g, about 91% of the adult mean weight of 819 g. Both weights and proportions are greater than those for Richdale's 'heavy' chicks taken from their burrows the morning before their departure. These averaged 622 ± 100 g. Our samples were more mixed in that many of the chicks would not have left for several days, during which time they would have lost about 30 g daily (Richdale 1963: 52). Similarly, our sample of adult weights, unlike his, were not all known to be of breeding birds. Hence the differences may be more apparent than real.

Another complication is Richdale's finding that the mean weights of departing fledglings varied from year to year owing, he suggested, to variations in the food available to the parents. Stonehouse (1964), in reporting a 'wreck' of young birds in May 1961, also hypothesised that these had fledged underweight as a consequence of food shortage. Lack (1968) wondered whether the sensitive parents could have been put off feeding their young by Richdale's activities, and so weighed less.

The figures in Table 5 do not suggest any decline in fledgling weight towards the end of the season, but the declining proportion of chicks less than 500 g with time suggests either that lightweight nestlings left early and/or that most such had died in their burrows and were

not included in the later samples. Partly as a consequence of the decrease of lighter chicks the variability of the later samples was less.

MORTALITY

We have no precise information on the proportion of chicks that died in their burrows of starvation and other factors. Otherwise, bad weather was the only major cause of mortality on land and this affected chicks only.

Thus on 26 January 1970, after 74 mm of rain overnight, many chicks were on the surface beside flooded burrows. Those alive were cold, wet and almost immobile, although capable of reviving when dried out indoors. The mortality in the areas affected was quite high but no precise counts were made. On 13 May 1972 after 51 mm of rain, dead chicks were again plentiful on the ground. Most were now well feathered and evidently deserted by their parents: again, many succumbed.

Some of the chicks exposed in this way were finally despatched by Southern Skuas (*Stercorarius skua*), particularly during the 1970 flooding, when for the first time significant numbers of skuas were seen below the forest canopy. Far more chicks died of exposure, however, than from skua attack.

TABLE 5 — Mean weights of 500 Sooty Shearwater chicks when banded in 1972.

Date	n	Mean Nt. ± S.D. (g)	Coeff. of Varn.	Range	% weighing < 500 g
pm 15 April	11	852 ± 216	25.4	494 - 1090	18
pm 21 April	31	707 ± 245	34.7	224 - 1415	16
am 23 April	48	709 ± 165	23.5	266 - 990	8
pm 23 April	29	610 ± 122	20.0	351 - 905	14
am 29 April	51	728 ± 168	23.1	422 - 1018	12
pm 29 April	7	704 ± 219	31.1	394 - 1018	29
am 1 May	24	774 ± 211	27.5	468 - 1178	17
pm 3 May	10	761 ± 155	20.4	506 - 921	0
pm 4 May	41	751 ± 151	20.1	402 - 1112	2
pm 5 May	110	781 ± 158	20.2	446 - 1183	3
pm 6 May	124	756 ± 134	17.7	469 - 1122	2
pm 7 May	14	765 ± 111	14.5	583 - 951	0

am = early morning before dawn; pm = after dark but before midnight.

Adult shearwater carcasses were common in skua middens, particularly on the west coast of Main Island, but we do not know if this was from predation or scavenging. We believe that deaths due to skuas were unimportant, as is indicated by the shearwaters' readiness to land in daylight and to leave after dawn despite skuas flying nearby. No skua:shearwater reactions were seen by us. Red-billed Gulls (*Larus novaehollandiae*) also got some eggs and small chicks from shallow burrows around the Boat Harbour where the gulls nest.

A small but steady source of mortality was the Sinkhole, a collapsed cave about 90 m by 30 m and some 30 m deep. Petrels commonly get trapped here and shearwaters were the commonest victims, their high wing-loadings preventing their flying out. On 30 January 1967 six exhausted shearwaters were rescued but 12 newly dead, one weighing 1030 g, were also collected. The total effect of such accidents must be quite minor, and even less important were the few occasions when adults died after being trapped in the branches of trees while trying to land.

Ectoparasites were not known to have caused deaths. About half of the chicks on the surface after the rains of 25 January 1970 carried one or more examples of the large blood-sucking leech *Ornithobdella eduntula*, whose activities could have contributed to the chicks' deaths. This leech was usually attached to the feet and webs, occasionally to the neck. In 1969 ticks were noted on the chicks' feet at about 14 days old, up to five being attached to the webs of one foot. The numbers generally declined as the chick grew. Such infestations varied from year to year and none was found on chicks in the 1971/72 and 1972/73 seasons during careful checks for ectoparasites. The only tick identified from the islands is *Ixodes auritulus zealandicus* Dumbleton.

DISCUSSION

That the Sooty Shearwater deserts its chicks for about 12 days implies that it is under some pressure to begin its long migration. At the end of this it undergoes its post-nuptial moult. Nonetheless, the breeders spend a long time at or around the nesting places. At The Snares the time between the first arriving adult and the last departing chick (8 September to 25 May) spans some 260 days but a typical breeder arriving on 25 September and leaving on 10 April will have spent about 6½ months in the area.

The breeding Short-tailed Shearwater, another migrant to the North Pacific, has a timetable closely paralleling that of the New Zealand bird, typically arriving about 28 September and leaving about 10 April (Serventy 1967).

In comparing the birds at Whero and The Snares, it will be noted that the former were smaller birds and laid smaller eggs. One of several explanations for this could be that the Whero colony included a higher proportion of young birds, which would be expected to lay

smaller eggs and at later dates. Their food supply too may have been less reliable or accessible, and in any case the Whero colony seems not to have been well established and in due course the whole colony was eliminated by Stewart Island Shags *Phalacrocorax carunculatus* (Richdale 1963: 72).

Our information on the timing of the breeding cycle compared with that of Richdale suggests that laying was about four days earlier at The Snares than at Taieri Island and hatching was some 11 days earlier than at Whero, and yet The Snares' chicks appear to have fledged later. As Richdale had no precise dates of laying and we have no precise dates of fledging, the apparent differences may not be real: nevertheless, mean hatching dates do seem to be significantly different. Note that the range of dates for our small sample (7-18 January) lies almost completely outside that of his 257 hatchings (16 January - 4 February). Because it is unlikely that there were differences in the incubation periods at the two sites and no indication that the Whero birds incubated intermittently, it seems probable that they did lay appreciably later than ours at The Snares. Also there are vast high-density colonies there, whereas the Whero colony was small. It could have contained a higher proportion of inexperienced breeders than ours. The small, rather narrow eggs laid on Whero (Table 1) may also be the result of a younger population. Perhaps with less competition for nest sites, and thus less selective pressure to lay early, later laying at Whero would be expected.

Information on the Sooty Shearwater's breeding timetable elsewhere in New Zealand is meagre. Oliver (1955) averred that the patterns are the same throughout the country, apparently following Falla (1934).

We can find very little data for the more northerly populations. According to Sandager (1890), eggs were laid at Mokohinau Island (36°S) from the beginning of December to mid-January, the young left in mid-April and all had gone by the end of May. His laying dates seem very imprecise. A November to early December laying period was deduced for the Alderman Islands' population at 37°S by Sladden & Falla (1927). Eggs were being laid at Hen Island on 28 November 1962 (P. C. Harper, pers. comm.). Further south in Cook Strait, New Zealand Banding Scheme records show that adults were ashore on The Trios by 3 October in 1963 and on Stewart Island (French Pass) by 9 October, with a bird banded on Stephens Island on 1 October that year being recovered off California on 26 August 1965 (Robertson 1972).

At Mangere Island in the Chathams Group (44°S), ten adults were banded on 8 and 10 October 1973, while hatching had been first recorded on 15 January in 1923 (Archey & Lindsay 1924). Elsewhere in the Chathams fresh eggs were being incubated on 1 December 1937, none had hatched that year on 31 December, and the chicks were traditionally harvested in March and April (Fleming 1939).

Further south in Foveaux Strait on Herekopere Island during 1911 and 1912 Guthrie-Smith (1914) found no eggs on 22 September or on 2 October, although on the latter date the birds were calling 'perhaps in hundreds.' This author noted that the Stewart Island mutton-birders believed that all the eggs were laid on 25 November each year. At Cundy Island, also in Foveaux Strait, some eggs were laid by 3 December in 1931, and further south on Solomon Island, the first was found on the night of 28/29 November that year (Wilson 1959).

Filhol (*in* Westerskov 1960) found birds on fresh eggs at Campbell Island (52°S) on 15 November 1874. Sorensen, at the same island, noted birds ashore on 16 October 1959, cleaned-out burrows on 18 October 1942, cleaned-out empty burrows on 30 October 1942 (perhaps during the prelaying exodus?), birds in burrows without eggs on 26 November 1943 and birds incubating on 7 December 1942 (Bailey & Sorensen 1962).

At the most southerly station in the New Zealand region, Macquarie Island (55°S), where the species is not common, our earliest definite record is of a bird in a burrow on 8 October 1960. It lacked a brood patch. On the previous day displacements of fenced entrances to Sooty Shearwater burrows and red faecal splashes nearby showed that the birds had recently arrived (Warham, pers. obs.). As far as it goes this information tends to support Falla's statement that breeding dates at Macquarie Island do not differ from those at places nearer New Zealand, and overall, the information summarised above does suggest that there are no major differences in the timetables of this species around the country despite the small variation between The Snares and Whero Island.

Precise information on the breeding season in Australia is also not available. Rohu (1914) took a bird and egg from a burrow on Broughton Island, NSW, on 29 December 1912. An adult and small chick (43 g) were found in a burrow on Lion Island, NSW, on 2 February 1947 (Keast & McGill 1948). Fullagar (1976) stated that the birds were present at Cabbage Tree Island, NSW (33°S), 'from September' and Lane (1965) and Robinson (1964) found eggs on Bird Island, NSW, and Courts Island, Tasmania, on 12 December 1963 and 28 November 1961 respectively. None of this information suggests any marked deviation in timing from that of the New Zealand populations.

The earliest date for the South American populations appears to be R. H. Beck's record of an irregular but steady southwards flight of Sooty Shearwaters off Cape San Diego (55°S) as early as 6 August 1915 (Humphrey *et al.* 1970) — compare sightings of this shearwater off Bald Head, south-western Australia on 9 August 1973 (Fullagar & van Tets 1976). Beck found well-incubated eggs at Wollaston and Deceit Islands on 28 December 1914 and early January 1915 and 'very hard set' eggs were collected on 22 December at Bayly and Wollaston Islands (Murphy 1936: 670).

Better information is available from the Falkland Islands, to which the birds return by the end of October (Cawkell & Hamilton 1961). Fresh eggs were found on 24 November 1961, adults had gone by 8 April 1961, fully feathered nestlings were in burrows on 16 April 1962 and the last chick was seen on 3 May 1962 (Woods 1975). Woods concluded that the breeders arrive in mid to late October and leave towards the end of March, the fledglings following in the first week of April.

Taken as a whole, therefore, the evidence suggests that the timetables of all these populations are rather similar despite being spread over 25 degrees of latitude and 147 degrees of longitude. The birds too are alike; no subspecies is recognised and it is not possible to separate a South American Sooty Shearwater from an Australasian one on external morphological characters. For example, a sample of 28 live birds measured in the North Atlantic by Brown *et al.* (1981), and presumably of South American origin, weighed 816 ± 87 g — virtually identical with ours from The Snares.

Despite similarities in the annual cycles and breeding of Sooty and Short-tailed Shearwaters, there is one notable difference between them: the former has only a partial but the latter a total prelaying exodus. Serventy (1967) showed that the exodus of Short-tails includes both breeders and the older prebreeders of both sexes. We do not know what categories of the Sooty Shearwaters leave, i.e., whether the females alone are involved, nor how far they go. If the males alone remain, as with petrels such as *Pachyptilla desolata* (Tickell 1962), it is surprising that Main Island was so quiet during the exodus. One obvious advantage of staying would be to allow the males to defend their nests from usurpation by others, and defending shearwaters usually call vigorously before attacking.

Tickell (1962) postulated that the exodus is needed so that the female can feed while making her large egg, which must be a considerable drain on her resources. In small petrels it may weigh more than 25% of the female's body weight; in *P. tenuirostris* and *P. griseus* it represents 16% and 13% of that weight respectively. Using his yolk-marking technique (Grau 1976, Roundybush *et al.* 1979), C. R. Grau has estimated that yolk formation in Buller's Shearwater (*P. bulleri*) takes about 18 days (pers. comm.). This makes even more understandable the need to feed while building the egg. That the females are indeed under stress is suggested by their prompt departure after laying, leaving the males to perform the first long incubation stint.

Large size being more conducive to energy conservation, *griseus* (819 g) may need to feed less than *tenuirostris* (560 g) to acquire the same proportional reserve of energy. Likewise the female *tenuirostris*, although smaller, produces a proportionately larger egg. She may need longer to acquire the necessary energy stores and/or may have to depend on richer and perhaps more distant food supplies

than *griseus*. We do not know how far the average Sooty Shearwater goes for food during the exodus, and we have often seen them feeding close inshore at The Snares (see also Fenwick 1978), but it is known that Short-tails may collect food for their chicks 1600 km from their nests (Serventy 1967). According to Shuntov (1974), these birds penetrate further north into the Bering Sea than do Sooty Shearwaters, and so Short-tails may also favour colder, more distant feeding grounds when nesting.

Another possible reason for the difference in the patterns of exodus in these two birds may be differences in the length of the males' first incubation spans. A Short-tail typically fasts for 12.6 days (Serventy 1967), our Sooty Shearwaters for about 9.5 days. Thus, while the female Sooty Shearwater may need to feed for a full two weeks, and could travel far in that time, a shorter feed in more local waters may suffice for her mate who might also even visit his burrow occasionally and still lay down enough fat to sustain his first incubation stint. The Hornings' observation of a marked increase in night-time activity on 6 November 1972 may have been due to a temporary return of such males. In contrast, the male Short-tailed Shearwaters may have to feed longer to lay down the bigger reserves needed for their longer first fasts on the egg. Naarding (1980) hypothesised that they feed in Antarctic seas on krill concentrations revealed by retreating pack-ice.

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SHORT NOTE

SOUTHERN SKUA IN WELLINGTON HARBOUR

On 26 June at 0830 when off Point Halswell, Wellington Harbour, I saw a Southern Skua (*S. skua lonnbergi*) flying around the ship. The wind was SSW 35-40 knots, and there were heavy passing rain squalls. It is probable that the bad weather had forced the bird into the harbour, where Southern Skuas are rarely seen.

JOHN JENKINS

THE BLACK-WINGED PETREL (*Pterodroma nigripennis*) IN THE SOUTH-WEST PACIFIC AND THE TASMAN SEA

By J. A. F. JENKINS and N. G. CHESHIRE

ABSTRACT

Black-winged Petrels seen since 1959 in the Tasman Sea and between 1970 and 1979 in the South-west Pacific are charted to show their distribution in the region. They are absent from the end of June to the end of October. The limited information on their breeding islands is reviewed and is amplified whenever possible by unpublished data.

Most recording was done from merchant ships on commercial voyages and so observations tend to follow the trade routes. Notable exceptions are the observations to the south-east of New Zealand made during the 1978 Bounty, Antipodes, Auckland, and Snares Islands Expedition; those made by J. A. Bartle and P. Roberts from research vessels; and those made by T. G. Lovegrove on yacht voyages to the north of New Zealand.

The charts (Fig. 2-13) show the highest count of Black-wings seen at one time in any 1° area, that is, an area of 1° of latitude by 1° of longitude (Cheshire 1977). The charts also show, by means of open circles, the areas visited where no Black-wings were seen. Areas not visited are left blank on the charts.

Throughout this report positions are given as, say, 27/176E, meaning that the sighting occurred in 27° South latitude and 176 East longitude. Since all latitudes referred to are South, we have omitted the indicator S.

DISTRIBUTION AT SEA

The Black-winged Petrel is readily attracted to ships and is easily identified. Its reappearance at sea in the South-west Pacific is not as dramatic as that of some other seabirds. They do not seem to arrive in concentrated flocks, as do, for example, Wedge-tailed Shearwaters (*Puffinus pacificus*) (Jenkins 1979), but our observations at sea show that the numbers build up throughout November before large numbers are seen in December. The probable reasons for the December increase are

1. As with other small *Pterodroma* petrels such as *pycrofti* (Bartle 1968), the bulk of the population might consist of unemployed birds. These, probably returning later than the breeding birds, would not

have the same strong attachment to the breeding islands and would quickly spread throughout the region.

2. In mid-December the breeding birds would be at sea, honeymooning, before egg laying. Our observations show that the distribution is widest in December and the numbers at sea in the region are probably higher in December than at any other time.

What information there is strongly suggests that most of the breeding population is back at the islands by the middle of November. The direct return to and subsequent attachment to the breeding islands during November apparently account for the low numbers seen at sea.

Twenty passages have been made between New Zealand and the Pacific islands during October, and as can be seen from Fig. 2, only six birds were seen, one at 27/176E on 22 October 1973 and five north of Raoul Island on 31 October 1979.

The chart for November (Fig. 3) shows increasing numbers north of New Zealand with the birds spreading into the western and southern Tasman Sea.

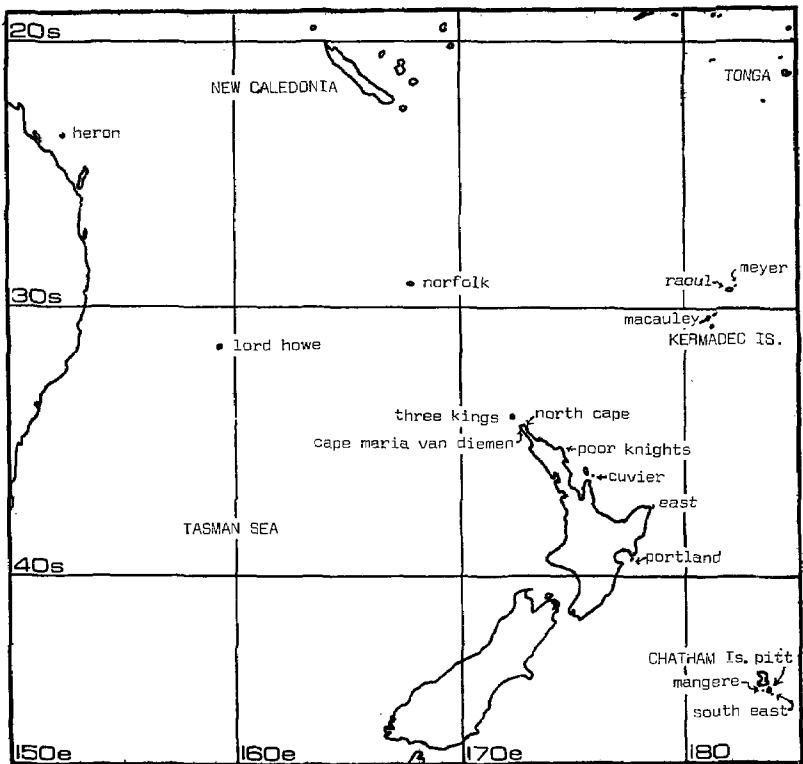


FIGURE 1

Figure 4, the chart for December, shows that most of the population has returned to the region. Numbers have increased and the distribution has broadened. This is the situation throughout January (Fig. 5) and February (Fig. 6), when numbers and distribution remain fairly constant, probably at a level slightly lower than that of December.

The chart for March (Fig. 7) shows a reduction in numbers, probably because the unemployed and failed breeding birds start to leave the region at this time. There is little change in distribution, including birds still in the southern Tasman.

In April (Fig. 8) and May (Fig. 9), numbers are further reduced and the birds apparently withdraw from the western Tasman.

By June (Fig. 10), the birds have completely withdrawn from the Tasman Sea and the New Zealand coast. The few sightings made were all to the north of New Zealand, and the last record for the year was at 24/175E on 28 June 1973.

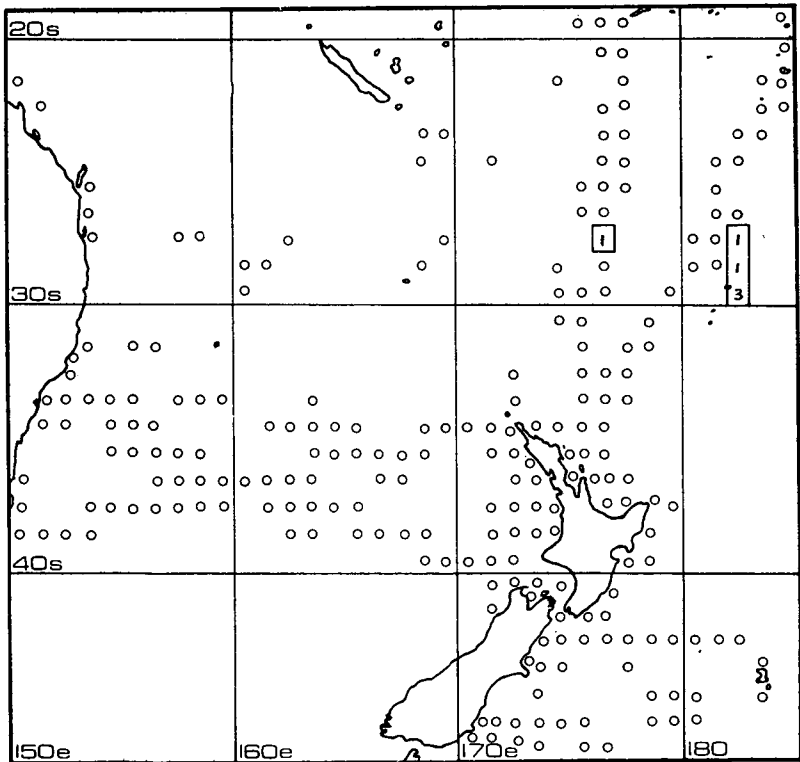


FIGURE 2 — October

As can be seen from Table 1 and Fig. 11-13, although the region was well covered, no Black-winged Petrels were seen during July-September.

MIGRATION

North of New Zealand we have seen a total of 10 birds during June and none anywhere in July-September. The first records for the new breeding season were made towards the end of October, when we have seen six birds. In November, although numbers at sea were low, birds were spread throughout the region. In the Tasman Sea and New Zealand coastal waters the last records were made in May and the birds did not reappear until November.

Of the breeding grounds in the Kermadec Islands Oliver (1955) said that the birds were first heard at night late in October and that burrow cleaning began in November. Merton (1970) reported that "Many thousands were present on Meyer on 19 November 1966, but even greater numbers were apparent in late November and early December." At Macauley Island on 10-22 November 1980, P. J. Moors

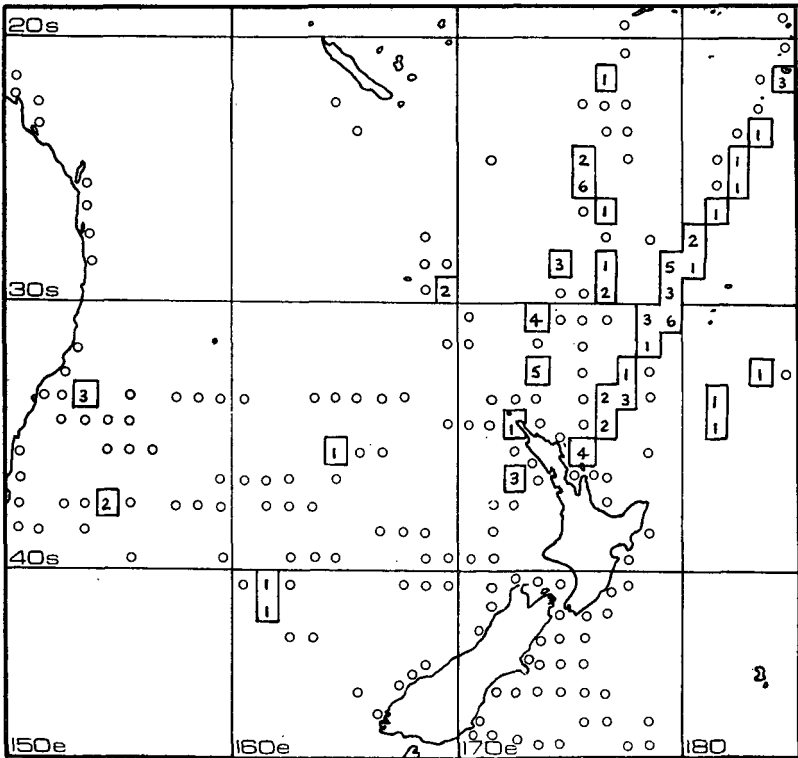


FIGURE 3 — November

TABLE 1 — The number of 1° areas visited in each month and the percentage of areas in which Black-winged Petrels were seen

Month	Number of areas visited	Areas in which Black-winged Petrels seen	
		Number	%
Jan	261	127	48.6
Feb	156	76	48.7
Mar	202	76	37.6
Apr	169	44	26.0
May	196	51	26.0
Jun	180	8	4.4
Jul	281	0	—
Aug	184	0	—
Sep	191	0	—
Oct	233	4	1.7
Nov	213	37	17.4
Dec	233	131	56.2

(pers. comm.) found very large numbers. It seems, therefore, that most of the breeding birds return to their breeding islands during the first two weeks of November.

Since we found few birds away from the Kermadecs in November it appears that the breeding birds return straight to the breeding islands and that the birds we saw elsewhere were wandering non-breeders, possibly the birds that have been reported prospecting new breeding sites around northern New Zealand and many other places in recent years. The direct return of the breeding birds to their islands would seem to be supported by the fact that, of our six October sightings, five were made just north of, or close to, Raoul Island, on one of our rare voyages to the Kermadec Islands.

Our data tell us little of the situation at the Three Kings Islands breeding grounds, but the small numbers of birds seen close to the north of New Zealand in November could well be birds returning to the Three Kings.

In the Central Pacific, King (1970) made the following observations.

“Black-winged Petrel was first observed in the study area on 17 March 1964. Only an occasional bird was seen until May when numbers began to increase. Numbers were fairly stable from May through September but rose sharply in October. A decrease in November to a level somewhat higher than the May-September level was followed

by a sharp reduction in December and January. No birds were seen in the 1965 season until 24 April.

“The bird attained its greatest density in October shortly before, or concurrently with, its reappearance on its breeding ground on the Kermadec Islands. By the time the eggs are laid (December) numbers in the study area were greatly reduced. No birds were seen in the study area from the time of hatching to fledging.”

When we summarise King’s and our own data, as in Table 2, we see that we may be dealing with the same population. A decrease in one area is shortly followed by an increase in the other. The only exception to this was during October, when the first birds were returning to the South-west Pacific but the numbers in King’s area are increasing, not decreasing as might be expected. We suggest that this increase is caused by birds which, having spent the non-breeding season to the north of his area, are passing through on their return to the breeding islands. J. A. Bartle (pers. comm.) has suggested that the

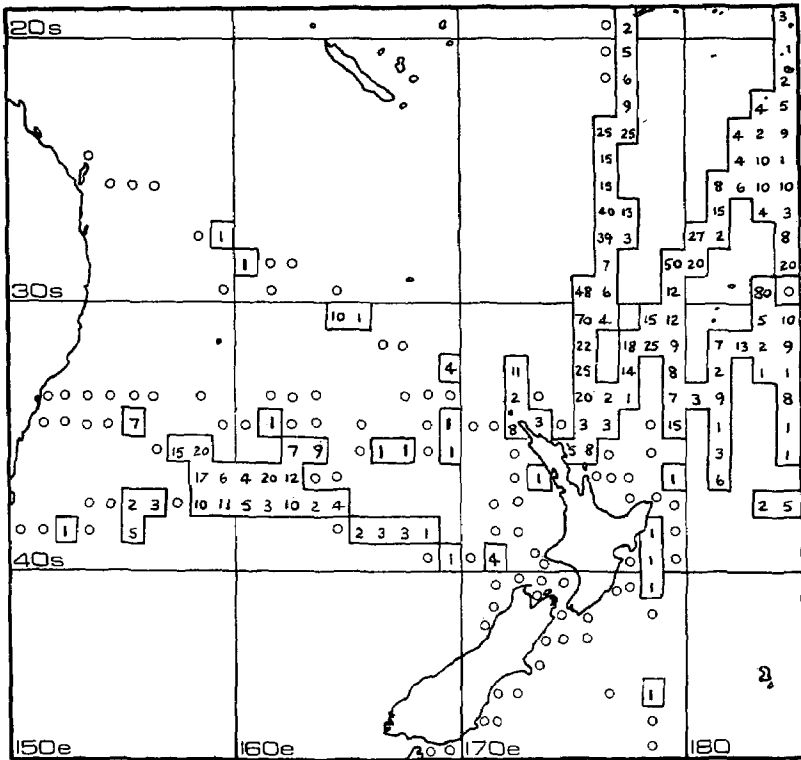


FIGURE 4 — December

TABLE 2 — Comparison of King's (1970) Central Pacific data with that from the South-west Pacific

Month	Central Pacific	South-west Pacific
Mar	None until occasional birds from mid-Mar	Reduction in numbers
Apr May		Reduction and withdrawal
Jun	Increase in May; stable until Sep	Last records for year
Jul Aug Sep		None
Oct	Increase in numbers	First records
Nov	Decrease to May/Sep level	Numbers increasing
Dec Jan	Sharp reduction	Widespread — majority of population present
Feb	None	

October increase in King's area may be accentuated by the birds' flocking and therefore greater conspicuousness before the transequatorial migration.

We can calculate possible times taken by the birds returning from the Central Pacific. Black-winged Petrels can easily fly at 30 knots. In fact the ease with which they overtake ships steaming at 15-18 knots suggests that they reach 40+ knots. From the south of King's area to Raoul Island is about 2600 n. miles. If they made the distance in one uninterrupted flight they would take between three and four days. Thus the increased numbers in the Central Pacific at the end of October could well be the same population as Moors's very large numbers in Macauley on 10 November and Merton's "many thousands" on Meyer Island on 19 November.

BREEDING ISLANDS

Austral Group

Murphy (1929) mentioned "Three specimens from Bass Rock, about 50 miles east by south from Rapa Island, Austral Group, 27 February 1922." Beck in the schooner *France* collected at Bass Rocks (= Marotiri) on that date, and in his journal (Whitney vol. E:98) said that "a small *Pterodroma* was seen half a dozen times and three birds were taken." Black-winged Petrels are so noticeable both at sea and near the breeding islands that "half a dozen" sightings made during a day spent close to the islands can hardly indicate a large,

if any, breeding colony. The *Pacific Islands Pilot* describes Marotiri as "... a group of small islets and several rocks; all are rugged and without vegetation or low lying ground. . . ." Although J. A. Bartle (pers. comm.) has suggested that *nigripennis* may nest in rock crevices, Marotiri hardly appears to be the site for a colony of a burrowing petrel. The Whitney party was unable to land owing to a heavy swell and numerous sharks about their boat. We have not found anything in the literature referring to landings since, and so Black-winged breeding at Marotiri is still doubtful.

At Rapa, Holyoak & Thibault (in press) found 200-300 pairs breeding on offshore islets. It is apparently absent from the main island. In 1974 the first adults were recorded ashore at the beginning of November. The freshly prepared burrows were deserted by 11 December when the birds would be at sea honeymooning before egg-laying.

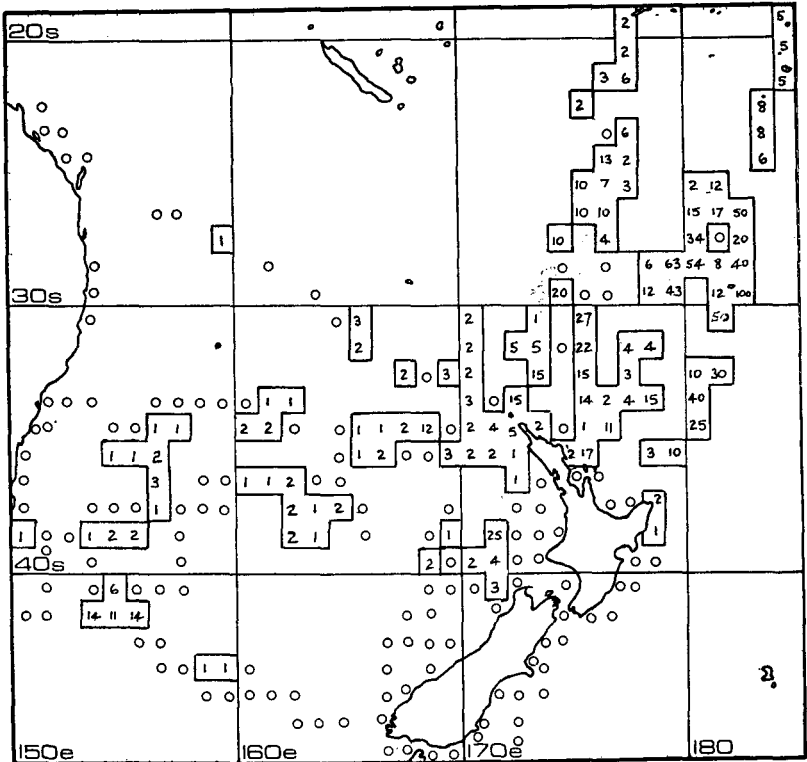


FIGURE 5 — January

Chatham Islands

The Black-winged Petrel was first found on South East Island by the Wanganui Museum Expedition on 6 January 1970, and although this is recorded in the *Annotated Checklist of the Birds of New Zealand* (1970), the discovery has yet to be written up (D. E. Crockett, pers. comm.). Imber (1978) reported that the birds returned to the island on 17 November in 1977, and this appears to be the only time that a definite date of return has been recorded at any island.

The following information is a summary by B. D. Bell (pers. comm.) of the status of the bird in the Chathams. The Black-winged Petrel seems to be focusing on five locations. The first of these is at the summit area of *South East Island*. Black-winged Petrels were first recorded investigating this area in 1970 by D. E. Crockett. Since then all parties that have visited the area at the correct time of the year have recorded activity. Although courtship flights and birds on the ground and in burrows have been observed, regular breeding has not been proved. Breeding is suspected but it is difficult to reach the

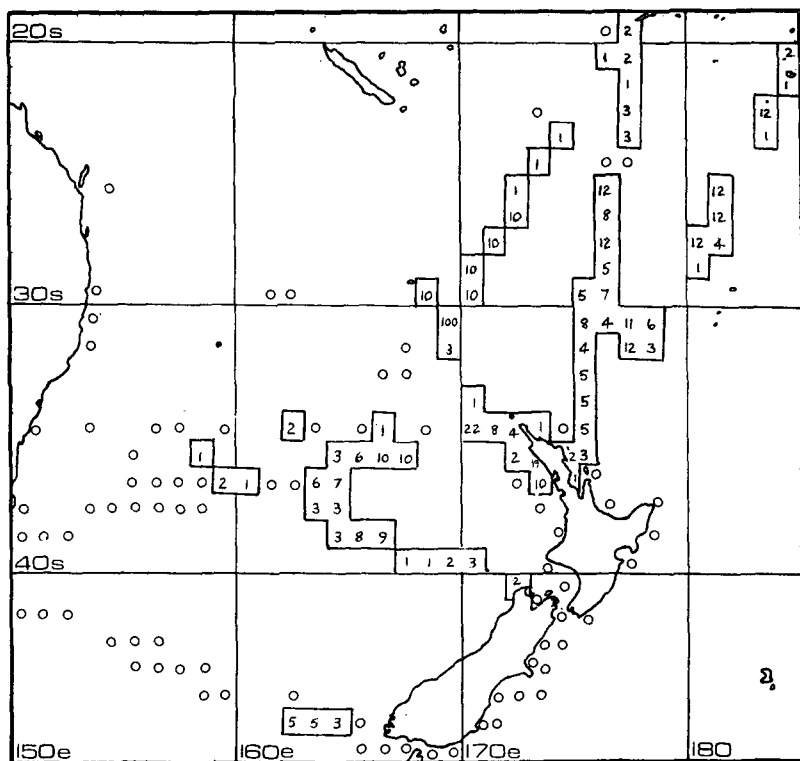


FIGURE 6 — February

burrows because of the steep rocky nature of the terrain and the very tight scrub.

On *Mangere Island* the calls of Black-winged Petrels were first heard in the early 1970s and over the years this has become a feature of the island. The corpses of this petrel first appeared in the skua middens in 1979. Although birds are present during the breeding season, breeding does not appear to have occurred.

The third area is *Rangiauria (Black Rock)* on *Pitt Island*, where prospecting has occurred for at least three years. Heavy predation by cats seems to be preventing colonisation of this outcrop.

The fourth locality is *Star Keys*, where skua-killed remains of two birds, one possibly a juvenile from the previous breeding season, were found in early November 1977. There was no activity of live birds then, but it was subsequently found that they returned to South East Island in mid-November (M. J. Imber 1978 & pers. comm.).

The fifth locality is *Forty Fours Islands*, where a pair of courting

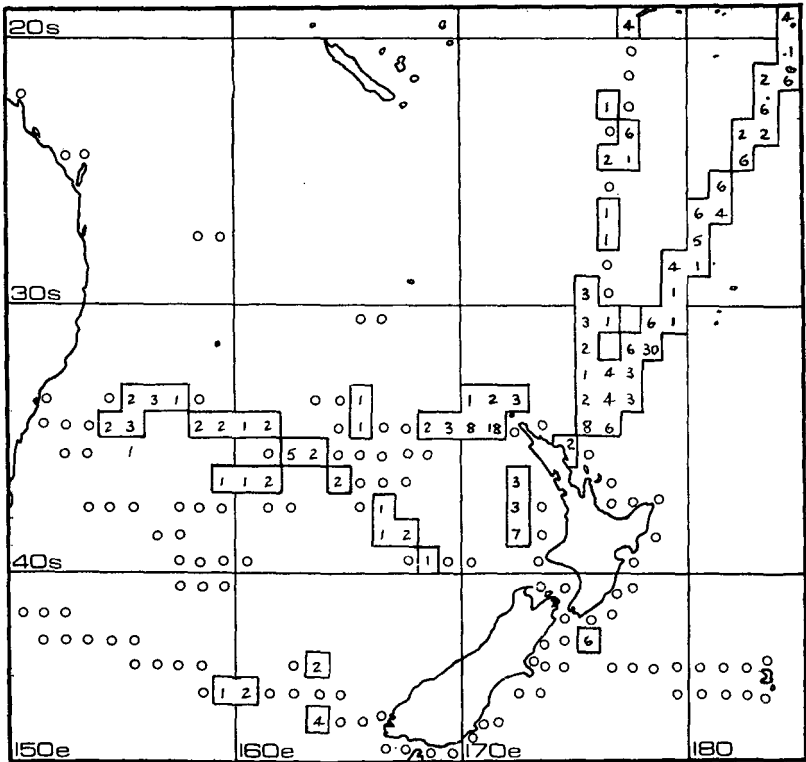


FIGURE 7 — March

birds was found in a rocky niche in the summer of 1974 (C. J. R. Robertson, pers. comm.).

East Island

Moors (1980) reported at least 100 birds over this small island off East Cape, in December 1979. Their behaviour and the finding of several birds in freshly cleaned burrows almost certainly means that this is now a breeding island. As eggs are not laid until late December-early January breeding could not be definitely confirmed.

Kermadec Islands

Merton (1970) listed the previous literature. He recorded extensive breeding on the *Herald Islets* to the north-east of Raoul. In the face of heavy predation, cats and rats being present, he said that the Black-winged Petrel would soon be eliminated from Raoul itself. At present, good numbers of Black-wings are seen flying around Hutchinson's Bluff and at D'Arcy Point and many of them land, as

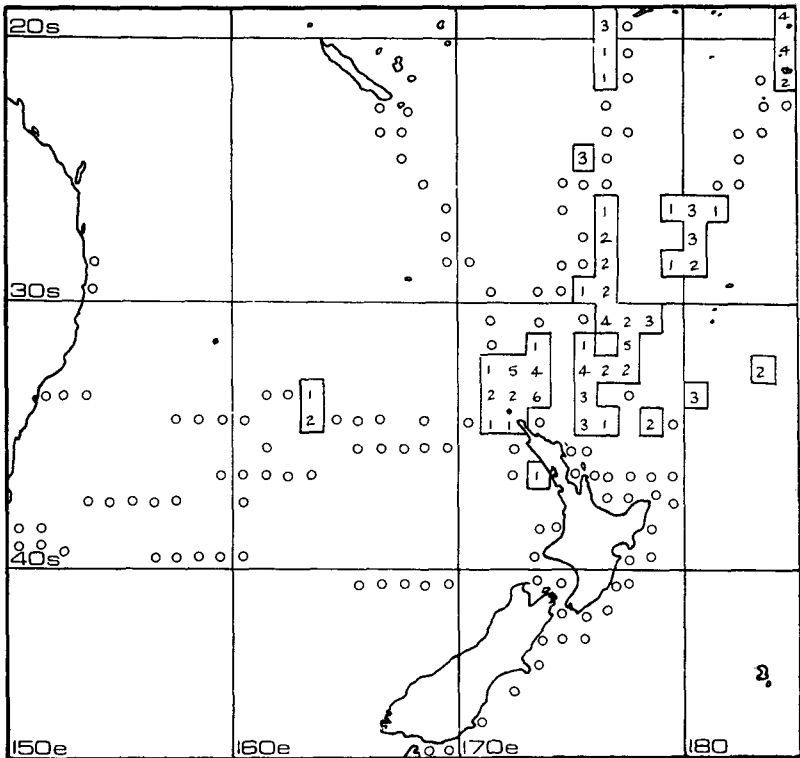


FIGURE 8 — April

shown by the finding of cat-killed corpses. J. A. Bartle (pers. comm.) has suggested that these birds are overflowing non-breeders from the Herald Islands and from Macauley rather than a remnant breeding population.

An expedition of the New Zealand Wildlife Service was on *Macauley Island* on 10-22 November 1980. P. J. Moors (pers. comm.) has given us the following information. "Black-winged Petrels were by far the most abundant birds on the island, both during the day and at night. Their numbers declined during the middle of the day, particularly if it was hot and sunny, but from about 4 p.m. onwards birds began to congregate again in the air and on the ground. By dusk the sky was a swirling mass of Black-winged Petrels.

There was much courtship activity by both pairs and single birds, including aerial chases, and vigorous calling by birds in burrows and on the ground. Many burrows were being cleaned out and had fresh piles of spoil at their entrances. Burrows were found all over the island (except on the steep coastal cliffs) but appeared to be most

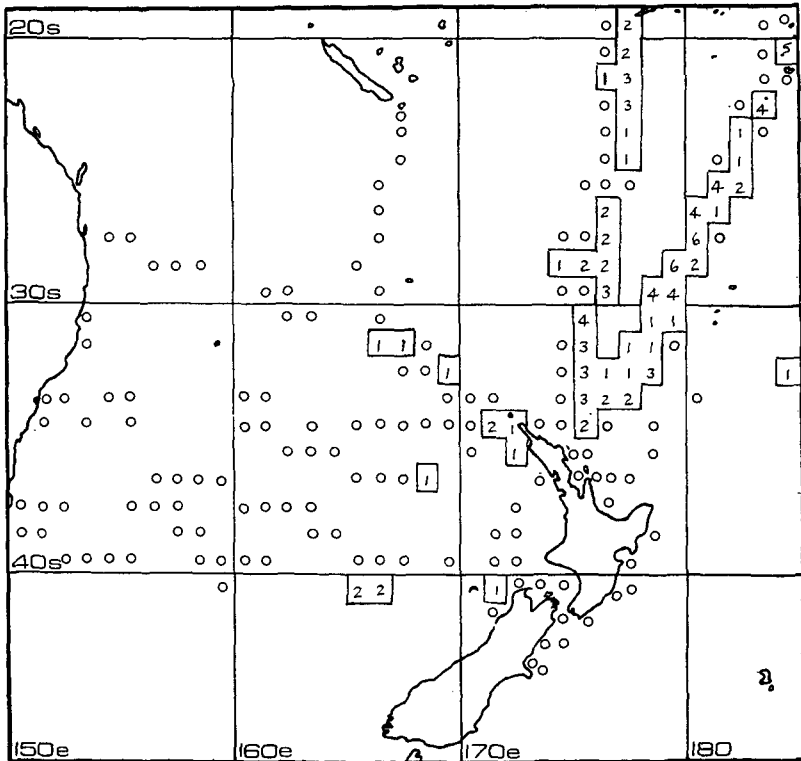


FIGURE 9 — May

dense on flattish ground covered by a thick mat of *Microlaena stipoides* grass.

Five hundred birds were banded from about 1.5 ha around the campsite. Judging from the recapture rate of banded birds in that area, the total population of Black-winged Petrels on Macauley (approximately 315 ha) exceeds 1.1 million. Twenty-eight birds were measured. Average dimensions were: bill length 24.7 mm; wing length 223 mm; tarsus length 30.5 mm; weight 172 g. Two fresh carcasses were found which had been gnawed by *Rattus exulans*, but it was not clear whether the rats had been responsible for the deaths. Rats were common on the island at the time."

Lord Howe & Balls Pyramid

Fullagar (1974) said that the breeding confirmed on Lord Howe in March 1971 could be a recolonisation of the island. He suggested that breeding occurs "in some strength" on Balls Pyramid. However, I. Brown (1979), who visited Balls Pyramid 19-26 November 1978,

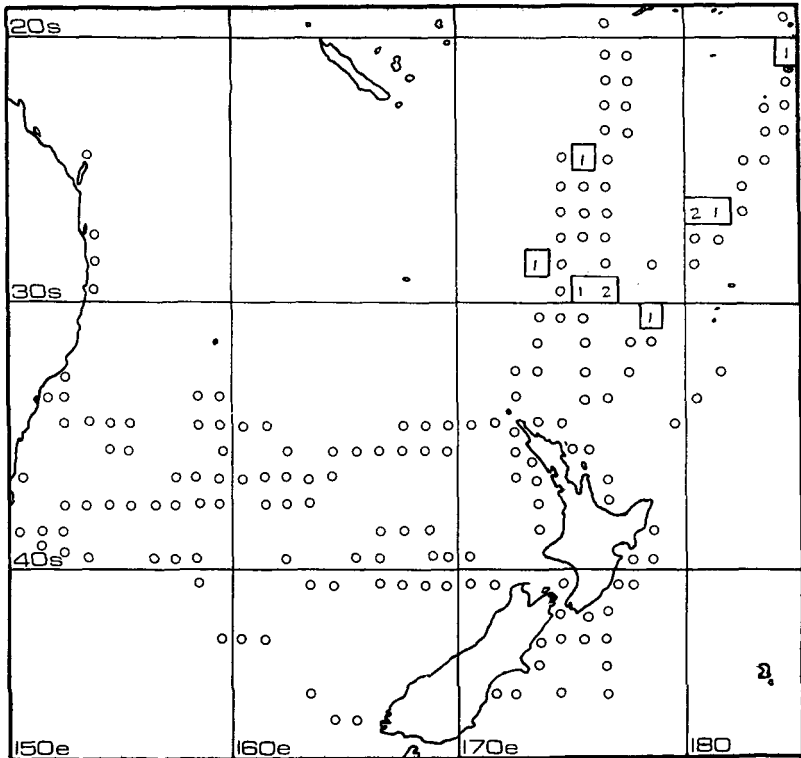


FIGURE 10 — June

noted the breeding of *Puffinus pacificus* and *Pterodroma neglecta* but did not mention even seeing *nigripennis*.

New Caledonia

Naurois (1978) recorded the first specimen caught in a burrow on Isle Mettre at the end of December 1971. He did not think it was a breeding bird. In January-February 1978 several hundred pairs were found breeding on small offshore islands.

Norfolk Island

The early history of the Black-winged Petrel was described by Serventy *et al.* (1971). Klapste (1981), in an interesting paper, showed that the birds are common on Norfolk, even though they are heavily predated by feral cats.

Portland Island

Eagle (1980) described the first breeding birds, which were found in February 1980.

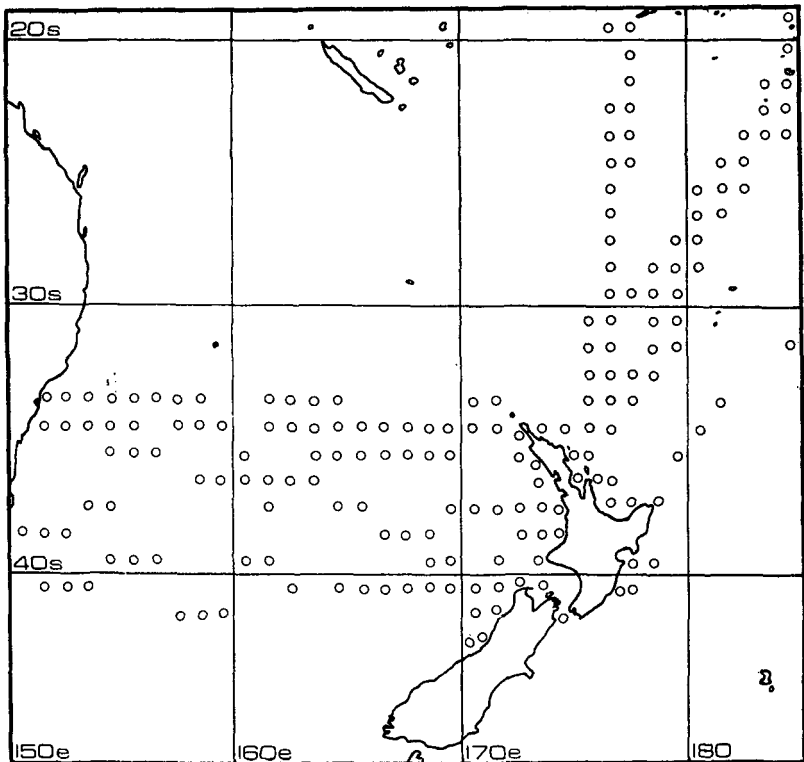


FIGURE 11 — July

Three Kings Islands

The first report of the Black-winged Petrel from the Three Kings was that of Bull (*in* Turbott & Buddle 1948). He reported at least 24 birds over Great King on 3 December 1945. Breeding was confirmed when a burrow containing a sitting bird was found on 14 January 1951 (Turbott 1951). During a visit to Great King in December 1952-January 1953, Turbott & Bull (1954) referred to a *Pterodroma* with a *ti-ti* or *kek-kek* call heard about Castaway Valley and from cliff tops to the west of the depot. This was probably the Black-winged Petrel (E. G. Turbott, pers. comm.). Nothing is in the literature since that time. J. A. Bartle, who visited the islands in January 1976, has said (pers. comm.) that the Three Kings is now a major breeding station. The largest colony is probably that on South West Island, but on Great King the colony has expanded with burrows more abundant in the old areas and spread into new ones. They may also breed on West and North East Islands.

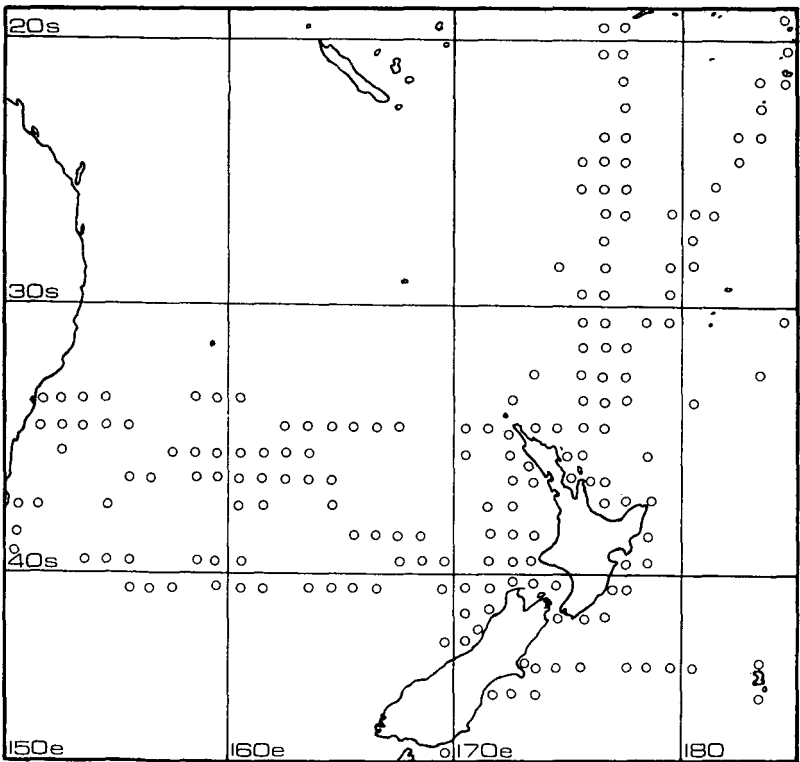


FIGURE 12 — August

Prospecting of new breeding sites in New Zealand

In recent years many Black-winged Petrels have been seen flying over headlands in northern New Zealand. Sibson (1978, 1979) and Thomas (1979) reported birds over the land at North Cape and Cape Maria van Dieman. Thomas's observations were discussed by McKean (1980) in relation to similar behaviour noted at Lord Howe Island. Offshore, the most consistent reports are those from the Poor Knights Islands, where J. A. Bartle (pers. comm.) recorded up to 50 over Aorangi Island in January 1978. However, Bartle found no sign of breeding during a thorough search of the island in February 1980. Black-wings have also been seen over Cuvier Island during the past few summers (T. G. Lovegrove, pers. comm.).

Distribution in Australia

Alan Rogers (pers. comm.) has summarised Black-winged records for Australia: "It was first recorded in 1962 when two birds were caught on Heron Island, Queensland. It has continued to occur there regularly and since 1975 has also been prospecting Muttonbird Island,

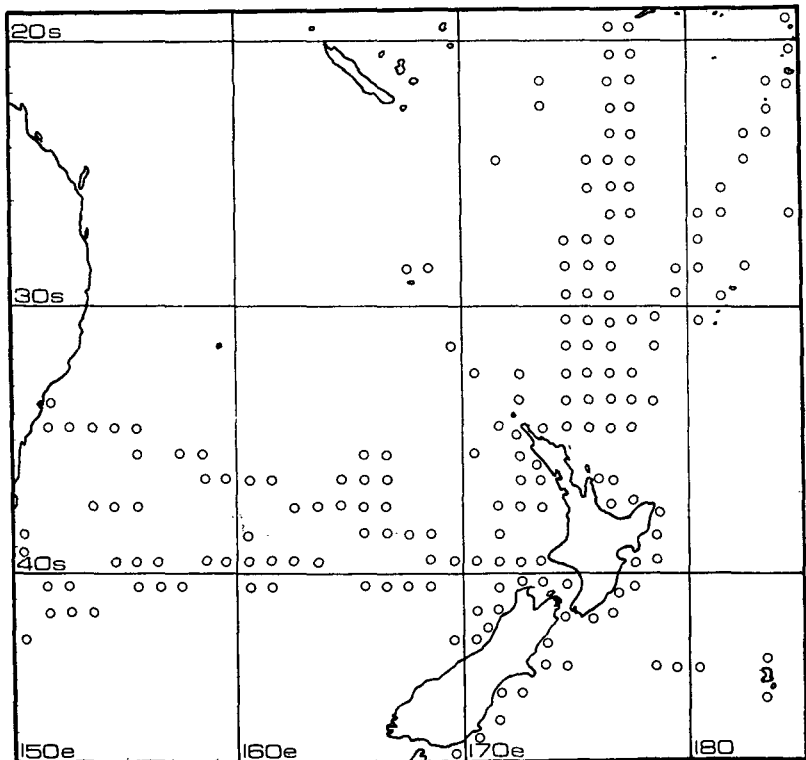


FIGURE 13 — September

Coffs Harbour, New South Wales. . . Breeding has yet to be proved at either locality.

Away from these sites, there have been occasional sightings and beach-washed records in both States and one occurrence in Victoria. There are no records for South Australia (D. Close, pers. comm.), Western Australia, Northern Territory (J. McKean, pers. comm.) or Tasmania (L. Wall, pers. comm.).

In a recent review, Klapste (1981) summarised details of published occurrences and provided a useful list of references. Thus only records which supplement or update that information are given here.

Two further birds were beach-washed at Byron Bay, New South Wales (Morris, McGill & Holmes 1981) and at Peregian Beach near Noosa Heads, Queensland, on 18 February 1977, now Queensland Museum specimen No. O. 16607 (G. Czechura, pers. comm.).

Sightings have continued at Muttonbird Island, Coffs Harbour, with several seen by J. Issard on 21 February 1980 (Lindsey 1981), one on 1 January 1981 (J. McKean, pers. comm.) and at least four on 1 February 1982 (G. Czechura, pers. comm.). There was an additional record at sea nearby when G. Holmes saw one attracted to ship lights near Solitary Island on 8 March 1976 (Rogers 1977).

It is noteworthy that all documented Australian records appear to fall in the period December-April."

ACKNOWLEDGEMENTS

We should like to thank the many people mentioned in the text for allowing us to include their observations and comments; P. Nesfield and A. Baines for providing extra sea observations; R. B. Sibson and Sir Charles Fleming for their comments on earlier texts; and B. D. Heather for help and encouragement throughout. Speculation and opinion in this paper are our own.

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THE STATUS OF BIRDS AT THE BOUNTY ISLANDS

By C. J. R. ROBERTSON and G. F. van TETS

ABSTRACT

Members of the first party to camp on the Bounty Islands in 170 years report on the ecology, behaviour and history of the penguin, mollymawk, cape petrel, prion, shag and tern that breed there and on the giant petrel, skua, gull and starling that stray there.

INTRODUCTION

Previous reports on the flora and fauna of the Bounty Islands have been based on observations from ships and landings of a few hours duration on Depot, Tunnel and possibly some of the other islands.

From 7 to 20 November 1978 a three-man party (C. J. R. Robertson, D. Horning and G. F. van Tets) camped on Proclamation Island. This was the first party to camp on the Bounty Islands for 170 years and the first biologists to do so at all. A photographic survey to record numbers and distribution of birds and mammals, made by helicopter from HMNZS *Waikato* on 7 November, provided data for islands not landed on. Further photographs taken during an RNZAF Orion flight on 29 November were also used. Both DH and CJRR visited Depot and Tunnel Islands by swimming. GFvT used a telescope to observe activity and faunal distributions on other islands.

The party made specific collections and studies during the expedition:

1. DH: Extensive underwater collections and studies of marine material, terrestrial plants, and invertebrates.
2. CJRR: Breeding ecology and behaviour of the Salvin's Mollymawk (*Diomedea cauta salvini*) and collections of birds and eggs.
3. GFvT: Breeding ecology and behaviour of the Bounty Island Shag (*Leucocarbo campbelli ranfurlyi*), and collections of bones.

This paper covers general observations on the birds of the islands.

HABITAT

The Bounty Islands are a group of bare rocky islands discovered by Captain William Bligh of HMS *Bounty* on 19 October 1788 while he was on his way to Tahiti to collect bread-fruit trees for the West Indies. Most of the rocks are covered by a polished film of hard

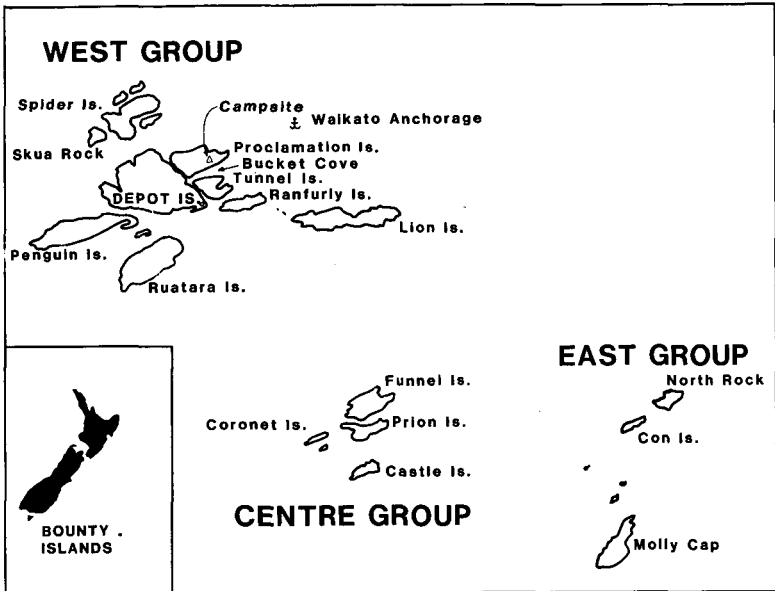


FIGURE 1 — Map of the Bounty Islands

guano, which may account for the 'white spots like patches of snow' reported by Bligh (1792). Resting spots for fur seals lack the white film and are stained brown, with a rough pitted surface. Rainwater pools and channels are encrusted with precipitation layers of a phosphate compound several centimetres thick. Relatively flat and hollow areas have accumulations of a brown organic mud formed from the decay of carcasses, excreta, food scraps and seaweed. The seaweed is brought ashore by shags for nesting material. Land vegetation consists only of lichens and green algae on a few sheltered vertical rock faces. These conditions are consistent with the report by Bligh (1792) that he did not see verdure on any of the islands.

Above the wash of storm waves broad slopes and ledges are occupied by dense concentrations of penguins, mollymawks and prions. Lower down are concentrations of seals, a few of which stray higher up the islands. Narrow cliff-side ledges and alcoves are occupied by Cape Pigeons, shags and terns. Shags roost and nest also on some skyline ridges. Giant petrels, skuas and gulls roost on Skua Rock and the western half of Lion Island, which are relatively free of other kinds of birds. Gulls also roost on cliff ledges elsewhere. At the main bird colonies skuas and gulls are mobbed by prions in the air and attacked by penguins on the ground. Figure 1 shows the islands in the group.

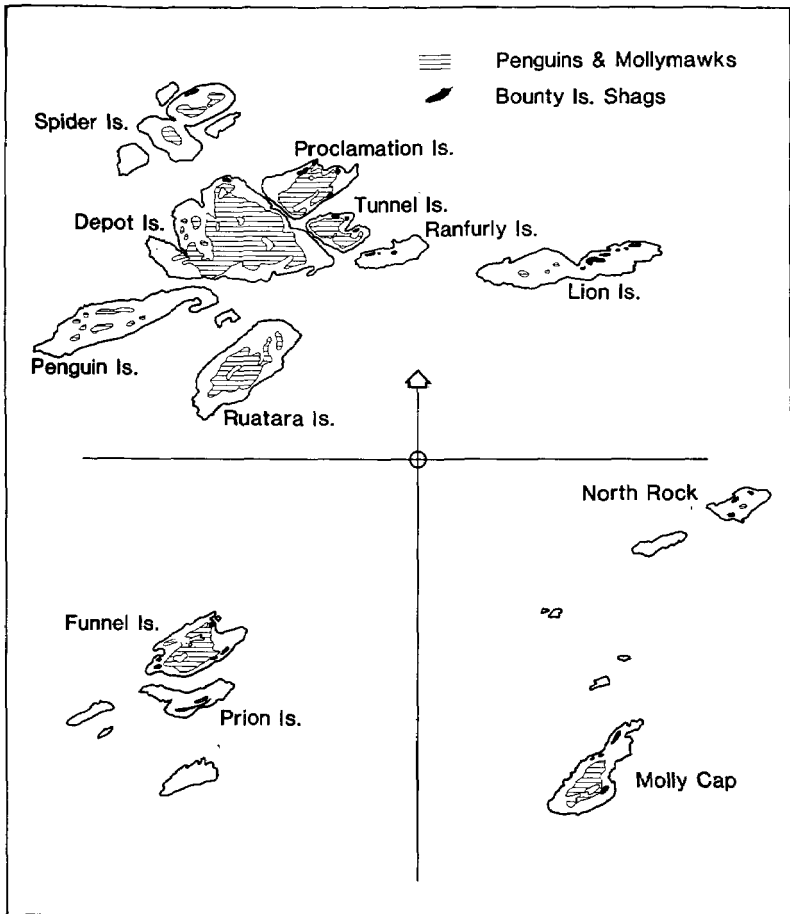


FIGURE 2 — Distribution of Erect-crested Penguins, Salvin's Mollymawks and Bounty Island Shags at the Bounty Islands

SYSTEMATIC LIST

ERECT-CRESTED PENGUIN *Eudyptes sclateri*

When Cook was near the Bounty Islands (Beaglehole 1961) (see Fig. 3), penguins with red bills were seen on 2 December 1773 and penguins were heard on 15 November 1774. Penguins were also seen on 19 September 1788 when Bligh discovered the islands. Reischek (1888) reported as breeding on the Bounty Islands in February 1888 the same three species of penguins he had seen at the Antipodes Islands: *Eudyptes pachyrhynchus*, *E. chrysocomus* (sic) and *E. filholi*. He gave no indication of their breeding status at the Antipodes.

Reischek's report for the Bounty Islands and Antipodes is of doubtful reliability as his visits were brief and in trying conditions. For example, he stated that no depot (provision) had been placed on the Bounty Islands, and yet he was travelling with Captain Fairchild who had installed a depot there two years earlier. These two island groups were visited after the Snares, Auckland and Campbell Islands and the activities included transhipping penguins from one island to another. He records that at the Antipodes "after exchanging some of our live-stock, by taking on fresh penguins and letting others go that we had taken from the Snares, we steamed to the Bounty Islands." Therefore, some confusion may well have occurred.

Reischek gave no descriptions of the penguins and presumably he used the names and descriptions of Buller (1882: 100 & plate 37). Buller (1888: 291) referred his *E. chrysocomus* to *E. pachyrhynchus* and his *E. filholi* to *E. chrysocome*. With Reischek at the Bounty Islands was W. Dougall (=Dugald in Reischek), one of whose photographs is reproduced in Buller (1888: 293 with comments on 200 & 288). The photograph shows a mixed group of penguins and molly-mawks, both with chicks about two-thirds adult height. The penguins clearly have the stubby bills and erect crests of *E. sclateri*, which Buller (1888: 289) named on the basis of a bird in the London Zoo from the Auckland Islands. Buller placed the photograph with the text for *E. chrysocome*, but on page 200 he called the penguins *E. pachyrhynchus*. Ogilvie-Grant (1898) recorded an immature skin of *E. chrysocome* and an adult skin of *E. sclateri* from the Bounty Islands. Hutton in Ogilvie-Grant (1905: 552) reported that *E. chrysocome* does not breed at the Bounty Islands and that *E. sclateri* is very common there and, according to Bollons, starts to breed during the middle of September. Since then only *E. sclateri* has been found to breed there, and there appears to be no published evidence that *E. chrysocome* has bred at the Bounty Islands, as is stated in various checklists, handbooks and field guides.

On 7 November 1978 we found Erect-crested Penguins on single large eggs, with freshly discarded small first eggs nearby. Nests consisted of loose accumulations of mud and debris that tended to wash away during rain showers. Females were about two-thirds the height of males. Near these nests the penguins screamed so loudly when we passed that it was painful to our ears. Males not on nest duty ran over and bit our legs. Penguins that had lost their eggs accepted onions, apples and oranges as substitutes. We did not see any chicks or hatching eggs by the time we left the Bounties for the Antipodes Islands on 20 November.

At the Antipodes hatching of Erect-crested Penguins had begun about 15 November (B. D. Bell, pers. comm.) and was completed there by 24 November when CJRR found no eggs still viable in the colony near the Antipodes Island camp. When we arrived at the Bounty Islands on 7 November, egg laying seemed to have been com-

pleted 7-10 days earlier, judging from the size of embryos in the eggs and the clean state of the shells. The considerable difference in breeding cycle within the same species but in colonies only 100 miles apart warrants further investigation, especially as the later breeders, those on the Bounty Islands, are to the north.

At the Bounty Islands, dense schools of 50-300 penguins arrived from at least 10 a.m. to dusk in Bucket Cove, between Proclamation, Tunnel and Ranfurly Islands. The schools were tightly packed and skittish, porpoising and diving in various directions before splitting up and dashing towards the landings. In heavy seas the penguins would leap from the crest of a wave and land feet first on the rocks, often to be washed off again. Only once was a penguin seen floating in the Cove that might have been killed during a landing attempt.

The penguins were as numerous as the mollymawks and prions, and their densities were comparable to those in Dougall's 1888 photograph and those taken in January 1968 and shown in Darby (1970: 174 & 176). We estimate that 115 000 pairs of penguins are on the Bounty Islands. See under Salvin's Mollymawk for discussion of nesting density and methods of calculation.

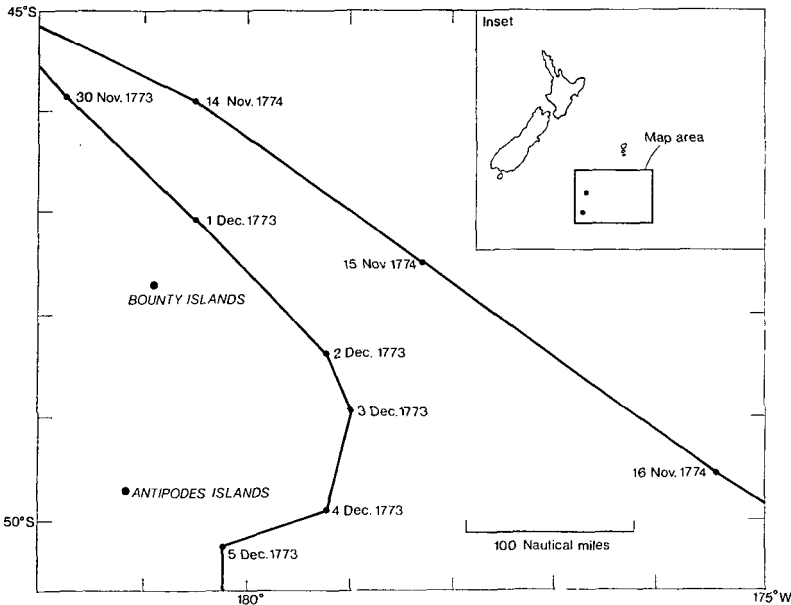


FIGURE 3 — Location of ship tracks made by Captain Cook near Bounty and Antipodes Islands based on noon positions

SALVIN'S MOLLYMAWK *Diomedea cauta salvini*

Grey albatrosses were seen on 2 December 1773 when Cook was near the Bounty Islands (Beaglehole 1961) (see Fig. 3). Bligh did not record any albatrosses when he discovered the islands on 19 September 1788, although he saw a great many two days later, 150 nautical miles to the east. Reischek (1888) reported two species of mollymawks, *D. melanophrys* and *D. chlororhyncha*, on the Bounty Islands, but Dougall's photograph in Buller (1888) shows only *D. c. salvini*, which is called *D. melanophrys* by Buller. Again, the validity of Reischek's account must be questioned, for earlier in the trip he recorded the same two species breeding on the cliffs of Campbell Island. They were at Campbell Island for only two days, and he probably did not visit the mollymawk colonies as he made no comment about their chicks. These identifications may therefore be based more on information from other sources than on direct observation. Hutton (*in* Ogilvie-Grant 1905: 558-559), on the basis of information from Bollons, stated that both *D. cauta cauta* and *D. c. salvini* bred at the Bounty Islands, with *cauta* starting at the end of August. Subsequently only *D. c. salvini* has been found to breed at the Bounty Islands.

On 7 November 1978 we found Salvin's Mollymawks on single eggs, some of which were starting to hatch, and when we left on 20 November, 45% of occupied nests still contained whole or pipping eggs. The nests consisted of columns of dried mud (Fig. 4) reinforced by moulted penguin feathers and some bird bones. Several layers of earlier seasons' dead chicks could be seen in some nests. The mean width of 35 nests was 37 cm. The form and heights of pedestals varied with the underlying terrain, ranging from an established solid column to little more than a lip stuck on the rock.

Mean pedestal heights for the sample were 85 mm for the

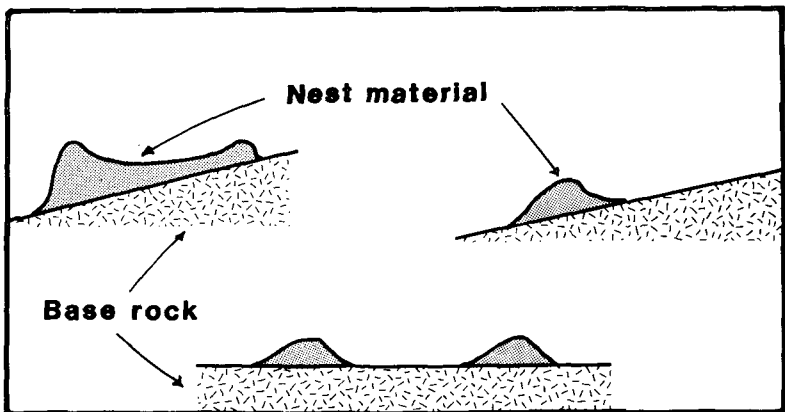


FIGURE 4 — Typical Salvin's Mollymawk nest structures



FIGURE 5 — A flat nesting area of mixed Salvin's Mollymawks and Erect-crested Penguins

lowest side of the pedestal to 155 mm for the highest side with an overall range for all sides of 15 to 247 mm. The highest pedestal seen and measured was 400 mm. The mean depth of the bowl for 35 pedestals was 35 mm.

To construct pedestals, the mollymawks used their bills to collect rain-softened mud from gullies and depressions and carried it up to 2 m to their nests. Nest centres averaged 1.2 m apart on flattish ground.

Only the bare, unfractured rocky tops of the islands can truly be called flat. Flattish areas are generally of rather broken terrain made up of loose rock slabs and creviced solid rock. Lower slopes were predominantly occupied by nesting penguins and, near seal rookeries, by penguin roosts. Flatter areas and gullies of the middle and upper part of the islands contained an even mix of mollymawks and penguins. Tops of rock slabs, inaccessible to penguins but in the lee of prevailing winds, were mainly used by mollymawks.

Figure 6 is a representation of the density of penguin and mollymawk nests on a typical flat area such as that shown in Figure 5. Penguins occupy the lower stratum, with no built up nests, below the mollymawk "high rise" on raised pedestals. Mean densities were 1 nest/1.9 m² for *D. c. salvini* and 1 nest/1.4 m² for *E. sclateri* in mixed colonies. In areas occupied solely by *D. c. salvini*, the nest

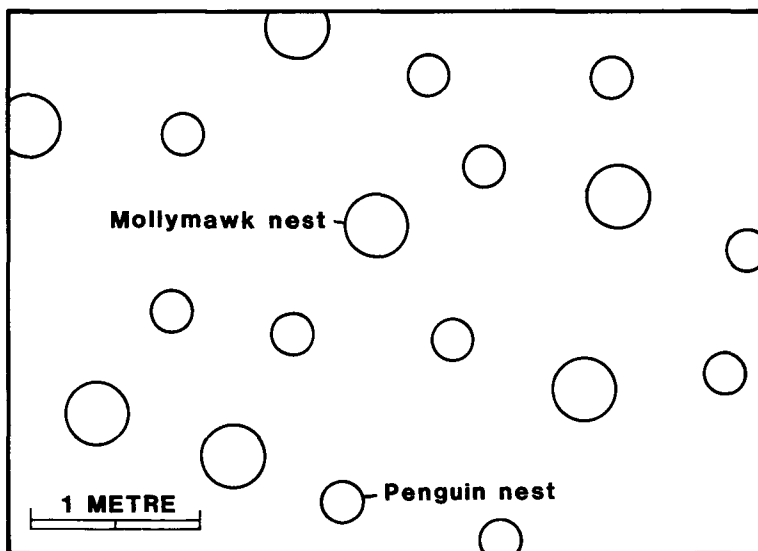


FIGURE 6 — The density of penguin and mollymawk nests on a typical flat area

density remained unchanged, but in areas occupied solely by *D. c. sclateri*, it increased to 1 nest/0.8 m².

Based on the nest densities we estimate that there were 0.5 pairs per square metre of *D. c. salvini* and 0.9 pairs per square metre of *E. sclateri*.

The photogrammetric branch of the Lands and Survey Department calculated a total area of 38 445 m² for Proclamation Island, which was the island most studied. By plotting the breeding areas of birds from visual mapping and air photographs (Fig. 2), we calculated the populations as shown in Table 1. The estimates for the whole island group are 76 000 pairs for *D. c. salvini* and 115 000 pairs for *E. sclateri*.

A sample of 42 eggs of *D. c. salvini* measured in the field, 34 at Bounty Islands and 8 on the Western Chain of the Snares Islands, has mean dimensions of 104 ± 4 mm x 67 ± 2 mm. This compares with a sample of 107 eggs of *D. c. eremita* from the Chatham Islands (CJRR, unpub., 1974) with mean dimensions of 102 ± 4 mm x 67 ± 2 mm and a sample of 74 eggs of *D. c. cauta* from Albatross Island (CJRR, unpub., 1981) with mean dimensions of 105 ± 4 mm x 67 ± 2 mm (± is standard deviation).

TABLE 1 — Breeding population of Salvin's Mollmawk, Erect-crested Penguin, and Bounty Island Shag, expressed in pairs

ISLAND	Mollmawks	Penguins	Shags
<u>West Group</u>			
Proclamation	8 656	15 580	20
Tunnel	5 027	9 048	30
Depot	35 380	63 684	11
Ruatara	9 185	16 533	-
Penguin	1 247	2 244	-
Ranfurly	-	-	66
Lion	-	476	165
Spider	4 006	7 211	12
<u>Centre Group</u>			
Funnel	8 240	-	64
Prion	-	-	70
Coronet	-	-	20
<u>East Group</u>			
Molly Cap	4 611	-	40
North Rock	-	187	71
TOTALS ESTIMATED	76 352	114 963	569

TABLE 2 — Contents of nests of *D. c. eremita* on Chatham Islands and nests of *D. c. salvini* on Bounty Islands, expressed as percentages.

	6.11.74 <i>eremita</i>	9.11.78 <i>salvini</i>	19.11.74 <i>eremita</i>	19.11.78 <i>salvini</i>
Egg	88	72	34	23
Hatching	10	17	8	25
Chick	2	11	68	52
n =	52	35	47	31

A study group of 35 nests containing eggs was chosen at random from various habitats and visited each day. One bird in each pair was marked with a patch of indelible dye on the forehead so that incubation and guard stints could be measured.

At the start of the study on 9 November 1978, four of the sample nests had chicks almost completely hatched indicating that hatching had begun on 3-5 November. The mean interval for hatching from pipping of the egg was 5 days. There are few data on the length of incubation for any *D. cauta* mollymawks.

P. M. Sagar visited the Western Chain of the Snares Islands on 21 November 1976. He reported (pers. comm.) that the majority of nests of *D. c. salvini* contained chicks with ages ranging from 3 days to unguarded. At our departure from the Bounty Islands on 20 November there were no chicks unguarded. As other mollymawks have a guard stage of about 3 weeks this probably indicates that breeding at the Bounty Islands is about 7-10 days behind that for the Snares Islands.

There is no published information as to when egg laying starts for any of the subspecies of *D. cauta*. Plomley (1966) recorded that many eggs of *D. c. cauta* were obtained by sealers on 14 September 1832 at Albatross Island in Bass Strait. On 18 September 1974, CJRR found some 90% of eggs had been laid by *D. c. eremita* at the Chatham Islands. One egg laid on that day was recorded as a chick on 19 November — 66 days later. Two eggs showed no sign of hatching after 63 and 64 days.

At Albatross Island in Bass Strait Gabriel (1896) found *D. c. cauta* eggs with embryos in all stages of growth on 31 October 1895 and estimated the incubation period to be about 8 weeks. Armstrong (1910) noted that the eggs were "far advanced in incubation" on 6 November 1909; and Ashworth & Le Souef (1895) noted that most eggs were hatched and all young were being brooded between 26 November and 1 December 1895. At Albatross Island in 1981, N. Brothers and CJRR (unpub.) recorded an incubation range of 68-75 days with a mean of 72 days for a sample of 15 *D. c. cauta* eggs.

Egg dimensions for *D. cauta* are similar to those of *D. m.*

TABLE 3 — Length of attendance at the nest of Salvin's Mollymawk when incubating, hatching and feeding chicks.

Days	Complete stints	Days	Incomplete stints
1	7	1+	18
2	10	2+	13
3	16	3+	10
4	9	4+	5
5	6	5+	8
6	3	6+	7
7	1	7+	0

Mean complete periods = 4.2 days

melanophrys, for which Tickell & Pinder (1975) recorded an incubation range of 65-72 days with a mean of 68 days. The range of hatching for *D. c. eremita* at the Chatham Islands indicates an egg-laying period of about 3 weeks. Tickell & Pinder (1975) recorded a guard stage of 21 days for *D. m. melanophrys* after hatching.

Figure 7, which sets out a probable breeding pattern for the *D. cauta* ssp., assumes a 3-week spread of laying and a 68-day incubation period.

Observations, although over a short period, gave a general indication of the length of incubation and guard stints at the nest by parents. Table 3 shows the distribution frequency of 52 complete and 61 incomplete stints.

Chicks were weighed and the culmen measured from the day of hatching. Figure 8 shows the daily weights of chicks during the

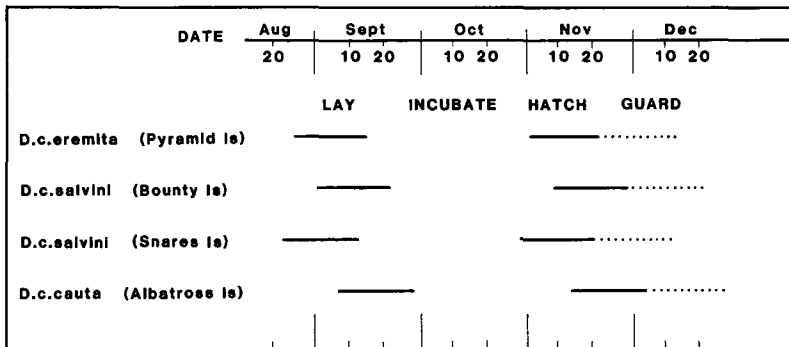


FIGURE 7 — Calculated spans of egg laying, incubation, hatching and guard stages in the breeding of *Diomedea cauta* ssp.

TABLE 4 — Measurements (mm) of live or freshly dead Salvin's Mollymawk

Males (n = 17)	Mean	Range
Culmen length	129 mm	124 - 135
Tarsus	92 mm	85 - 95
Wing	577 mm	555 - 600
Tail	222 mm	210 - 235
Weight	4.00 kg	3.3 - 4.9
<u>Females (n = 12)</u>		
Culmen length	127 mm	123 - 135
Tarsus	90 mm	87 - 95
Wing	574 mm	555 - 590
Tail	219 mm	210 - 228
Weight	3.59 kg	3.3 - 3.7

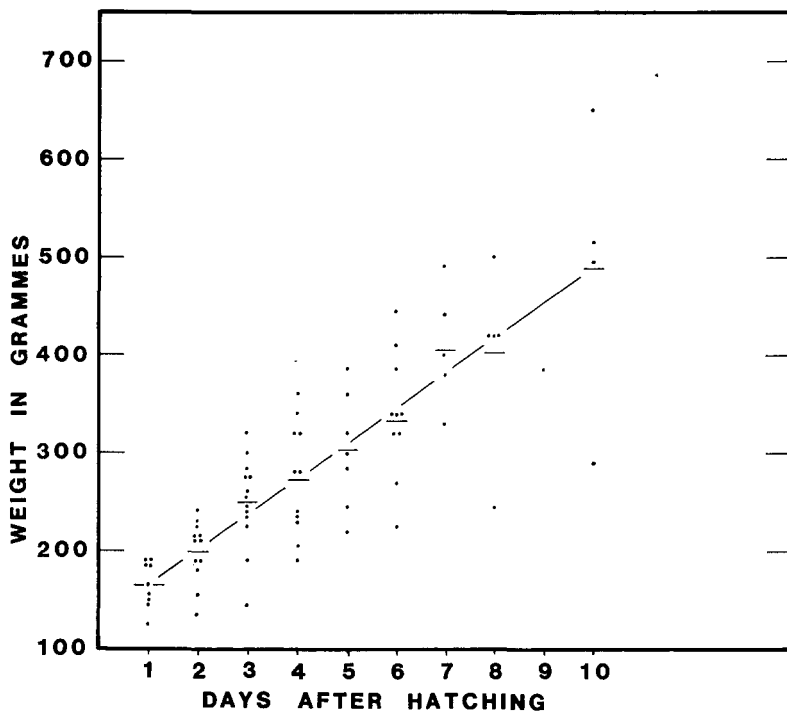


FIGURE 8 — Weights of Salvin's Mollymawk chicks for ten days after hatching

ten days following hatching. Although wide fluctuations are to be expected in the daily weights of chicks, some chicks increased at much better rates than others. Figure 9 shows the individual growth rates for five chicks and the associated guard periods for individual parents. There is some evidence that parents ran short of food to feed chicks when the guard period exceeded three days, but one adult that came in for only one day failed to maintain the weight growth of its chick.

A total of 17 males and 12 females was measured, either live from nest sites or freshly dead and deposited with the National Museum. As in other mollymawks, in live birds the skull width provides a

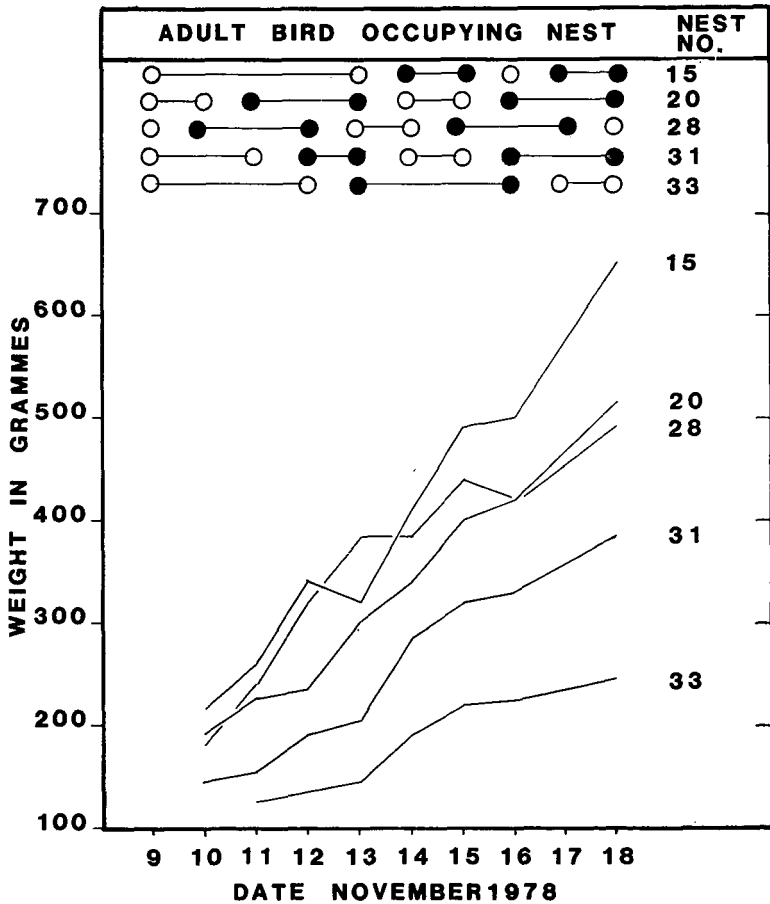


FIGURE 9 — The influence of parental presence and feeding on chick growth rates in Salvin's Mollymawk

useful method, in association with weight or culmen length, for demarcating the sexes.

GIANT PETREL *Macronectes* sp.

'Giant fulmars' were first reported offshore at the Bounty Islands in February 1926 by R. H. Beck and J. C. Correia of the AMNH Whitney South Sea Expedition (Darby 1970: 175). We saw at least five giant petrels on 9 and 15 November 1978 and at least one on 7, 8 and 16 November. They were all dark-plumaged immatures which we were unable to identify to species. Nearest breeding ground for *Macronectes halli* is Antipodes Island and for *M. giganteus* is Macquarie Island. They roosted with the skuas on Skua Rock and the western half of Lion Island. Five giant petrels fed two at a time on a dead penguin floating in Bucket Cove. They threatened one another with arched wings and snapping bills.

CAPE PIGEON *Daption capense*

'Pintadoes' were reported on 2 December 1773 in the vicinity of the Bounty Islands by Cook (Beaglehole 1961) (see Fig. 2). They were not reported again at the Bounty Islands until February 1926, when Beck and Correia saw them offshore, and in January 1968, when Darby (1970: 177) found them breeding on almost inaccessible ledges of precipitous cliffs.

When we arrived on 7 November 1978 we saw only one Cape Pigeon. On 8 November we saw five, including three on nests, and on 9 November we saw an egg in one of the nests, which when collected on 19 November, contained a small embryo. This seems to indicate that laying starts during the second week of November. Cape Pigeon numbers gradually increased to 36, with most of them on nest sites on, or visible from, Proclamation Island. At the Antipodes a freshly laid egg was recorded (B. D. Bell pers. comm.) between 19 and 22 November 1978. On 15 November at least 30 congregated to feed on a dead penguin floating in Bucket Cove, from time to time making brief panic flights away from the carcass. On 19 November at least six fed on the remains of a mollymawk floating in Bucket Cove.

The nests of the Cape Pigeons were in alcoves and horizontal fissures of the seaside cliffs. One nest was made of dried mud and debris, about 225 mm wide and up to 150 mm high. This nest was similar to but not as regular in shape as, those of the mollymawks. However, other nests were merely scrapes of stone chips. Single birds were seen flying along the cliffs as if looking for nesting sites and landing at likely ledges with a purring *courr* call. At a nest containing an egg the pair greeted each other with a chirping *churr* call. The bird on the nest was presented by its mate with bits of mud and debris.

FULMAR PRION *Pachyptila crassirostris*

Reischek (1888) reported that *Prion turtur* nested during February 1888 at the Bounty Islands. Mathews (1912) named prions from

the Bounty Island *crassirostris* as a new subspecies of *Pachyptila turtur*. It is doubtful whether the lectotype AMNH 527264 (Hartert 1926: 355), which is from the Reischek collection, was in fact from the Bounty Islands because the dates and location are incorrect (cf. Greenway 1973: 222). The systematics of prions, including the *P. turtur* - *P. crassirostris* complex, are in a state of flux because of inadequate samples of breeding birds from the islands they nest on. Ecologically, *P. crassirostris* differs from *P. turtur* by nesting in natural cavities rather than in burrows (cf. Law & Burstall 1953: 17, Fleming 1939, Darby 1970, Fullagar in Slater 1970: 167, and Fleming & Baker 1973).

Between 7 and 20 November 1978, we found Fulmar Prions courting out in the open throughout the day with a peak of activity in the middle of the day. The calls of presumed males were four-syllabled with an emphasis on the first or second syllable. They sounded like the following phrases in a clipped Oxford accent: 'What-not-to-do,' 'Not-prof-it-able' and 'Not-poss-si-ble.' Fights were seen between prions making four-syllabic calls. The response by presumed females to the four-syllabic calls was a somewhat slurred and cooing call with equal emphasis on three syllables, sounding like *Co-ver-up* and *Coore-corr-corr*. These calls differed from those of *P. turtur*, which sounded to GFvT at Stephens Island, Cook Strait, as *Cup-a-curr*, and to Fullagar (in Slater, 1970: 167) as *Kuk kuk coo-er*, a soft evenly phrased cooing uttered quickly and usually several times in close succession.

No nests were seen completely in the open, and the main localities were in angled rock fissures and under slabs or piles of rock. The nests were small dried pellets of mud with or without an overlay of penguin quills and small mollymawk body feathers. In suitable "caves" and overhangs, nests were often as little as 0.3 m apart. Of two eggs collected on 19 November, one was little incubated and the other contained a large embryo with no sign of feather development. This may suggest that egg laying started at about the beginning of November.

A sample of 31 eggs measured 46 ± 2 mm x 33 ± 1 mm. This is similar to 13 eggs of *P. crassirostris* ssp. from the Western Chain of the Snares Islands, which measured 46 ± 1 mm x 33 ± 1 mm (P. M. Sagar, pers. comm.), and 30 eggs of *P. c. pyramidalis* from the Pyramid, Chatham Islands, which measured 46 ± 2 mm x 33 ± 1 mm (CJRR, unpub.). Measurements of six Fulmar Prions collected were included in those published by Harper (1980).

Although the prions were impossible to census, as they formed a subterranean population wherever suitable habitat occurred, we estimated that they were as numerous as the mollymawks, about 76 000 pairs (see Table 1).

Unlike Fulmar Prions in the Chatham Islands but like those

of the Western Chain of The Snares (Fleming & Baker 1973), the Bounty Island prions moved about freely in daylight, and the open-air courtship indicates an absence of effective predators. Any skua or gull venturing over the island in daylight caused "mobbing" flights with seemingly all prions on the surface taking off and flying about, and had a tight group of about 100 prions closely pursuing it. Once the intruder was out of range prions returned to the surface and resumed displaying and calling. Unlike other prion species, these birds ceased vocalisation at night, a complete reversal of the normal diurnal pattern.

Beck recorded that in late February 1926 prions were everywhere under the rocks but he made no mention of birds sitting on the surface. This may indicate that by then "courting" is completed.

An immature male fur seal was seen holding a prion in its mouth by its wings and toying with it. Eventually the prion escaped, flew around for a while and then landed back near the seal. A foraging flock of prions in Bucket Cove was seen to peck small items off the sea and some of them dived from the water surface and were briefly submerged. They also foraged together with Cape Pigeons in rough water over Blackfish Shoal. Three prions were seen hovering over giant petrels and Cape Pigeons feeding on a penguin floating in Bucket Cove.

BLACK-BELLIED STORM-PETREL *Fregatta tropica*

Beck and Correia reputedly found Black-bellied Storm Petrels nesting on 26 February 1926 at the Bounty Islands, according to Darby (1970). However, a re-examination of the MS of the journals of Beck and Correia does not confirm this. Single Black-bellied Storm Petrels were seen at sea near and to the north of the Bounties, but none was recorded ashore. We are not aware of anyone else having recorded them there. During November 1978, we saw them from HMNZS *Waikato* in the vicinity of the Bounty Islands, but we did not see them on the islands or find remains of storm petrels or of their eggs in rock crevices.

BOUNTY ISLAND SHAG *Leucocarbo campbelli ranfurlyi*

The following quotations from Ogilvie-Grant (1905: 543, 544, 572) describe the discovery of the Bounty Island Shag.

"Towards the end of 1897 a communication was sent to the Earl of Ranfurly, Governor of New Zealand, requesting him, if possible, to obtain examples of birds from that Colony and the adjacent islands for the British Museum (Natural History). With this object in view, Lord Ranfurly ordered a large number of jars of various sizes to be made, and forwarded them filled with formaline solution to a few gentlemen who had undertaken to assist him. On the 19th December, 1900, Lord Ranfurly started in the Government steamer 'Hinemoa' for the Bluff, and visited the outlying islands — namely, the Snares, Campbell, Auckland.

Antipodes, and Bounty. Capt Hutton, the Curator of the Christchurch Museum, was his guest, and, from his knowledge of natural history, largely assisted in the formation of the collection made during this trip."

". . . as this was a sea-trip, aquatic birds naturally formed a large part of the collection. Cormorants being especially numerous. One of these, obtained on the Bounty Islands, proved to belong to a species hitherto undescribed, and was named *Phalacrocorax ranfurlyi*. Lord Ranfurly had asked the captains of the various British cruisers in New Zealand waters to get any specimens obtainable, and he had also written to the Resident of the Cook and Harvey Islands with a view to obtaining the birds found on those groups. Subsequently Commander J. P. Rolleston, of H.M.S. 'Archer,' procured living specimens of *P. ranfurlyi* from the Bounty Islands"

". . . some of which reached New Zealand alive, but were subsequently killed and forwarded to England with other birds in formaline."

The holotype skin of *Leucocarbo ranfurlyi* (Ogilvie-Grant 1901), an adult male, is registered as 1901.10.21.50 in the British Museum (Natural History) (Warren 1966: 242). Subsequently visitors reported that the Bounty Island Shag bred on narrow ledges of the sea cliffs (Oliver 1955, Darby 1970). It is the only kind of shag that has been reported from the Bounty Islands, and it has not been recorded elsewhere. The description of two shags seen in 1950 at Bollon's Island, Antipodes Islands (Warham & Bell 1979), could also fit several other species of shag.

Before 9 a.m. on 7 November a foraging flock of about 300 shags was seen from HMNZS *Waikato*. Up to half of these may have been non-breeding birds. This was the largest number of shags seen at any one time.

From 7 to 20 November we found all stages from courting to well-advanced incubation, but no chicks. Hatching had begun by 19 November in one of ten eggs we examined that day. The hatching egg and five others were collected for the National Museum of New Zealand. During the Auckland Islands Expedition of 1972/73, GFvT had found the incubation period of four first eggs of *Leucocarbo colensoi* to be 28, 28, 29 and 32 days. Therefore, *L. ranfurlyi* may have started laying eggs during the middle of October. Egg laying of *L. colensoi* in the Auckland Islands starts in November and of *L. campbelli* at Campbell Island in August or September.

Based on photographs taken by helicopter on 7 November and on observation by telescope from Proclamation Island from 7 to 20 November, 569 pairs of nesting shags were distributed as shown in Figure 2 and Table 1. Most nests were on narrow cliff-side ledges, and a few were on narrow skyline ridges of Lion and Coronet Islands. The nests were 35 cm wide and up to 15 cm high with the centres of adjacent nests as little as 1 m apart. The nests were mainly made

of a brown alga, *Marginariella*, which grew in a band at least 10 m below sea level. The shags dived for the alga during heavy seas, presumably the surge helping them to break off strands a metre or more long. The alga became sticky, staining the white breasts of the shags brown, before it dried out glued to the nest structure. The nest structure also contained cone-like epiphytes that grow on *Marginariella*, feathers, stones, debris and mud. Tussock grasses, which form the bulk of the nests of shags at Auckland, Campbell and Macquarie Islands, were not available at the Bounty Islands.

Up to three eggs were found in a clutch. A sample of 20 eggs of *L. ranfurlyi* measured in the field and in the collection of the National Museum of New Zealand has mean dimensions of 64 ± 2 mm x 41 ± 2 mm. These are slightly larger than the mean dimensions of a sample of 32 eggs of *L. colensoi* (GFvT, unpub.) measured in the field at Enderby Island, Auckland Islands, which were 60 ± 3 mm x 39 ± 2 mm.

In mated pairs females left the nesting area shortly after dawn to go foraging and returned during the middle of the day. Males left some time after the return of their mate and foraged during the afternoon. Many were seen flying back at dusk from far out to sea. Before they left they regurgitated a green or pink pellet of food remains and pebbles with a soft *Gock-gock-gock* . . . sound. They also dived a few times for seaweed to augment the nest before flying out to sea to go foraging. The pellets contained beaks of a small cephalopod, bones and earstones of a small fish, fragments of snail shells, snail shells containing tiny hermit crabs, sea urchin spines, coral fragments, pebbles, tapeworms, and bits of kelp and dirt.

From nine *L. ranfurlyi* collected on 19 November, the following remains were in the following number of stomachs: fish (8), snail shells (8), cephalopods (4), isopods (4), hermit crab (1), crab (1), sea urchin (1), coral (3), stones (5), and nematodes (2). The hermit crabs were in snail shells and cavities of coralline concretions. Thirty-five stones, including eight coralline concretions, in the shag stomachs ranged from 0.2 to 1.5 g and had a mean weight of 0.5 ± 0.3 g. Because of the surge around the islands, the stones, shells and bits of coral probably came from sheltered sea caves or very deep water. DH saw and collected similar hermit crabs from bare, vertical rock walls below the brown alga zone.

The shags foraged out to sea and around the islands. To dive from the water surface, they usually jumped higher than a body length above the water. On shore they rested on ledges and in alcoves of cliffs and on skyline ridges. Like other subantarctic shags they did not spread their wings to dry.

Externally the sexes are alike, except that males are slightly larger than females. The adult plumage is black with a blue sheen above and white below. The black-and-white border starts at the side of the throat. The upper wing-coverts are dark brown with a

green sheen and narrow indistinct borders. White alar patches are prominent in some and poorly developed in others. White scapulars have not been recorded. White back patches, which range from prominent to poorly developed on at least a few males, are lacking on more than 90% of the adults. The holotype male has one white feather on each side (Ogilvie-Grant 1901). In *P. colensoi*, white back patches are restricted also to a few males. White patches have not been recorded on *P. campbelli*. Some birds have a white axillary line along the front of the humeral area of the under wing. Some males have a second white line further back on the inside of the under wing. The bill is brown or pink with a dark ridge and a light tip. The face is red, orange and/or purple with a red-orange, purple or pale brown eye ring. The throat is orange red. Instead of caruncles above the base of the upper bill, there is a variable amount of orange-yellow at the unfeathered proximal ends of the upper and lower bill, resembling in some but not all birds the patterns of *L. colensoi* and *L. campbelli*. The iris is light brown. The legs and feet are pink with variable amounts of grey smudges around the top of the tarsus and on the toes, which have dark brown nails.

Immatures differ by being brown above and white below. A few have brown spots on the white foreneck. J. P. Rolliston collected on 15 January 1903 a juvenile male, presumably a specimen in the British Museum (Natural History) (Ogilvie-Grant 1905), and an immature female, A.03.24 in the Otago Museum, that both have a broad brown band across the foreneck as in *L. campbelli* and some *L. colensoi*. None of the *L. ranfurlyi* seen in 1978 had such brown bands.

We did not see any juveniles or nestlings. F. W. Hutton and J. P. Rolliston (*in* Ogilvie-Grant 1905) described the soft part colours of juveniles as follows: "The young in first plumage has the iris pale brown, skin round eye and lores brown, gular pouch grey, and the bill and feet brownish-flesh-colour." It is possible that this description was based on only the above-mentioned juvenile male.

The measurements in Table 5 are by GFvT from three dry skins in the Canterbury Museum, 16 in the National Museum of New Zealand, including 12 we collected, and two in the Otago Museum. The weights are from specimen labels.

Males make soft purring and ticking sounds audible only a few feet away, and females are silent except for soft, almost inaudible, puffing sounds heard only during a copulation.

When the shags are on or near a nest site their forehead crest remains up and the nape line, formed by depressing the crown feathers and raising the neck feathers, is prominent and continuous along the hyoids to the front of the throat.

As in other Phalacrocoracidae, males choose the nest site, which they defend against other males and on which they advertise for a mate. Females choose a male and his nest site and approach

TABLE 5 — Measurements of dry skins of *Leucocarbo ranfurlyi*

<u>Males</u>	No	Mean	Range
Culmen length	11	59 mm	56 - 62
Tarsus	10	69 mm	67 - 71
Wing	11	294 mm	285 - 300
Tail	11	127 mm	117 - 134
Weight	7	2.5 kg	2.3 - 2.9
<u>Females</u>			
Culmen length	8	55 mm	52 - 59
Tarsus	10	67 mm	65 - 70
Wing	10	278 mm	272 - 287
Tail	8	116 mm	107 - 137
Weight	6	2.5 kg	2.0 - 2.7

him cautiously. After she is accepted she builds the nest, mainly with material he brings to her, and copulation takes place on the nest. During incubation extra material is brought to the nest by both parents before and after nest relief. Birds of both sexes on the nest site have the closed wings drooped down beside the body, thus exposing the back, whereas birds outside the nest site have the wings folded well up, covering the back. Male-advertising displays are performed by males to attract a mate and after pair formation by males and sometimes females to call their mate. The displays cease when eggs are in the nest. Recognition displays are done by the bird on the nest site to acknowledge the arrival of a potential or actual mate. Some recognition displays follow or may be fused on to the end of a male-advertising display.

The male-advertising of *L. ranfurlyi* (see Fig. 10) consists of *Gargling*, in which, with the body upright, the bird swings its head back through a vertical arc until crown and nape touch the rump, and it then swings its head back to the starting position. Sometimes, birds do Gargling from a sitting position with the breast being raised or while standing on both feet or only one foot. During this display the bill usually opens as the head reaches the rump and snaps shut as the head returns to the forward position. Sometimes the bill remains closed and at other times the bill remains wide open for several displays in succession and during the subsequent Forward-gaping. During Gargling, the tail is raised almost vertically and the wings droop down beside the body. Once a male made a soft *hargh* call about 1.5 m away, which would have been inaudible from much further away.

Recognition consists of *Forward-gaping* and *Nest-worrying*. During Forward-gaping, the bird directs its wide-open bill forward and

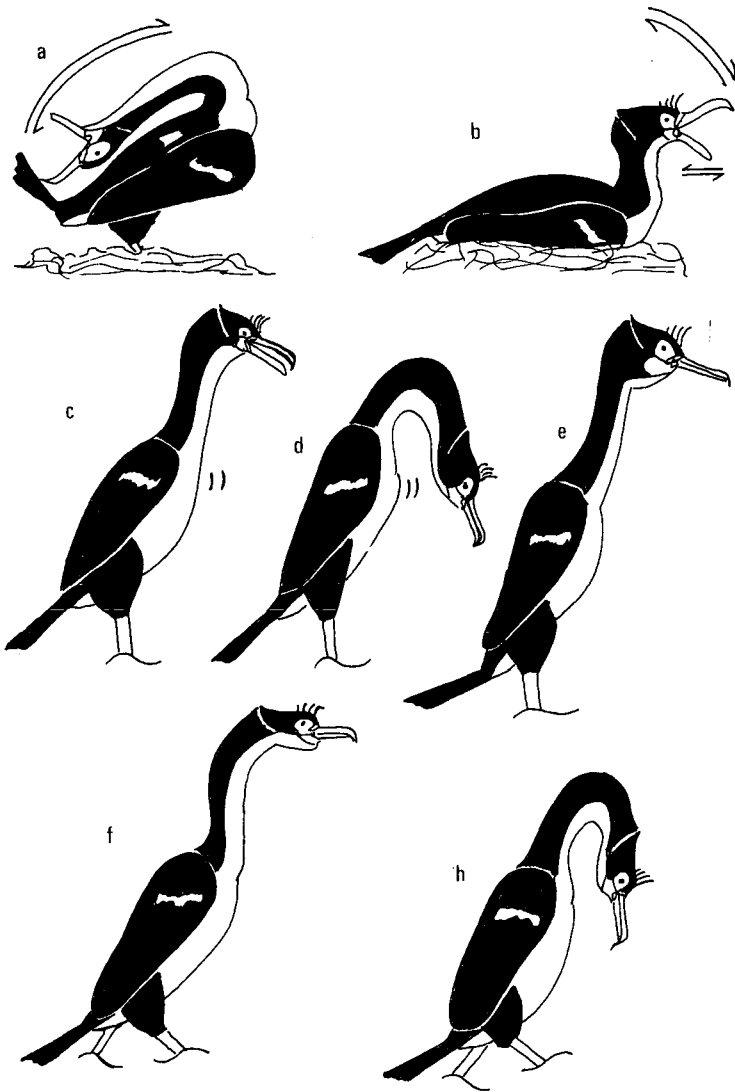


FIGURE 10 — Behaviour patterns of the Bounty Island Shag. (a) Gargling; (b) Forward-gaping, (c) Pre-take-off, (d) Pre-hop, (e) Post-landing, (f) Kink-throating, (h) Penguin-walking. Drawn from field sketches by GFvT.

sometimes somewhat upward and moves it back, forth and sideways above the front of the body. Males make a soft *he-he-he* . . . sound and females are silent.

In *Nest-worrying*, a bird worries the nest material with the bill. It makes no sound. Sometimes it worries the tail of its mate beside the nest instead. Scars of this behaviour can be seen on the tails of some museum specimens and should not be confused with hunger bars.

Another greeting display performed by both the bird on and the bird beside the nest site is *Head-lowering*. In it the head is lowered and raised in front of the body with the bill closed and horizontal. Usually the body is horizontal and the tail down below the horizontal. Often it is done by both birds in synchrony.

A bird threatens intruders with a wide open bill, a bulging throat, and by moving the head back and forth and sideways with irregular sinusoidal neck movements. Sometimes, males utter a soft *borr-borr-borr* . . . Females threaten silently.

When there is no cause for alarm cormorants and shags leave their nesting area slowly and deliberately with a characteristic posture of head and neck, the *Pre-take-off* posture. In this posture, *L. ranfurlyi* holds the head high with closed or slightly open bill sloping slightly downwards. Usually the neck is almost vertical with a slight arching of the whole neck holding the head somewhat forward. The breast and abdomen pulsate, while males sometimes make a ticking *t-t-t* . . . and females make no sound. Males also make this sound and pulsate their breast when they are about to rise from their nest and let their mate take over incubation.

Kink-throating is the main display of cormorants and shags when approaching the nest site and it often continues for a while after landing. It is also used when birds are mandibulating nest material near the nest site. Kink-throating, which is very like the food-begging of chicks, consists of a forward protrusion of the hyoid or tongue bones, giving the throat a characteristic kink. When Kink-throating near the nest, males of *L. ranfurlyi* sometimes make a soft *herr-herr-herr* . . ., *corr-corr-corr* . . ., or *horr-horr-horr* . . . sound, and females are silent.

During pair formation there is also a *Post-landing* posture, which is most elaborate in females approaching an advertising male cormorant or shag. It is an exaggerated recovery after landing, in which the posture of head and neck is highly species specific and so presumably serves as a guard against hybridisation. In the *Post-landing* posture of *L. ranfurlyi*, the bird raises its head with the bill horizontal and the throat bulbed. Its neck and body are almost vertical and the tail is down below the horizontal. It makes no sound. The *Hop* is a characteristic display of cormorants and shags near the nest site. In essence it is an abbreviated symbolic flight which starts with a *Pre-take-off* posture and ends with a *Post-landing* posture. All gradations

occur such as flying from one part of the nesting colony to another, *Circle-flying* away and back to the nest site, hopping from one perch to another, hopping only a few inches, and Pre-take-off posture alternating with a Post-landing posture without the feet leaving the ground (van Tets 1965). In some species of cormorants and shags, the *Pre-hop* and *Post-hop* postures differ from the *Pre-flight* and *Post-landing* postures, but in *L. ranfurlyi* only the Pre-hop posture is different, the neck being arched and the closed bill being directed vertically downward. In males sometimes a soft ticking *t-t-t*... starts and a soft *aw-orgh* ends a Hop, but females are silent.

Penguin-walking is done by *Leucocarbo* shags, including the Bounty Island Shag, when walking through or near their nesting colony, especially by males gathering nesting material and by females in search of a mate. The bird walks with the upper neck arched and the closed bill pointed vertically downward. It forms a ridge of feathers along the nape line by depressing its forehead crest and crown feathers and by raising its upper neck feathers. It folds the wings tightly on top of the back and holds the tail down below the horizontal. Sometimes when a bird is leaving the nest the Penguin-walking is preceded by a Pre-hop posture and when it ends near the nest it may be followed by either Kink-throating or a Post-landing posture.

Authors differ on whether *L. ranfurlyi* is related to the *L. carunculatus* or the *L. campbelli* group of *Leucocarbo* shags. By having an orange-yellow gape instead of a pair of orange-yellow caruncles on the base of the upper bill and by lacking a blue eye ring, *L. ranfurlyi* clearly belongs to the *L. campbelli* group: the subgenus *Nesocarbo* Voisin 1973. In their nesting ecology and behaviour the *Nesocarbo* shags differ from most other kinds of *Leucocarbo* shags by nesting on the sides of cliffs rather than on exposed relatively level ground.

L. ranfurlyi differs from *L. campbelli* and *L. colensoi* by being larger, having very rarely a dark foreneck; having a variable pattern of yellow at the gape, having various facial colours, and having a light brown iris. *L. campbelli* differs from *L. ranfurlyi* and *L. colensoi* by having a dark foreneck with a sharp border between the dark neck and the white breast. *L. colensoi* differs from *L. ranfurlyi* and *L. campbelli* by having a variable amount of white and dark feathers on the foreneck and having a prominent pink or pale shiny-purple eye ring that contrasts with a dark purple face. *L. ranfurlyi*, *L. campbelli* and *L. colensoi* differ also in details of their behaviour patterns, as will be reported elsewhere. We, therefore, regard them as three distinct species rather than as subspecies of *L. campbelli* or *L. carunculatus*.

SOUTHERN GREAT SKUA *Stercorarius skua lonnbergi*

Port Egmont Hens (= Catharacta skuas) were seen on 2 December 1773 when Cook was near the Bounty Islands (Beaglehole 1961). Since then the only published record of skuas at the Bounty Islands

was of a couple seen offshore on 26 February 1926 by Beck and Correia (Darby 1970 and Beck MS).

While we were on the Bounty Islands, Southern Skuas seen were as follows: one 7 November, two 8 November, four 9 November, seven 11 November, eight 12 November, ten 15 November, eight 17 November and one 18 November. These numbers indicate that they were transients, as suggested by Oliver (1950: 320). They were mainly seen resting on Skua Rock and the western end of Lion Island, which are relatively low, rounded and exposed to the highest storm waves. Elsewhere over the islands the skuas were mobbed by prions in the air and attacked by penguins and mollymawks. One skua was seen several times lifting a deserted egg in its bill as if to judge its weight before hacking it open with a closed bill and eating its contents. The same skua went to a fresh dead mollymawk and ripped bits off it until chased by penguins. All skuas were in new dark plumage similar to those at the Antipodes Islands.

SOUTHERN BLACK-BACKED GULL *Larus dominicanus*

According to Darby (1970), Black-backed Gulls were first found on the Bounty Islands on 26 February 1926 by Beck and Correia, and she wondered about the status of Dominican and Red-billed Gulls, thus implying that she saw both there on 12 January 1968. We are not aware of any other records of Red-billed Gulls (*L. novaehollandiae*) at Bounty Islands and can find no reference in Beck's manuscript.

When we arrived on 7 November, HMNZS *Waikato* attracted at least 20 Southern Black-backed Gulls. One pair was building and occupying a nest on the eastern end of Lion Island at least from 13 to 18 November. The distribution of pairs appeared to be four on Lion Island, one on Ranfurly Island, one on Coronet Island and two or three on Prion and Castle Islands. On 17 November 6 adults, 2 subadults and 10 juveniles were roosting on ledges on the western side of Proclamation Island. On 20 November ten, including four subadults, followed HMNZS *Waikato* from the Bounty Islands to the Antipodes Islands. There may be a regular interchange of gulls between these islands, which are only a few hours' flying apart. At the Bounty Islands the gulls foraged at sea and along the shores. They were not as vigorously mobbed by prions as the skuas and appeared better able to avoid attacks by penguins than skuas. A gull that landed on Tunnel Island caused intense aggressive screaming from surrounding penguins as it moved around near nests. An adult joined a group of giant petrels and Cape Pigeons feeding on a penguin floating in Bucket Cove.

ANTARCTIC TERN *Sterna vittata bethunei*

A "white kind of gull with a forked tail" was seen when Bligh discovered the Bounty Islands on 19 September 1788. Bethune in 1895 collected the first terns from the Bounty Islands, one of which is the lost type of *bethunei*, the subspecies that breeds on the subantarctic

islands near New Zealand (cf. Murphy 1938). Neither Beck nor Correia recorded terns in their diaries for the 1926 visit. On 12 January 1968 Darby (1970) found Antarctic Terns breeding on almost inaccessible ledges of precipitous cliffs.

We saw fish-flights on 8 and 10 November, and on 18 November DH found two nests with one egg each on ledges of Depot Island. We saw two plumage stages among non-adult terns roosting on narrow ledges of a perpendicular cliff of Proclamation Island: (a) black bill and legs, and white/pale grey crown with black sides paling to grey on nape; (b) red bill and legs, white crown with grey stripe from eye to nape. Both forms had white plumage between the eye and base of the bill. Presumably they were immatures and subadults of the Antarctic Tern. The terns rested mainly on small ledges and in cavities of steep cliffs. They were seen foraging over the sea around and between the islands, including the narrow gorges between Proclamation, Tunnel and Depot Islands. CJRR photographed a tern ashore on Proclamation Island going into horizontal rock fissures to feed on amphipods. The terns foraged in groups of up to six. Because of their mobility it was hard to estimate how many there were, but we gained an impression of about 20 adults and immatures.

STARLING *Sturnus vulgaris*

A Starling was seen on 26 February 1926 by Beck and Correia on Depot Island and flying between islands (Darby 1970 and Beck MS). We saw at least one adult in the gorge between Proclamation and Tunnel Islands. It was the only land bird recorded on the islands.

CONCLUSIONS

Species composition of the birds breeding on the Bounty Islands was very simple with only single representation at the subfamily level. Only the shag is restricted to breeding on the Bounty Islands.

The lack of land vegetation other than lichens and algae may be explained by the hard substrate, high phosphate levels, extensive runoff and salt-laden spray combined with the very high density of nesting penguins and mollymawks. The birds breeding at the Bounty Islands, therefore, are those that can manage without substantial amounts of land vegetation and soil. The shags used marine algae instead of tussock grasses to build their nest; and the mollymawks were using moulted penguin feathers instead of their normal vegetation to reinforce their mud nests. There were no burrowing petrels, and surface-nesting scavenger/predators such as *Macronectes* and *Stercorarius* need a more sheltered and less crowded habitat for breeding. Other than a stray Starling, there were no landbirds.

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SHORT NOTES

WHISKERED TERN IN BREEDING PLUMAGE

The Pukekohe-Tuakau sewage oxidation ponds are about 22 km from the mouth of the Waikato River and close to the willow belt that borders the river. Here on 8 March 1980, we saw a tern with the characteristic flight of a marsh tern. As we approached, we realised that it was a Whiskered Tern (*Chlidonias hybrida*) in breeding plumage, for it had a black belly. The following notes were made during a 3-hour watch, the bird sometimes coming as close as 10 metres.

Bill crimson, fairly long, about as long as the head. Forehead, crown and nape black; on the crown a short faint diffused line of white flecks. The cap encompassed the eye. Below it, a broad and obvious white margin extended from the bill along the cap to the hind neck.

Upper surfaces: Wing, shoulder, and back an even silver-grey. Outer three or four primaries dark grey with white quills; the tips of these outer primaries showed as a dark trailing edge. Pale behind the carpal joint. Rump and tail pale silver-grey.

Underparts: Neck and breast even silver-grey. A smoky-grey margin to leading underwing from body to carpal joint; rest of underwing off-white. From a distance, the belly looked black in contrast with the grey neck and pale underwing; it was in fact uneven dark grey and black when seen closely. This dark colour stopped abruptly behind the wings. Sides of rump, vent, and under tail-coverts white. The end of the tail had a shallow curve with the outer edge looking rounded when half spread. The broken colour on the belly and the faint white line over the crown indicated transitional plumage.

Legs red (darker than those of Red-billed Gulls, *Larus novae-hollandiae*). They were hard to see because the bird tended to perch only briefly and at a distance, but in flight in strong wind, when the legs were held dangling, the legs were obvious and looked surprisingly long.

The bird fed regularly on the longest beat available on the ponds, some 50 metres, with a strong wind on its left quarter, constantly dropping to the right to take food. When feeding, it flew 2-3 metres high over open water, up to 4 metres over ponds with vegetation, and sometimes remained on the wing for over 2 hours.

The bird was seen later by various members, including B. Brown, J. Eller, H. & T. R. Harty, D. A. Lawrie, A. Monaghan and S. M. Reed. We saw it last on 11 March, when it flew south over the willows toward the river.

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SEED-DISPERSING BIRDS IN NEW ZEALAND

In a recent note Norton (1982) stated that plants such as *Pseudowintera*, *Myrsine* and the podocarps, all of which have fleshy fruits suited for bird dispersal, were present in New Zealand before the arrival of frugivorous birds.

Norton apparently deduced from a paper by Fleming (1962) that birds arrived in New Zealand in the Miocene, c.25 million years ago. This is a misinterpretation, because Fleming clearly stated that the three endemic families of New Zealand birds (NZ Wrens, Wattle Birds and NZ Thrushes) were probably of early Tertiary origin and that the two endemic orders (Kiwis and Moas) probably dated from the Upper Cretaceous.

Although there are no known land-bird fossils from New Zealand older than the Upper Miocene (Fleming 1975), Cretaceous feather impressions confirm that birds were present in Australia about 125 million years ago (Talent *et al.* 1966). This is well before New Zealand separated from Australia in the Upper Cretaceous, perhaps 80 million years ago (Stevens 1980). Cracraft (1973) has stated that the diversity of birds known from the early Tertiary suggests that 'the class Aves, much as we know it today, was present on all continents in the Cretaceous.' There is no reason to doubt that New Zealand was already well-populated with birds, including frugivorous species, when the Tasman Sea started to form, or that it continued to be colonised by flying species after this event. Moas must be included among the frugivores (and potential seed dispersers) of probable Cretaceous origin, since they are known to have eaten the fruits and seeds of several plants, including *Myrsine divaricata* and *Podocarpus spicatus* (Burrows 1980).

The rise of the angiosperm plants, which now dominate the flora of New Zealand, dates from the Cretaceous (Fleming 1975), and so angiosperms such as *Pseudowintera* and *Myrsine* have probably evolved in the presence of birds throughout their history. The same is not true of the podocarps, which date back to the Triassic (Fleming 1975), before birds evolved. Nevertheless, New Zealand podocarps and their ancestors have probably coexisted with birds for over 100 million years, providing ample opportunity for the development of bird-adapted seed dispersal systems.

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THE LOCATION OF ADELIE PENGUIN COLONIES, WINDMILL ISLANDS, ANTARCTICA

During the 1976 winter, measurements were made of the elevation above sea level and orientation of raised-beach formations on several islands in the Windmill Group (100°30'E, 66°20'S), Antarctica. The aim of this work was to gain an overall picture of glacial retreat in the region and the isostatic response of the land.

In the raised beach survey, elevation a.s.l. for each definable raised shoreline and the size and 'roundness' of boulders at each formation were measured, and the orientation of raised beaches was recorded to determine the relative contributions of sea fetch and sea ice in beach formation.

When, in October, Adelie Penguins (*Pygoscelis adeliae*) returned to their nesting sites, strong correlations were found between location and size of colonies and the occurrence, composition and extent of raised-beach formations. The following correlations were observed.

1. All major penguin colonies were on raised-beach formations composed of well-sorted angular rock debris ranging from 2 to 6 cm long. This relationship also held for old deserted nesting sites, identified by discoloured patches of rock fragments and set in concretous guano. In younger deserted sites, bone and feather remains were also apparent.
2. Present-day colonies, with one exception, were on raised-beach formations. The preference to colonise beach formations, most of which are fully exposed to the prevailing weather, illustrates how important the availability of nest-building material is to colony location. In the exception to this relationship, on Nelly Island, the birds used a combination of moraine and solifluction debris for nest building.
3. Colony size and nest density appeared to be directly related to the availability of stones. This was most apparent on Clark Peninsula and the islands to the north, where numbers in colonies increased with distance from the ice cap. The more distant and larger colonies were on much larger and better-sorted beach formations — a result of a greater contribution of sea and wave action to transport, deposit and sort glacial rock debris on land outcrops downwind.

The maps and photographs given by Penny (1968) in a comprehensive study of the territorial and social behaviour of Adelie Penguins show the locations and variations in colony topography in the Windmill Islands. In particular, the occupied and relict colonies mapped in Figure 3 are on raised-beach formations, showing how much marine-worked marine-deposited glacial debris determines the location, distribution and elongated shape of colonies.

Although other factors undoubtedly influence the location of Adelie Penguin breeding sites, the availability of nest-building material, at least in the Windmill Island group, seems to be a major factor,

I am grateful to Dr G. W. Johnstone, Antarctic Division, for advice on this note.

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OYSTERCATCHER'S BREAST IMPALED BY BILL

On 11 April 1982 on the beach at Miranda, Firth of Thames, I saw a South Island Pied Oystercatcher (*Haematopus ostralegus finschi*) flying in an awkward way. Something was wrong with its neck. On closer inspection I discovered that the unfortunate bird had impaled itself through the breast with its bill. The bill entered high up on the bird's breast and emerged at the bottom of the breast. Altogether about 4-5 cm of the bill was hidden from sight.

Although I tried to catch the bird, it was able to fly. I tried again the next day but, although the bird was weaker, it could still fly. I could not find it on the fourth day.

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REVIEW

C. McGowan 1982: *The wing musculature of the Brown Kiwi Apteryx australis mantelli and its bearing on ratite affinities. J. Zool. Lond.* 97: 173-219, 18 figs.

Most previous accounts have dealt only with the proximal muscles. The kiwi's wing musculature resembles that of other ratites but is markedly dissimilar to that of carinates. In fore-limb musculature the ratite condition is closer to that of reptiles than carinates. The present skeleto-muscular data, with other evidence, suggests that ratites are primitive birds that evolved from a primitive flying ancestor. Some of the discrepancies in the published descriptions of ratite muscles may be due to individual variation and there is obvious need for more dissections. McGowan, who works in the Royal Ontario Museum and University of Toronto, used two adult female kiwis provided, in a fresh-frozen condition, by the National Museum, Wellington. McGowan summarises the arguments of Furbringer, Beddard, Parker and Owen, last century, P. R. Lowe's (1935) forceful argument that ratites evolved from a non-volant ancestor, and the later contributions of Tucker, De Beer and Ostrom. He concludes that his results are consistent with a hypothesis that derives ratites from a primitive volant ancestor that had not evolved the advanced flight mechanism of carinates.

— C. A. Fleming