KERMADEC ISLANDS EXPEDITION REPORTS: A GENERAL ACCOUNT OF BIRDLIFE

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SUMMARY

From 13/11/66 to 27/1/67 the Ornithological Society of New Zealand's 25th Anniversary Expedition was based on Raoul (Sunday) Island in the Kermadec Group. North Meyer in the Herald Islets, and Denham Bay on Raoul, were in continuous occupation from 19/11/66 to 20/1/67 and 14/11/66 to 24/1/67 respectively. Ornithological surveys were carried out on Raoul and all adjacent islets and more detailed studies made on Raoul and North Meyer; opportunity did not permit landings to be made on other islands of the group.

A general account is given of birdlife found inhabiting Raoul Island and the Herald and Milne Islets, and the status of species recorded is reviewed.

The Kermadec Allied Shearwater, known to breed only on Meyer, was found to have bred on Raoul and on most islets of the Herald Group. It, and remnant breeding colonies of Wedge-tailed Shearwater and Black-winged Petrel on Raoul, are endangered as a result of heavy predation by feral cats. A storm-wrecked specimen of the rare, endemic Sunday Island Petrel was the only evidence found of this species.

The Kermadec Petrel which, earlier this century, bred in hundreds of thousands on Raoul during summer, is now virtually extinct as a breeding species on this island; evidence of only two nests was found. Predation by cats and rats is thought to have caused this dramatic decline. Breeding recorded from all islets in the Herald Group followed the pattern of that of the winter-breeding **variety** on Meyer. (No morphological character has been found whereby Kermadec Petrels breeding on Meyer and Raoul can be separated taxonomically; however, because of their distinct breeding cycles, Iredale (1914) considered the Meyer population to be a "variety" of the species.) The majority of these birds are known to lay in February and March, but it was proved that some nesting occurs throughout the year. Although the polymorphic range on Meyer was as great as that reported from Raoul by Iredale (1914) in 1908, the extremes were less common.

The Red-tailed Tropicbird was nesting in greatest numbers on Dayrell and South Meyer, but the Masked Booby was breeding in numbers only on the Chanter Islets. Thirty-six occupied booby nests were on the Herald Islets. Besides the well known Denham Bay colony, Sooty Tern were found nesting at Hutchison Bluff and on Meyer and Dayrell Islets, the total breeding population being approximately 80,000 pairs. Mortality of chicks banded at between one and three days was considerably greater than that of older chicks. The White-capped Noddy, found breeding only on Meyer, had a more protracted breeding season than that recorded by Oliver (1955). The Grey Ternlet was found breeding on all but the Milne Islets and was in greatest numbers on Napier Islet.

Sooty Shearwater, Grey Plover and Southern Black-backed Gull were recorded apparently for the first time at the Kermadecs.

Comparative measurements indicate that some minor morphological differences may exist between Kermadec and New Zealand mainland forms of Pukeko, Kingfisher and Tui.

INTRODUCTION

From 13/11/66 to 27/1/67 seven members of the Ornithological Society of New Zealand, a botanist and an entomologist were based on Raoul (Sunday) Island in the Kermadec group in order to study birdlife and conduct biological surveys. The venture marked the Society's twenty-fifth anniversary (Merton 1968).

Two years earlier the Society had sent a similar expedition to the Kermadecs but only two days after its arrival a volcanic eruption on Raoul resulted in total evacuation and so the project had been postponed for two years (Edgar, Kinsky and Williams 1965). Of the thirteen members comprising this earlier expedition, only four were available to join the subsequent party. They were Messrs. D. E. Crockett, J. A. Peart, W. R. Sykes and myself as leader. Other members were Drs. J. C. Watt and M. F. Soper, and Messrs. J. F. Anton, W. V. Ward and C. R. Veitch.

The main object of the expeditions was to make ornithological surveys on Raoul and as many other islands in the Kermadec Group as possible. The last comprehensive survey was that of Oliver and Iredale who, in 1908, spent 10 months based at Denham Bay during which time the two Meyers, Napier and Dayrell of the Herald Islets were briefly visited, as well as Macauley and Curtis Islands and L'Esperance (French) Rock (Oliver 1909, 1910 (a) and (b), 1911 and 1912; Iredale 1910, 1912 and 1914).

It was unfortunate that neither Curtis nor Macauley Islands could be visited, even briefly, and our course did not take us close enough for useful observations to be made. Macauley was, however, occupied by a N.Z. Wildlife Service party from 28/7/66 to 22/8/66 (O'Brien 1966; Williams and Rudge 1969).

GEOGRAPHY

The Kermadecs comprise two large and over a dozen smaller islands, which are the summits of volcanic cones rising from a sub-oceanic ridge on a volcanic fault line extending from New Zealand to the Tongan archipelago. They constitute the most northern and only sub-tropical islands within New Zealand's biogeographical region. Raoul is the major and only habitable island and has an area of approximately 7,200 acres and rises to 1,694 feet above sea level. Its position is 29° 16'S. by 177° 55'W. Cape Brett, the nearest New Zealand landfall, is 531 nautical (611 statute) miles to the south-west; the distance from Auckland is 585 nautical (674 statute) miles, Norfolk Island is 750 nautical (864 statute) miles due west, and the Tongan group 500 nautical (576 statute) miles to the north-north-east.

Macauley (764 acres), is the second largest island and lies 60 nautical miles south-south-west of Raoul. Nineteen nautical miles south-south-west of Macauley are Curtis and Cheeseman Islands (128 and 19 acres respectively), and 52 nautical miles south-south-west again is L'Esperance or French Rock (12 acres), the most southern of the Kermadec group. (Data from "The N.Z. Pilot" 1958.) Raoul and Curtis are active andesitic volcanoes. Most of the smaller islands are situated in the Herald Group which lies between one and two miles off the north-eastern coast of Raoul (Figure 1).

The fauna and flora of the Kermadecs have a close affinity to those of New Zealand, but there is a tropical Polynesian element.

Curtis and Macauley were discovered and named by Capt. Sever of the British transport ship "Lady Penrhyn" on 31/5/1788 — not 30/6/1788 as stated by Smith (1887) — and Raoul and the Kermadec Group were named by Rear-Admiral Bruni D'Entrecasteaux in 1793 (Watts 1789; Smith 1887).

On 8/2/34 the Kermadec Islands, with the exception of a 275 acres block on the northern coast of Raoul, granted in 1887 to the celebrated settler Thomas Bell (Morton 1964), were gazetted "Reserves for the Preservation of Fauna and Flora" (N.Z. Gaz. 1934, p. 201) to be administered by the Lands and Survey Department. In 1937 the freehold block was resumed by the Crown for use as an aeradio station (N.Z. Gaz. 1938, p. 275) and the few settlers departed. This area, together with the aeradio station now sited upon it, is administered by the Civil Aviation Division of the Ministry of Transport (Figure 1). The history of Raoul Island has been reviewed by Haigh (1968).

Raoul Island is a roughly triangular-shaped, active, andesitic volcano, 22 miles in circumference, approximately 5½ miles long by 3½ miles wide, with an area of 7,275 acres. The highest point, Mt. Moumoukai (1694 feet above sea-level), is on the rim of the crater, which is approx. 1½ miles in diameter. Boulder beaches flanked by cliffs up to 800 feet high surround much of the island, but gravel beaches exist at Denham Bay and on parts of the northern coast. The topography is rugged; the only relatively extensive flat to undulating areas being Bell's Flat, a terrace above the northern coast (which comprises the 50 acres farm managed by the staff of the meteorological station); Low Flat, a sandy area at the back of North Beach; the narrow flat behind the Denham Bay Beach, and the crater floor.

Three lakes are found in the crater. The largest of these, Blue Lake, was a source of water for the meteorological station prior to the 1964 eruption, but is now polluted. Green Lake has apparently always had a high mineral content, and Tui Lake, little more than a pond in size, is stagnant.

Volcanic activity in November 1964 resulted in the formation of one large and ten smaller vents in the region of Green Lake. Ash showers fell over most of the Island to a greater or lesser degree. The eruption was responsible for destroying pohutukawa *Metrosideros kermadecensis* forest on Devastation Ridge, which separates Blue and Green Lakes, and around the shores — particularly at the eastern end — of Blue Lake (Adams and Dibble 1967).

Raoul is the only island in the Kermadec Group to have anything more than a purely coastal forest association; and many of the species found there are endemic. Some of these and the communities they comprise, are threatened by the browsing of feral goats (Sykes 1969), so that if their survival is to be assured positive action must be taken without delay.

The forests are dominated by pohutukawa in most places with *Myrsine kermadecensis* prominent in the understorey at lower levels and *Ascarina lucida var. lanceolata* at higher altitudes. Other more common forest species include karaka *Corynocarpus laevigata,* wharangi *Melicope ternata,* kawakawa *Macropiper excelsum var. majus,* mahoe *Melicytus ramiflorus,* tree-ferns *Cyathea kermadecensis* and *C. milnei* and nikau *Rhopalostylis cheesemanii.* In parts, particularly near Boat Cove, nikau dominates large areas and forms almost pure stands. More open areas such as old "burns" or coastal faces are clothed in native ferns, rushes and grasses. From sea level to near the summit of Moumoukai, in open sites or in wet or dry forest, there are few places where the aroid *Alocasia macrorrhiza* is not flourishing. This plant — and taro *Colocasia esculenta* — was apparently introduced by the settlers for food, but unlike the latter it has spread so much that it now dominates many areas and forms dense growths of up to 7 feet high. It has also spread to both of the Meyer islets. (Vegetation of the Kermadec Group has been studied by Cheeseman (1887), Oliver (1909) and Sykes (in press).)

Raoul Island is biologically a great disappointment because the arrival of goats, cats and, more recently, Norway Rats *Rattus norvegicus*

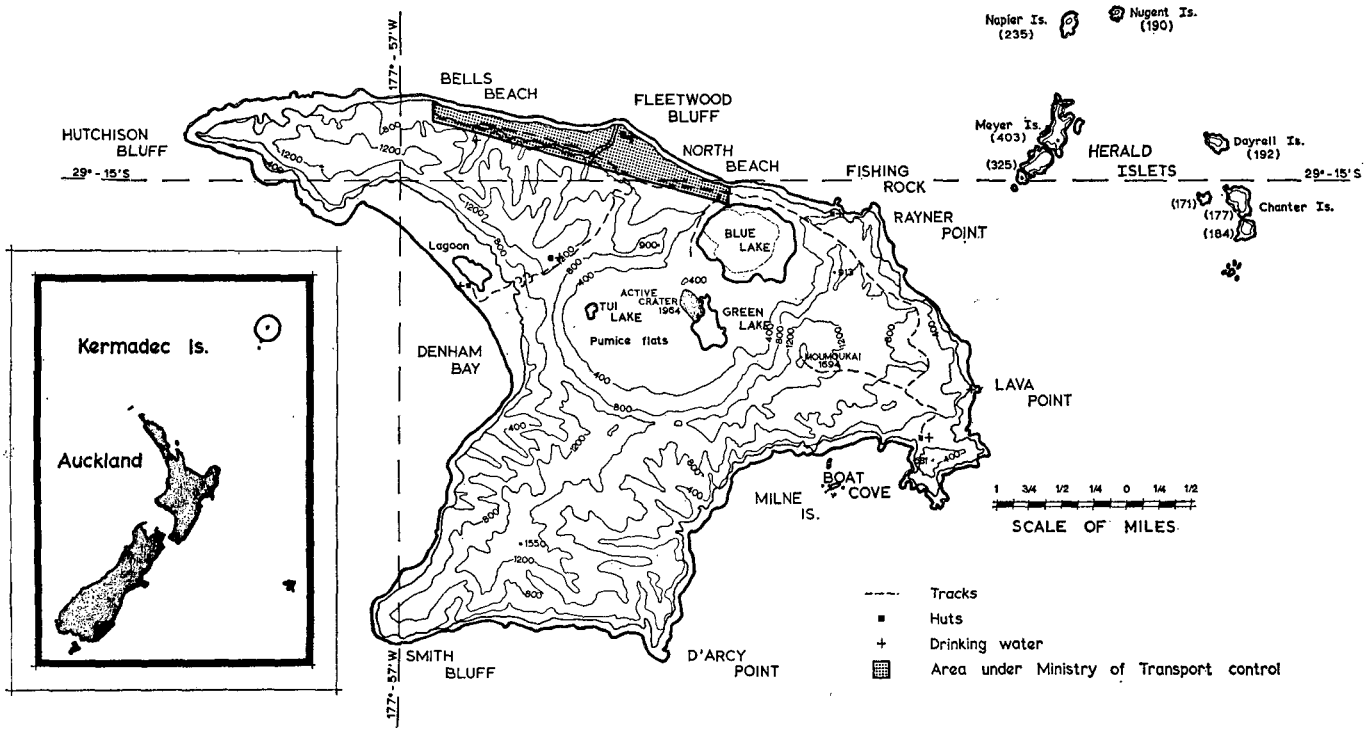

FIGURE 1 — Raoul Island and associated islets showing places referred to in the text.

has caused dramatic changes to the island's ecology. Goats, cats and rats were found throughout this island.

Goats, apparently first introduced in 1836 by Mr. James Reid (Rhodes, in Straubel 1954), one of the earliest European settlers, have modified the island's vegetation so that today only the less palatable species are regenerating successfully.

Feral cats were introduced to Raoul by " visiting ships " (Bell, in Oliver 1955) probably before the middle of last century. They have found their way to every part, including such inaccessible places as below Smith Bluff and the Sooty Tern colony at Hutchison Bluff, and signs indicate that they are moderately abundant throughout. According to Bell (Cheeseman 1887), cats were responsible for the extermination of both the Kermadec Parakeet on Raoul and a large indigenous fruit-pigeon* (Appendix V).

We found cats feeding to a large extent upon petrels as they came ashore to nest and it is reasonable to assume that in the past cats have played a major role in virtually exterminating the island's vast Kermadec Petrel breeding population (see below). At the present rate of predation it seems that both Black-winged Petrel and Wedge-tailed Shearwater must share a similar fate in the very near future.

Trapping confirmed the continued existence of kiore or Polynesian Rats *R. exulans,* the last previously recorded being in 1944 by Sorensen (Watson 1961). Of nineteen rats collected, nine were kiore. No obvious pattern of distribution was apparent, both kiore and Norway Rats being widespread. Kiore are thought to have reached Raoul in the canoes of Polynesian voyagers† (Oliver 1910b) and, because they and the more aggressive Norway Rat rarely occur together in the New Zealand region, it was interesting to find these two species co-existing there forty-five years after the arrival of the latter.

Mice are reputed to have appeared on Raoul after the 1953 visit by the " Holmburn " (Bell 1955) and the sighting of a number of smaller rodents in the vicinity of the meteorological station buildings and farm led us to believe that they were present (Merton 1968). However, four of these which were collected, proved to be young kiore.

Norway Rats reached Raoul in 1921 (Watson 1961) when the " Columbia River " was wrecked on the southern coast. We found this species plentiful, particularly so in the vicinity of the meteorological station and at the Denham Bay, trig V and Boat Cove huts.

Native birdlife on Raoul was most disappointing and it was obvious that dramatic changes to the island's ecology had occurred since Oliver and Iredale's visit in 1908.

* The systematic status of the Kermadec Pigeon has not been determined and no specimen exists (Oliver 1955).

† Maori tradition records that Raoul (Rangitahua) was a staging-point for canoes of the "fleet" period migration to New Zealand. It seems likely that the island may also have been visited in pre-European times by Cook or Society Islanders (Duff 1968).

Herald Group

Meyer, the largest of the Herald Islets, comprises two rounded hummocks of similar features separated by a narrow chasm which, under ideal conditions, can be waded at low tide. It is located about one mile north-east of Rayner Point, Raoul Island, and has a north-north-east/south-south-west axis. The northern islet is about 600 yards long with an average width of about 250 yards and rises to 403 ft. above sea level. The southern islet is about 400 yards long with an average width of about 200 yards and rises to 325 ft. above sea level; the combined area of the two being approximately 40 acres. Several rocks and stacks are nearby.

The islets are volcanic and are composed of beds of compact, yellow, andesitic tuff, intruded by a series of lava dykes. The north-western slopes, although steep (about 40°), are covered by rich, heavily burrowed loam and coastal scrub, as are the south-eastern aspects above their sheer sea-cliffs.

At the northern end of the northern islet is an extinct volcanic vent, the rim of which is roughly 300 ft. above sea level and measures about 150 yards in diameter. The sea enters this on the north-eastern side under a natural bridge.

Towards the southern end of North Meyer's north-western coast is a miniature natural harbour opening to the west and running in for over 100 yards with an average width of about 20 yards. We found that it was only during gales from the exposed quarter that heavy surge occurred within this harbour, or that the outer reef failed to stop the seas.

Our tent was pitched on a small, sheltered flat overlooking this harbour, and just beyond a few square yards of sandy beach. No other such area was found on any of the Herald Islets.

Towards the south western corner of this islet was a small extinct crater which we named the " Amphitheatre." This was invaluable for recording bird calls as its acoustics were outstanding, yet wind and sea noises were often hardly audible (Ward 1969).

On South Meyer, an anchorage for the dinghy was found near the north-western corner from where a wave platform, running almost the entire length of the islet provided access to the most suitable campsite, a small expanse of flat rocky ground at the south-western end.

Both islets, like all others of the Herald Group, are waterless, although rain-water is trapped in a rocky depression about 10' x 5' x 2' deep at the south western corner of North Meyer. Apparently this pond contains water (of sorts) in all but very dry periods. At the time of our arrival it was full, but the water was polluted by birds so that one would not have drunk it by choice. By mid-December it was dry. Other smaller depressions were found on the two Meyer islets but these contained water for only a few days after rain had fallen.

Meyer supports a coastal scrub association of pohutukawa, karaka, ngaio *Myoporum obscurum* and parapara *Heimerliodendron brunonianum* which, in places, reaches a height of 30 feet. Beneath this is a typical petrel-modified forest floor with little ground cover or understorey, except where gaps in the canopy allow additional

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Plate XIII — Camp on North Meyer Islet.

light to enter. The rocky coastal zone supports a growth of *Coprosma petiolata, Sicyos angulata, Cyperus ustulatus, Tetragonia tetragonioides, Asplenium obtusatum, Lobelia anceps* and *Disphyma australe.*

The Meyer Islets must be amongst the most fascinating, unspoiled bird-islands to be found anywhere. Few parts were not being used for nesting by at least one of the twelve breeding species; and although petrels and shearwaters were most active ashore before dawn and after dusk, their calling and activity was continuous. This may well be an adaptation resulting from the virtual absence of predators, as no bird-of-prey is resident at the Kermadecs.

Napier Islet is an andesitic laval stack 300 yards long by 175 yards wide, situated 700 yards north of Meyer. It has a north-north-east/south-south-west axis and reaches 235 feet above sea level. Sheer cliffs rise directly to the summit ridge on the eastern side; the western face, broken by numerous rock outcrops is steep and bluffs exist at each end of the islet. Blocks of coral were commonly found embedded in the lava; this and Nugent Islet being capped by quite massive uplifted coral reefs (R. N. Brothers, pers. comm.). On the western face where sufficient shelter and depth of soil permits, a stunted, windswept pohutukawa/ngaio association exists, and *Cyperus* dominates the exposed summit ridge.

Landings were made on 26/11/66 for about two hours and 2/1/67, also for two hours.

Oliver (Chilton 1910) believed that pieces of coral, shells and small stones he found high on Napier, had been carried there by land-crabs *Geograpsus grayi.* We also found such material on both Napier and Nugent and from the arrangement and position of some, believed them to have been so placed by land-crabs. However, there is no doubt that this material could have weathered from the uplifted coral reefs and so had not necessarily been carried from sea-level by land-crabs as Oliver inferred.

Nugent Islet, a conical, volcanic stack, 150 yards in diameter at sea level and rising to 190 feet lies 425 yards east-north-east of Napier. A little soil, present in several small depressions, supports a sparse growth of low, stunted ngaio, *Cyperus, Asplenium, Disphyma, Tetragonia* and other hardy, salt-tolerant species.

A landing was made on 2/1/67 when about two hours were spent ashore.

Coral and shells, similar to those found on Napier, were present near the highest point, and pieces of quartz were commonly found embedded in the rock.

Dayrell Islet: One mile east of Meyer is Dayrell, a flattish, vegetated islet with a north-west/south-east axis, rising to 192 feet a.s.l. and sloping gently to the north. It is about 300 yards long by 200 yards wide and is composed of andesitic tuffs bisected in various directions by lava dykes. Beneath underlying beds of white calcite rock are hard sandy tuffs containing marine fossils. Much of the islet is soil-covered and supports a wind-battered association of pohutukawa and ngaio, with a zone of low salt-tolerant herbs nearer the coast.

On 26/12/66 a landing was made on the north-eastern coast and two hours were spent ashore.

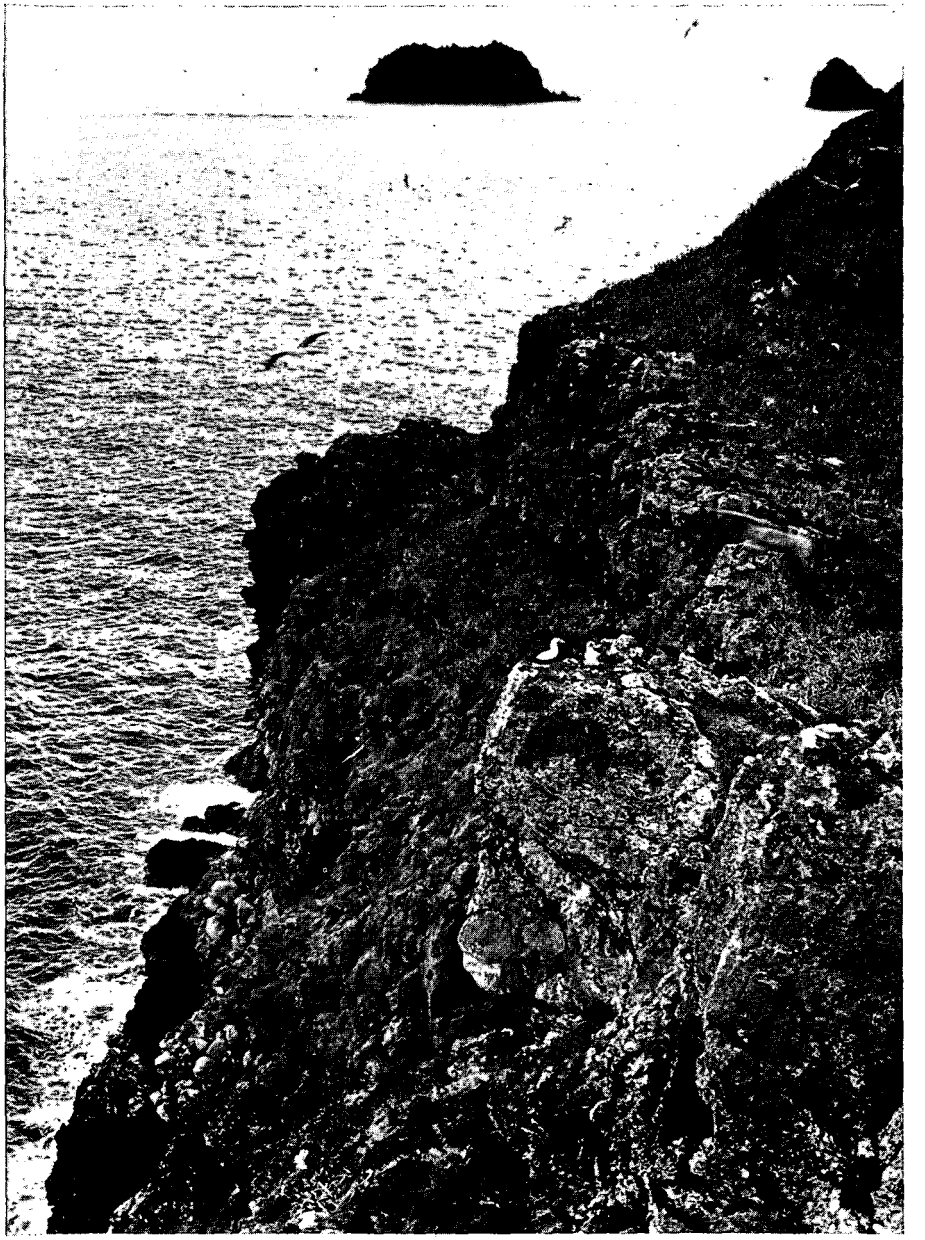

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Plate XIV — North Chanter Islet. Napier and Nugent Islets in background.

Chanter Islets: This group of two islets and one stack lies 2¼ miles east of Rayner Point and 400 yards south-south-east of Dayrell. The northern islet is about 350 yards long by 250 yards wide and rises to 177 feet a.s.l. The second islet, 50 yards to the south is approx. 225 yards by 200 yards and reaches 184 feet. The 171 feet high stack lies 200 yards west of the northern islet.

Geology is similar to that of Dayrell, and all are bounded by sheer cliffs. The dominant vegetation of the intensively burrowed soils covering the undulating plateaux is *Cyperus,* but small areas of stunted pohutukawa, ngaio and *Coprosma* scrub also exist.

They were inspected from the sea on 26/12/66 and on 1/1/67 we spent 2½ hours ashore on each. A party landed on the northern coast of the southern islet, and with some difficulty, scaled the eastern cliffs. Another party landed on the eastern coast of the northern islet, but no landing was attempted on the stack.

Milne Islets: A group of low, wave-swept andesitic rocks, 400 yards off the coast near Boat Cove. The highest reaches 45 feet, and it alone supports vegetation. A landing was made on 30/12/66 and several stunted, prostrate pohutukawa and a patch of *Disphyma* found near the summit. Six other salt-tolerant species were represented.

BIRDLIFE

(Nomenclature and presentation order follow Fleming (1953).)

Wandering Albatross *Diomedea exulans exulans*

Bell (Cheeseman 1887 and 1890) believed that this bred on the Chanter Islets. However, Iredale (1910 and 1912) disproved this and maintained that it was in fact rarely seen in Kermadec waters. Nevertheless most observers have recorded this species in the area. Iredale reported that the remains of one were found on Denham Bay beach in 1908; in November 1962 C. M. Clark (pers. comm.) found a storm-wrecked specimen of what he believed to be another there, and in June 1969 the remains of one were found on Bell's Beach (R. G. Lovegrove, pers. comm.).

Up to 17 off Curtis Island, were seen from the ship on 12/11/66 (Appendix I), one was noted at sea north of North Meyer on 30/11/66 and a humerus was found on Denham Bay beach (Appendix IV).

Giant Petrel *Macronectes giganteus*

Although Fleming (1953) stated that this species ranges " north rarely to 25°S.", the only record of it from the Kermadecs appears to be that of the Wildlife Service party which, in August 1966, saw one off the coast of Macauley (O'Brien 1966).

We recorded one on 1/12/66 off Meyer.

Wedge-tailed Shearwater *Puffinus pacificus pacificus*

A specimen collected on " Sunday Island " by Bell and sent, without data, to Cheeseman (1890) was identified as this species. However, Cheeseman tentatively identified fledglings from the same source as *Puffinus carneipes* (Iredale 1910 and 1912). According to Iredale, in 1908 birds arrived at Raoul and Meyer in mid-October

TABLE 1

DISTRIBUTION OF SPECIES FOUND BY 1966/67 ORNITHOLOGICAL SOCIETY EXPEDITION ON RAOUL ISLAND AND ADJACENT ISLETS

Recorded: x Breeding: b Storm-wreck or remains: + Unconfirmed sighting: o	Raoul Island	Herald Islets								Milne Islets
		Nth. Meyer	Sth. Meyer	Napier	Nugent	Dayrell	Nth. Chanter	Sth. Chanter	Wst. Chanter	
Wandering Albatross	+									
Wedge-tailed Shearwater	xb	xb	xb	xb		xb	xb	x		
Sooty Shearwater	+									
Kermadec Allied Shearwater	xb	xb	xb	xb		xb	xb	xb		
Sunday Island Petrel	+									
Kermadec Petrel	xb	xb	xb	xb	xb	xb	xb	xb	x	
Black-winged Petrel	xb	xb	xb	xb		xb	xb	xb		
Kermadec Storm-Petrel										o
Red-tailed Tropicbird	xb	xb	xb	x	xb	xb	x	xb		
Masked Booby			x			xb	xb	xb	xb	
Frigate Bird	o									
Grey Duck	xb									
Spotless Crake		xb	x							
Pukeko	xb									
Grey Plover		x								
Pacific Golden Plover	x	x								
Asiatic Whimbrel	x	x								
Eastern Bar-tailed Godwit	x									
Wandering Tattler	x	x	x							x
Turnstone	x									
Knot	+									
Southern Black-backed Gull	x									
Red-billed Gull	o									
Sooty Tern	xb	xb	xb			xb				
White-capped Noddy	x	xb	xb							
White Tern	xb									
Grey Ternlet	xb	xb	xb	xb	xb	xb	xb	xb	x	x
Kermadec Parakeet	+	xb	xb	x		x	x	x		
Shining Cuckoo	x									
Long-tailed Cuckoo	x									
Kingfisher	xb	x								
Skylark	o									
Song Thrush	xb									
Blackbird	xb	xb	x							
Pipit	o									
Tui	xb									
Redpoll	x									
Yellowhammer	x									
Starling	xb	xb	xb	xb		xb	x	x		

and bred " in immense numbers," mainly on the northern and eastern coasts of Raoul, and he considered it was " probably the most abundant bird breeding on the island." Davison (1938) found it numerous on open ridges, near the coast and on the north side of the island in late October 1937, and in December 1954 L. C. Bell (1955) saw " a few coming in at dusk round the station." It may also breed on Curtis, for on 16/4/29 Guthrie-Smith (1936) found a nestling which was " twice the size of (the) fluffy *Pterodromus nigripennis* " chicks, in a burrow there. In August 1966 the remains of many chicks were found on Macauley by the Wildlife Service party, and it was considered to be a very common breeding species (O'Brien 1966).

We found small breeding colonies on all headlands and along the tops of many coastal cliffs on Raoul. However, we saw no evidence of a " large breeding colony " reported by Edgar *et al.* (1965) on the ridge behind the station buildings; a few scattered — mainly unoccupied — burrows were found there. The often vast numbers of unoccupied burrows were an indication that the present colonies are no more than remnants of a much greater population. Of 50 burrows examined on 15/12/66 at Hutchison Bluff, only 19 were occupied, and of many hundreds seen at D'Arcy Point on 30/11/66, about 20 showed signs of occupation. Fresh carcases eaten by cats occurred, often in quite large numbers, near most colonies (e.g. 46 in one " midden " at D'Arcy Point on 30/11/66). A feature of some burrows, particularly at D'Arcy and Rayner Points, was their huge entrances and great length. Some entrances were large enough for a man to crawl into and were nine feet or more in length.

The breeding population of Meyer was estimated to be ten thousand pairs, and burrows were widespread. Birds were active ashore in late November, but from 1-5/12/66 numbers declined and the first eggs were seen on 12/12/66. Torrential rains on 7/1/67 flooded many burrows on the lower western slopes of North Meyer, causing 54% of those in the study area to be deserted (Crockett, in press).

On Napier one bird was seen to land during the afternoon of 26/11/66 and on 2/1/67, 2 (without eggs) were occupying burrows.

The species was plentiful and breeding on Dayrell. Some burrows were unusually short and on 26/12/66 several birds were incubating beneath a shallow overhang. All nests contained an egg.

Several birds were seen in flight over the Chanters on 26/12/66. None were found on the southern on 1/1/67 but 3, brooding eggs, were seen on the northern islet.

Sooty Shearwater *Puffinus griseus*

Three fresh specimens were washed ashore on Denham Bay beach on 22/11/66, 3/12/66 and 24/1/67. Measurements* (in millimetres) are given below.

This species has not previously been recorded from the Kermadecs.

* Measurements given in this paper are those described and recommended by Baldwin, Oberholser and Worley (1913).

Bill						
Length	Depth	Width	Mid-toe and claw	Tarsus	Wing	Tail
40	14	15	62	55		
41.6	13.9	16.5	70	56.1	270	78
42	14	15	67	55	295	97

Kermadec Allied Shearwater *P. assimilis kermadecensis*

In a letter in which he described his botanical findings on "Sunday" Island during the period 2-27/7/1854, Milne (1855) mentioned seeing "two kinds of mutton-bird; one is large . . . , the other is *Puffinus assimilis.*" The inference is that the observation was made on Raoul, however Iredale (1910 and 1914) has shown that this was not so; specimens of *P. assimilis* (Cheeseman 1890), and other species, obtained by Macgillivray during the visit and labelled "Raoul" were in fact collected on Meyer, and no large muttonbird breeds on Raoul at that time of year, but both Kermadec Petrel and Allied Shearwater would have been ashore in numbers on the Meyer Islets at that season. Iredale (1910) visited Meyer on 3/8/1908 and found that most *P. assimilis* burrows contained hard-set eggs, however fresh eggs and 3 downy young were noted.

The subspecies was described by Murphy (1927) from specimens collected from the Herald Islets in November 1925 by Beck of the Whitney South Sea Expedition.

Although most observers have found it breeding abundantly on the Meyer Islets, there appears to be no record of its ever having bred elsewhere. However, circumstantial evidence obtained by the

TABLE II

Summary of measurements (in millimetres) of adult Allied Shearwater remains from the Herald Islets.

	Number	Mean ± S.d.	Range
Bill length	11	26.8 1.16	25.5 - 29
depth	11	8.4 0.57	7 - 9
width	11	9.1 0.74	8 - 10
M.t.c.	11	44.5 1.36	42.5 - 46.5
Tarsus	11	39.0 1.24	38 - 41
Wing	12	182.6 4.20	176 - 191
Tail	10	70.0 4.00	66 - 77.5

1964 Kermadec Islands expedition (Edgar *et al.* 1965) indicated that the species may breed on Raoul, and the findings of the current expedition confirm this.

On 13/12/66 the cat-eaten remains of three juveniles were found at about 300 feet above sea level on Rayner Point (wing measurements 150 mm., 172.5 mm. and 175 mm.). A dead adult was found at the foot of the cliff on the same day and on 14/11/66 the remains of a juvenile (wing measurement 147.5 mm.) were found at sea level near Fleetwood Bluff where I had found the remains of two juveniles in November 1964.

Several almost fully feathered chicks were seen exercising their wings outside their burrows, often during daylight, on North Meyer, the last being observed on 7/12/66. The only live adult recorded was ashore on North Meyer on the night of 29/11/66.

A small number of dead adults and young, found on South Meyer, Napier, Dayrell and the two Chanter islets, was evidence that breeding had occurred.

Sunday Island (Black-capped) Petrel *Pterodroma externa cervicalis*

This was first mentioned by Cheeseman (1890) who was given specimens and informed by Bell that " it is by no means common. It arrives about the end of September and remains until the end of June . . . ." It was described by Salvin in 1891. Iredale (1910) observed that in 1908 " it was estimated that less than 500 pairs were breeding and that little increase is being made, owing to the ravages of wildcats. Scattered colonies exist all over the island, but in no case are these of any extent, and none, as far as was known, exist on the outlying islets." He found that colonies were always on ridges and that it arrived in October and departed in May.

Despite our efforts to locate this rare endemic none was found. A relatively fresh storm-wrecked specimen was found on Bell's Beach on 5/1/67 however, (measurements in millimetres below) proving that this handsome petrel still exists.

Dominion Museum Number	Bill			Mid-toe and claw	Tarsus	Wing	Tail
	Length	Depth	Width				
D.M. 12843	38	16	17	50.5	37	311	128

The only other reports appear to be those of Jenkins (1970), who saw what he believed to be birds of this species off the Kermadecs on 4/1/70 (2), 5/1/70 (1 and 1) and 18/1/70 (groups of 1, 10, 4 and 3 birds).

Kermadec Petrel *P. neglecta*

When Capt. Sever discovered the group, and on 1/6/1788 landed on Macauley, he reported that " the inhabitants are the brown gull, . . ." (Watts 1789). As gulls do not normally occur at the group it seems likely that the birds referred to were in fact winter-breeding Kermadec Petrels. Macauley was visited again on 20/12/1836 by Capt. Rhodes of the whaling barque " Australian," who reported that the island " . . . abounds with goats and pigs," and that the latter were inedible; their flesh tasting strongly of fish, apparently

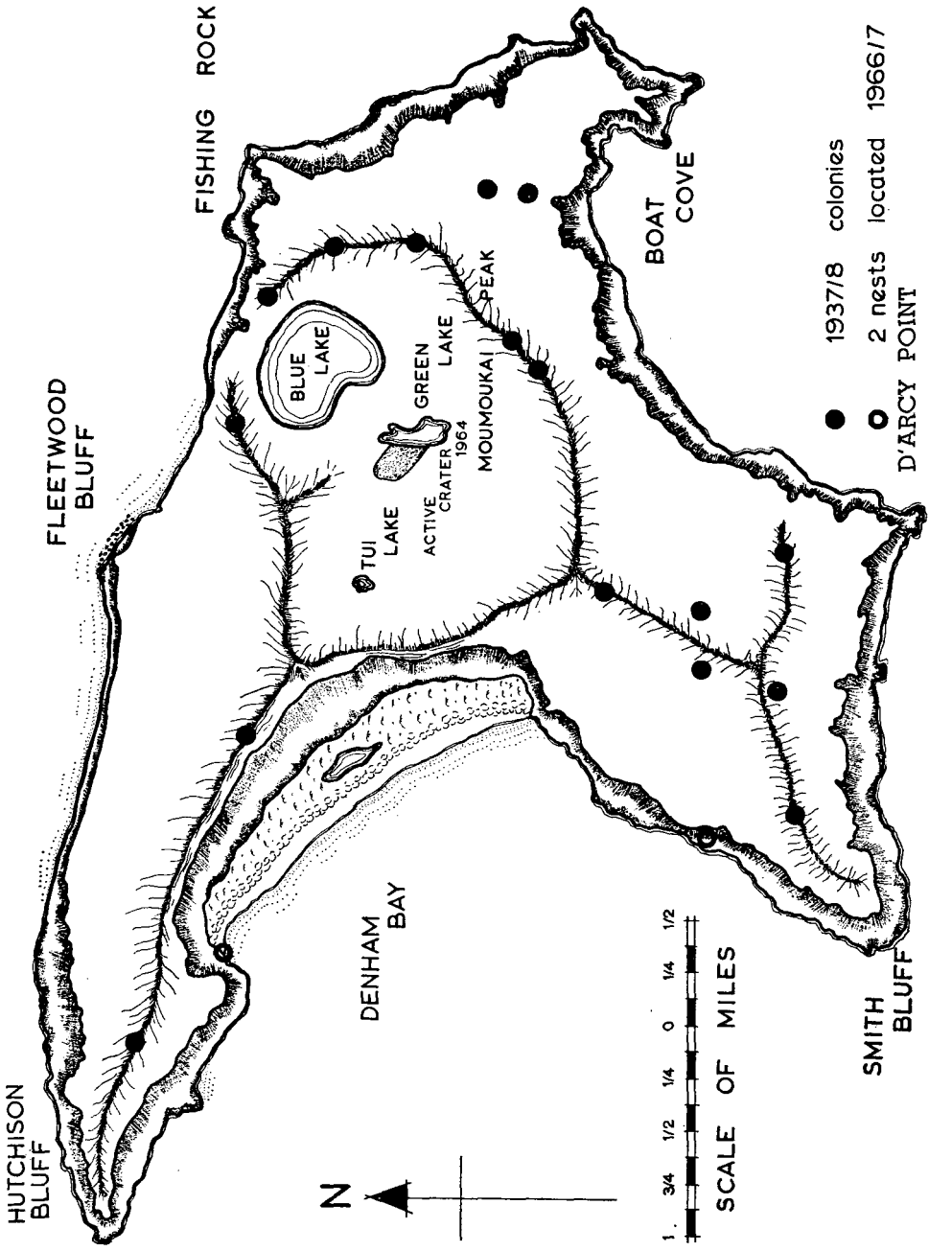

FIGURE 2 — Raoul Island showing distribution of breeding Kermadec Petrel *Pterodroma neglecta* during 1937/38 and 1966/67 breeding seasons. 1937/38 data from Davison (1938).

as a result of their feeding upon birds. Pigs were no longer present in 1887, but goats were plentiful (apparently they remained so until being exterminated in 1966 (Williams and Rudge 1969)) and a feral dog was seen (Smith 1887). Disturbance by these animals, and predation by the pigs and dog would have been disastrous to surface-breeding petrels and may account for the fact that the species was not recorded there by Cheeseman or Iredale, who visited the island in August 1887 and November 1908 respectively. Furthermore winter-breeding birds would have been absent at these times. However, in August 1966 a N.Z. Wildlife Service party (O'Brien 1966) found the remains of two fledglings, proving that it breeds there.

Macgillivray, naturalist on H.M.S. " Herald," which visited the Kermadecs in July 1854, collected the species on Meyer (Iredale 1914). Not only is this bird polymorphic, but those inhabiting Raoul and Meyer have distinct breeding seasons, and this unusual phenomenon has been interpreted by different systematists in different ways. Hence Macgillivray (1860) believed the variation in colour was due to immaturity though all birds were breeding, and Cheeseman (1890), after consultation with Buller and Hutton, recorded the species under three specific names. In an attempt to clarify the matter Iredale (1914) studied these birds while on Raoul for ten months in 1908. He concluded that those on Raoul, " whatever their colouration or habits, belong to one species," and those on Meyer are a " variety " of the same species — a view which is now generally accepted. However, the findings of the present expedition indicate that further complications exist and that the matter may never be finally resolved: the Raoul population is now virtually extinct, and that of Meyer (and other of the Herald Islets) has a very protracted breeding season, which, in a minority of instances, actually corresponds with that of the summer-breeding population which formerly bred on Raoul.

Iredale (1914) estimated the breeding population of Raoul in 1908 at " about half a million individuals " and the young, known locally as " boobies," were harvested in large numbers by the settlers (12,000 in 1889 according to Cheeseman (1890)). The species bred on the surface at a density of up to 800 nests per half acre early this century according to Venables (1937). However in 1937, Bacon, a settler whose association with Raoul began in 1889, observed that Kermadec Petrels were " very scarce " (Bacon pers. comm.), and " not nearly so numerous as they were ten years ago, . . ." (Davison 1938). Sorensen (1944) found it breeding in 1944, but in December 1954 L. C. Bell (1955) failed to find it ashore, although it was present in " large numbers " overhead. It was not encountered on Raoul by the 1964 expedition (Edgar *et al.* 1965), and during our stay evidence of only two nests could be found (Figure 2). Factors which may have contributed to this decline are discussed briefly below.

Muttonbirding is unlikely to have had any appreciable effect upon a breeding population of such magnitude. However, it does seem reasonable to suppose that mobs of goats, especially if disturbed by man or dog, moving over ground densely populated by surface-breeding petrels, may have had an adverse effect upon nesting success. Pigs or dogs have apparently at no time become widespread, or established in a feral state, on Raoul.

[M. F. Soper

Plate XV — Typical dark and intermediate phase Kermadec Petrels breeding on North Meyer Islet.

The kiore or Polynesian Rat *Rattus exulans* cannot be ignored as a factor capable of having contributed to the decline of this, and other, species. According to Bell (1911), this rat preyed to a considerable extent upon the young of *P. neglecta,* e.g. on 8/3/11 he wrote — " I do not think there is 5% of the young that were hatched now alive. It is one of the worst years for them I ever saw. Rats are principally to blame for this destruction. I should think that out of every 100 killed 80% have been killed by them, about 15% by cats and about 5% by rain." Kepler (1967) records that on Kure Atoll in the Hawaiian Leeward Islands, the Polynesian rat is a predator of adult and nestling Laysan Albatrosses *Diomedea immutabilis,* Bonin Petrel *Pterodroma hypoleuca* and Sooty Tern *Sterna fuscata* eggs, and Noddy Tern *Anous stolidus* chicks. Although there seems to be no conclusive evidence of predation by *R. exulans* upon adult or young birds in the New Zealand region, I know of no sympatric populations of kiore and high-density breeding Procellariiformes and believe that this rat is affecting these birds — especially the smaller forms; and Fleming (1969) has suggested that the Polynesian rat may have been a factor in the reduction or extermination of some 27 species (7 genera) of moa (Dinornithiformes) and ground-nesting carinates such as *Aptornis, Notornis* and *Cnemiornis* during the late Holocene. Furthermore, like Oliver (1910b), I have found the kiore to be a scavenger of the flesh and fat of birds, mammals and fish, especially during autumn and early winter, and in those years when its numbers are higher than usual. It will also eat eggs, for on Hen (Taranga) Island, in 1933, Stead (1936) found " a number of petrels' eggs," including three of Pycroft's Petrel *Pterodroma pycrofti,* which had been " eaten " by kiore, and Oliver (1955) records that in 1908 he saw " several " Tui *Prosthemadera novaeseelandiae* nests on Raoul Island, the eggs of which had been " destroyed " by these rats.

It seems unlikely that a very large Kermadec Petrel population could persist for long on Raoul in the presence of kiore predation of the order described by Bell. However it is possible that this rat, although present on Macauley since that island's discovery in 1788, may have been a more recent arrival on Raoul than is generally believed. Raoul has been spasmodically occupied by Europeans since 1836 (Smith 1887; Rhodes, in Straubel 1954) and kiore are thought to have been present prior to this (Cheeseman 1887; Oliver 1910b), but rats do not appear to have been recorded until 1887 (Cheesman 1887; Smith 1887). Subsequently their seasonal incursions caused widespread damage to settlers' crops (Oliver 1910b). An alternative possibility is that kiore have been present on Raoul since before European settlement began, but their habit of preying upon nestling petrels there has been more recently acquired. However, as Bell's observation appears to be an isolated one and the spectacular decline of Kermadec Petrels breeding on Raoul did not occur until after the arrival of Norway Rats in 1921, a natural phenomenon such as a failure in the food supply, as is known to occur occasionally in the breeding colonies of most colonial sea birds, would be a more acceptable explanation for the vast numbers of dead young seen by Bell in 1911. That a large percentage had been partially devoured by rats could be irrelevant if, as one would expect, the rats had attacked the carcases *after* death. On the other hand it must be

remembered that Roy Bell was an experienced field observer with an intimate knowledge of Raoul's natural history (Iredale 1910), and the extraordinarily placid nature of these petrels would make them most vulnerable to attack by rats and cats. The latter are known to have killed considerable numbers of adults and young (Bell *loc. cit.;* Bacon pers. comm.; Sorensen 1944), and are generally regarded as being responsible for the decline.

The extinction of the Kermadec Petrel as a breeding species on Raoul is now virtually complete and was predicted by Davison (1938) when in 1937 he noted heavy predation by both Norway Rats (eggs) and cats (adult birds).

On 13/12/66 two birds (one light and one intermediate phase) were found together at a nest under fern near the head of a slip at the northern end of the Denham Bay beach. These birds were seen here spasmodically, either together or singly, until our departure from Denham Bay on 24/1/67, at which time they had not laid. On 27/3/67 K. Wickens (pers. comm.) and other meteorological station staff saw a chick in this nest.

In 1908, according to Iredale (1914), birds began coming ashore in numbers on Raoul in August (first week in August 1937 (Davison 1938)), and laying began in mid-October. No egg was found being incubated later than 9/2/08 and all young had departed by the end of May. The egg in the above nest however, could not have hatched before early March.

Birds were heard calling as they circled above Hutchison Bluff, (one bird) on 15/12/66 and Smith Bluff (two birds) on 12/1/67, where nesting was suspected but not proven. On 17/1/67 a downy chick (about 2 weeks old), which had obviously been washed from its nest by recent heavy rain, was found dead well above high-tide mark at the base of cliffs about three-quarters of a mile north of Smith Bluff.

The remains of an adult were found above Smith Bluff on 12/1/67. Areas of exceptionally lush growth and obviously of unusually high fertility for such situations were seen there and more particularly above the Denham Bay cliffs and on the ridge leading to Hutchison Bluff. These were thought to have been former sites of nesting colonies of this species; old skulls and other bones occasionally being found at such localities.

One would expect that, with hundreds of thousands of petrels depositing nutrients from the sea onto the ground near their nests for about 9 months each year (Iredale 1914), fertility would have been unusually high, and such were the findings of Wright and Metson (1959) in their soil survey. They commented that " generally organic matter is remarkably high for such young soil " but this they attributed to the vigorous plant cover and not enrichment by birds. In fact, the only " bird-soils " mentioned are those of Denham Bay where a Sooty Tern breeding colony exists. Wright and Metson also found unusually high organic phosphorus ratios in older soils and that the distribution of organic matter showed abrupt changes in nitrogen content. These again may have been influenced by former concentrations of breeding petrels.

In 1908 Iredale (1914) found that the species arrived at Meyer about January, laying occurred in late February and March and all young had departed by early August. On 14/4/29 Guthrie-Smith (1936) found that incubation was in progress and saw a week-old chick, and Davison (1938), who visited Meyer in July 1937, found well-grown young.

On 19/11/66 however, we found that some had laid and several young were present, one of which was almost able to fly. Unseasonal breeding on Meyer appears to have been a recent innovation; the only other references being those of Sorensen (1964), who in August 1944 found fledglings ready to fly, downy chicks and one bird incubating, and Edgar *et al.* (1965), who on 20/11/64 recorded 3 nests, 2 of which contained eggs. Furthermore, from apparently conflicting statements made by Iredale (1910 and 1914), it would appear that small numbers may have bred previously. In his former account he stated that " whilst Sunday Island is the resort during the summer months of many thousands of birds, only about half a dozen pairs breed on Meyer Island," but in the latter he wrote: " By the middle of November (1908) there were no signs of these birds about Meyer Island." The few summer breeders are perhaps remnants of the vast population which formerly bred on Raoul at this season. However, I rather suspect that for a minority of birds, the breeding season has always been protracted.

Seven chicks were known to be present on the northern islet on 26/12/66, 17 on 3/1/67, 24 on 12/1/67 and 25 on 20/1/67. Most of these early nests were situated on the south-eastern slopes beneath a low ngaio and *Coprosma* understorey; shade apparently being an important factor in the selection of a nest-site (Anton, in prep.).

Of 24 nesting pairs in the Camp Flat study area on 13/12/66, only 2 had eggs. Heavy rain on 7/1/67 washed out 14 of these nests, and 3 with eggs were completely buried by debris, but none was deserted as a result. Those on steeper ground fared better. On 25/1/67 106 occupied nests were counted in this area (0.8 acre) and this density was considered representative, so that the total breeding population of the Meyer Islets (c. 40 acres) was estimated to be 5,000 pairs. Numbers were still increasing at this time so that the ultimate breeding population would probably have been nearer 6,000 pairs. The same number was estimated by Iredale to have bred in 1908. The normal clutch is one, but 2 nests, each with 2 eggs, were seen. Nests were observed on the stacks off the coasts of Meyer.

All colour phases were represented, but intermediate forms were by far the more numerous and as they themselves varied considerably we found it difficult to group birds into three phases according to plumage colouration, as others had done.

Of 890 breeding adults examined from all altitudes and aspects on both islets, 9% were light (head white or very light with a few dark brown markings on the crown, throat and underparts white, upper parts dark brown), 13% dark (dark brown to black all over, but some had a small light patch at the base of the bill) and 78% were of an intermediate colour. Leg and foot colour varied and was not taken into account. Pairs of mixed colouration were very common.

Using the above classification, of 264 birds from all altitudes and aspects on Raoul examined by Iredale (1914) during the spring of 1908, 17% were light, 37% dark and 46% intermediate. This result confirms Iredale's belief that " the extremes were much rarer " on Meyer. We could offer no explanation for this, but our findings were in line with Iredale's theory that the species is " excessively variable, one form producing, or partially producing, in an irregular way, the other."

During December and January numbers of adults on Meyer increased, so that by late January they were in large numbers and competition for nest-sites was becoming intense. The peak laying period would have occurred after our departure.

All colour phases were represented on Napier. Several partially dried corpses of half-grown young and a nest containing an egg were found on 26/11/66, and of c. 30 occupied nests on 2/1/67, several contained an egg, but most birds had not laid — proving that the breeding season is protracted and is of a pattern similar to that on Meyer. One intermediate phase brooding an empty nest and the remains of 2 eggs were found on Nugent on 2/1/67. The species was plentiful and breeding on Dayrell, and all colour phases were represented. The breeding pattern was similar to that on Meyer; some nests contained an egg on 26/12/66, but most birds had not laid. An approximately two-month-old corpse of a large chick was evidence that some breeding had occurred during spring. The breeding pattern on the Chanters was similar to that found on others of the Herald Group, and although nesting birds were in moderate numbers throughout both islets on 1/1/67, eggs were recorded only from North Chanter. Semi-fresh remains of half-grown young were evidence of spring breeding. Dark and intermediate colour phases were recorded on South Chanter. On North Chanter all forms occurred, of which intermediates were predominant.

TABLE III

Summary of measurements (in millimetres) of adult Kermadec Petrel from the Herald Islets.

	Number	Mean ± S.d.		Range
Bill length	16	29.8	1.20	28 - 32
depth	16	13.7	0.91	12 - 15.25
width	16	13.7	1.10	11.25 - 15.5
M.t.c.	16	51.5	1.86	48 - 54.75
Tarsus	15	39.6	1.31	38 - 42
Wing	14	284.8	6.15	272 - 294
Tail	15	105.1	4.39	99 - 114

Black-winged Petrel *P. hypoleuca nigripennis*

Cheeseman (1890), who obtained specimens from Bell, identified this as "*Œstrelata cookii*." However Rothschild recognised it as being distinct, and in 1893, described and named it.

According to Cheeseman, this bird bred on Meyer and more sparingly on Raoul Island, and Iredale (1910 and 1912) confirmed that in 1908 this was so. Iredale also recorded it on "the outlying islets" (Napier and Dayrell), as well as on Macauley and Curtis Islands, and in April 1929 Lindsay (1929) collected 4 young on the latter. Signs found in August 1966 by the Wildlife Service party on Macauley indicated that it is a common breeding species there (O'Brien 1966).

No burrows containing eggs were located on Raoul during our stay, although T. Blake (meteorological station staff), who was on Raoul for his second successive year, assured us that small numbers of juveniles had left the island during the previous March.

At any time of the day or night birds of this species could be heard cavorting overhead and we concluded that this behaviour, particularly during January when incubation was in progress, was an indication that these birds were unemployed. We found them frequenting all headlands, often in association with Wedge-tailed Shearwater, but the biggest concentration was at Smith Bluff where about 100 were in the air together at dusk on 12/1/67.

The abundance of cat-eaten remains proved that these small petrels were attempting to use their ancestral breeding grounds in spite of heavy predation. The largest cat-"midden" found was on the farm and on 23/1/67 it contained the remains of 44 Black-winged Petrels within a 10 yard radius. Other smaller "middens" were commonplace in areas frequented by the species.

Many thousands were present on Meyer on 19/11/66, but even greater numbers were apparent there in late November and early December. At first, birds were to be found singly on the ground, but by 29/11/66 they were more often in pairs. On 21/11/66 12 burrows were examined; 7 were occupied by two birds each and the remainder by single birds. All nest chambers were lined with fresh green leaves and litter debris. Of 50 nest chambers examined on 12/12/66, all contained birds and were lined, but no eggs were found.

The first egg was found on 23/12/66 and by 4/1/67 few burrows were without an egg. In almost all instances burrows containing eggs were betrayed by fresh green ngaio leaves in their entrances. No young were seen.

Torrential rain on 6, 7 and 15/1/67 caused some burrows in dry friable soil on the lower western slopes to be blocked with rubble or to collapse. Subsequently, the displaced birds sat about on the surface or attempted to open up burrows.

Examination of six 10-square-metre plots, selected at random on the upper eastern slopes of South Meyer on 25/1/67, gave a range of occupied burrows of from 0.3/m^2 to 2.2/m^2, with a mean of 1.56/m^2. Such a burrow density was considered representative over much of the two islets.

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Plate XVI — Black-winged Petrels.

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Plate XVII — Black-winged Petrel climbing a pohutukawa to facilitate its departure from North Meyer Islet.

The breeding population of Napier was estimated to be several hundred pairs and all soil of sufficient depth was intensively burrowed. No eggs were seen on 26/11/66; however all burrows examined on 2/1/67 contained an egg. The species was plentiful and breeding on Dayrell. Most burrows examined on 26/12/66 contained an egg. It was also plentiful and breeding on both Chanter islets and all burrows examined on 1/1/67 contained an egg.

TABLE IV

Summary of measurements (in millimetres) of adult Black-winged Petrel from Raoul and the Meyer Islets.

	Number	Mean ± S.d.		Range
Bill length	35	23.9	0.91	22 - 26
depth	32	11.4	0.55	10.5 - 13
width	36	11.1	0.57	10 - 12.25
M.t.c.	35	35.3	1.83	31 - 39
Tarsus	35	30.6	1.07	28 - 32
Wing	35	222.7	4.97	215 - 234
Tail	33	101.8	4.03	91 - 109.5

Kermadec Storm Petrel *Pelagodroma marina albiclunis*

Cheeseman (1887 and 1890) found this " plentiful everywhere at sea " in 1887, and he was informed by Bell that it bred " on Meyer Island and on other outlying rocks." Iredale (1910) recorded that two specimens were washed ashore on Raoul in October 1908 — one, a female, was fresh and in breeding condition, nevertheless Oliver (1911) regarded it as a " visitor " to the group. The subspecies was described from specimens collected near Raoul and the Meyer Islets in November 1925 by the Whitney South Sea Expedition (Murphy and Irving 1951). It was apparently next recorded by Edgar *et al.* (1964), who reported that on 22/11/64 two were seen near Napier Islet.

Although North Meyer was in continuous occupation from 19/11/66 - 20/1/67 no sign of storm-petrels was found: nor were signs found on other of the Herald Islets, on Raoul or the Milne Islets, so that the breeding ground is still unknown. It was not seen at sea during our stay, but on 18/11/66 a group of what appeared to one observer to be a dozen storm-petrels, was seen — by binoculars — to be feeding over broken water near the Milne Islets about half a mile distant. Other members who saw these birds had little doubt that they were Grey Ternlets.

Red-tailed Tropic Bird *Phaethon rubricauda roseotincta*

This is first mentioned from the Kermadecs by Bowes (1788) who was on board the "Lady Penrhyn" when, on 1/6/1788, Capt. Sever and party landed on Macauley and reported "sea fowls, many sorts of which resort to this island. There were many Tropic Birds under the trees, some of which were asleep and those they took by hand and brot (sic.) on board with them." Furthermore on 2/6/1788, when what was later to be named Raoul Island was sighted for the first time (Williams unpubl.), Bowes remarked that "many Tropic Birds (were) seen." It seems strange that it was ashore — or present — in numbers at this time of year, however recent observations have shown this to be feasible: about 6 well-grown nestlings were seen on Macauley in August 1966 by the Wildlife Service party (B. D. Bell, pers. comm.).

Although not seen by Cheeseman (1887 and 1890), Bell informed him that it bred on the islands and "visits Sunday Island in great numbers for breeding purposes, arriving about the end of October or beginning of November and leaving again in June or July." However Iredale (1910) found that in 1908 it was absent in June and July and arrived in early August, but in 1937 Davison (1938) first saw it in the second week in October. No young of less than 4 weeks old were seen on Meyer by Guthrie-Smith (1936) on 14/4/29.

We first saw it on 13/11/66 when 2 were flying aerobatically high above the northern cliffs near Hutchison Bluff. Numbers increased daily over the next few days, about 20 being counted in the same locality on 25/11/66. Forty-two were in sight at one time over South Meyer on 30/11/66 and 87 were counted between the two Meyer islets on 22/12/66. Although greatest numbers were found to nest on Dayrell and South Meyer Islets, small numbers were nesting on Raoul, generally in inaccessible parts of coastal cliffs.

Six seen cavorting off Meyer on 22/11/66 were the first recorded there during our visit; but, following this, numbers increased rapidly. On 26/11/66 two birds were seen ashore and on 26/12/66 15 were ashore on the northern islet and aerial displays were becoming less frequent.

On 27/12/66 large numbers were present off the eastern cliffs and, of 40 nests found on South Meyer, all but 8 contained an egg. Each of the latter was attended by 2 birds, whereas those with an egg were being brooded by single birds. However, one nest containing a newly-laid egg (still moist) was also attended by 2 birds. Nests were under fern or in open situations at the bases of trees, up to 15 yards from the cliff edge; but the favourite site appeared to be a cave or fissure in a sheer rock face. The mean dimensions of nine eggs measured were 67.3 x 47 mm. and they ranged from 63 - 72 mm. in length and from 45 - 48.5 mm. in width.

Only 4 accessible nests with eggs were found on North Meyer and these were under low vegetation on the eastern slopes. A further 5, first seen on 2/1/67, were in inaccessible situations. Human activity may well have been the reason for the scarcity of nests on this islet.

One bird, banded (K.707) as a breeding adult on "Meyer" on 4/1/63, was recaptured on 27/12/66 while brooding an egg on South Meyer. Eighty-one breeding adults were banded on South Meyer (Appendix III).

No eggs had hatched by 25/1/67, but 4 nests on the southern islet apparently washed out by heavy rains, were deserted and their eggs broken. One banded bird, which had nested unsuccessfully in a cave on the western face, was re-nesting in the cave 8 feet from its original nest, but had not relaid.

No nests were found on Napier but on 2/1/67 one of more than eight frequenting the southeastern cliffs was seen to land. Two occupied nests were located on Nugent. On 26/12/66 about 60 were in flight off the south-western cliffs of Dayrell, where the species was breeding in small caves. No accessible nests were found but several birds seen at a distance were apparently incubating. The species was numerous in the vicinity of the Chanters, where it was breeding on inaccessible cliff ledges on the southern islet.

Masked (Blue-faced) Booby *Sula dactylatra personata*

One of the inhabitants of Macauley reported by Capt. Sever, was the "ganet" (Watts 1789). It was also mentioned by Cheeseman (1887, 1888 and 1890) who, in 1887, found it "not uncommon all through the Kermadec Group," and breeding on Curtis Island — and, on information supplied by Bell and Capt. Fairchild — Meyer and Haszard Islets. In 1908 Iredale (1910) found that it "bred in numbers on one of the outlying islets" of Raoul known as "Gannet Island" and that "a couple of pairs" had bred on Meyer. He also recorded it breeding on Macauley Island. Breeding had ceased on Curtis on 16/4/29 when Lindsay (1929) collected one adult and 2 addled eggs. On 24/9/44 Sorensen (1964) found several incubating on Meyer and two accessible nests contained eggs. In August 1966 the Wildlife Service party found about 30 pairs breeding on Macauley and laying had just begun (O'Brien 1966). A recently fledged juvenile was also present (B. D. Bell, pers. comm.).

We found that small numbers were always present feeding off Raoul. No nests were on the two Meyer islets, although an addled dwarf egg (55 mm. x 39 mm.) was found on 27/12/66 on the southernmost promontory of South Meyer, where adults occasionally roosted. On 22/11/66 a large chick was observed in a nest on a stack off the eastern coast of North Meyer. This chick had not flown on 25/1/67.

Two occupied nests were present on Dayrell. On 26/12/66 one contained a newly-hatched chick and the other an almost fully-fledged juvenile. Twelve occupied nests and 16 adults were present on South Chanter. They comprised 1 nest with 1 addled egg, 1 nest with 2 addled eggs, 3 nests with single naked chicks, 3 nests with single downy chicks and 4 with single fledging young. No unemployed birds were present. Seven juveniles and 10 adults were banded, during which process several flying-fish were regurgitated; the largest being 41.3 cm. long. Twenty occupied nests were found on North Chanter and comprised 1 nest with 2 addled eggs, 2 nests with single naked young and 17 with single young ranging from small white

downy to flying age. Seventeen juveniles and 6 adults were banded, and several unemployed birds were present. One occupied nest (the contents of which could not be determined) on the stack, was seen from South Chanter.

The above — giving a total of 36 breeding pairs plus a small number of unemployed — makes an interesting comparison with the estimate, made from the sea, that on 22/11/64 about 50 birds inhabited the Herald Islets (Edgar *et al.* 1965).

Nests were scattered singly in small clearings, and consisted of depressions with slightly raised rims of soil, guano and often a little vegetation. Mean dimensions of the 5 eggs were 67 x 47 mm. and they ranged in size from 64.5 - 70 mm. in length and from 46 - 49.3 mm. in width.

Frigate Bird *Fregata sp.*

Cheeseman (1887 and 1890) included this on the authority of Bell, who stated that it was a regular visitor each spring and summer, but was not resident. The species was not recorded by the 1908 expedition; however in November 1944 Sorensen (1964) saw a bird "which was undoubtedly a Frigate Bird at Raoul Island," and on 20/11/64 2 females were seen there by members of the 1964 expedition (Edgar *et al.* 1965).

Unconfirmed sightings were made at Denham Bay (3 on 20/11/66) and off Bell's Beach ("several" during early January by meteorological station staff).

Grey Duck *Anas superciliosa*

Cheeseman (1887 and 1890) admitted this to the Kermadec list on the authority of Bell, who said that it existed in the crater lakes, but had become very scarce since the 1872 eruption — the total population being estimated at not more than 7 birds. Iredale (1910 and 1912) recorded it from the crater lakes and Denham Bay Lagoon, and confirmed its identity, but did not know whether it was referable to the New Zealand or Australian form. He noted that although it was seen throughout the year, he saw no signs of breeding. However Oliver (1912) stated that in 1910 two nests were found in the crater. About 30 frequented the lakes in 1937, but most of these apparently left the island in September of that year (Davison 1938). Sorensen (1964) found that in 1944 Green Lake was its preferred habitat, 31 being seen there on 7 May, and on 5 September 12 were on Blue Lake. In December 1954 L. C. Bell (1955) saw 20, including 2 half-grown young, in the crater — mostly on Green Lake, and Edgar *et al.* (1965) reported that in November 1964 2 were seen on Green and one on Blue Lake.

Blue Lake and, to a lesser degree, the Denham Bay swamp were the only places where ducks were recorded during our visit, other crater lakes apparently proving unsuitable. The largest count made on Blue Lake was of 26 adults plus broods of 5 half-grown, 3 newly hatched and 5 approximately 12 days old ducklings on 19/12/66. One other brood of 6 newly hatched ducklings was seen on the road near Ngaio Bluff on 23/12/66 and a nest containing 9 eggs was found in fern behind our base camp on 8/1/67.

The stomach contents of two juvenile females collected from Blue Lake were as follows:—

Dominion Museum number 12399, collected 19/12/66: Mainly grit with fragments of macerated plant material and fragments of *Solanum nodiflorum* and *Cyperaceae* seeds.
Dominion Museum number 12398, collected 6/1/67: Mainly grit with macerated plant material, especially stalks and a single *Coprosma* seed. Fragments of at least two long-legged spiders.

Spotless Crake *Porzana tabuensis plumbea*

The occurrence of this species was first noted by Cheeseman (1890) who received a skin obtained by Bell on Meyer. In 1908 it was recorded by Iredale (1910) near the Denham Bay lagoon, on the north coast (1 dead), in the crater and on Meyer. Oliver (1912) recorded details of nests found by the Bells near the Denham Bay lagoon between 1909 and 1911 but it does not appear to have been seen on Raoul since. Lindsay (1929) collected it on Meyer in 1929 and I saw three there in November 1964 (Edgar *et al.* 1965).

We found no evidence of its presence on Raoul. Mist-nets were placed across part of the Denham Bay swamp and the area driven with no success. Denham Bay camp at the edge of this swamp was virtually in continuous occupation from 14/11/66 to 24/1/67, but none was seen or heard.

Crakes were recorded only on the Meyer Islets where they were not uncommon and inhabited a variety of vegetation types and aspects. Territories were in occupation and the total population was considered to be not more than about 20 pairs (Soper 1969c). Birds were commonly seen by day and night foraging for invertebrates in litter. Other feeding stations included the tideline, clumps of *Cyperus ustulatus,* petrel burrows (particularly freshly excavated soil), branches, foliage and noddy nests.

A nest with 4 newly-hatched chicks was found in *Paspalum* overgrown with *Sicyos* on 27/12/66 and two unoccupied nests in *Digitaria adscendens* were found on 9/1/67 and 19/1/67. Nests were well concealed and rather untidily constructed of short lengths of *Cyperus,* fern fronds and fine grass and were about 4" in diameter. On 23/11/66 a 7 to 10-day-old chick was seen with an adult and on 28/11/66 a chick of about the same age was found dead.

Of two adults collected on South Meyer one was captured at night while perched on a *Cyperus* inflorescence, but it is not known whether it was feeding or roosting there.

Pukeko *Porphyrio porphyrio*

Cheeseman (1890) recorded seeing a single specimen in 1887 in the Denham Bay lagoon, and he was told by Bell that the species was " decidedly scarce." It was not recorded by the 1908 expedition (Iredale 1912), and Oliver (1911) considered the species an " accidental visitor " to Raoul. In the following year a specimen was taken on the Denham Bay beach where it had apparently been feeding upon dead Sooty Terns (Oliver 1912). It was not recorded by Sorensen (1964) in 1944, but 6 were observed in the crater by L. C. Bell (1955) in December 1954, and 2 were seen near Blue Lake in November 1964 (Edgar *et al.* 1965).

We recorded it on Blue Lake and in the Denham Bay swamp. The largest count on the former was of 8 adults plus a brood of 3 half-grown young on 6/1/67. At least 3 adults and one chick were known to have been resident at Denham Bay.

The stomach contents of two adults collected from near Blue Lake on 6/1/67 were as follows:—

D.M. 13298; fibres of rush, sedge and wool, long-legged spiders, fragments of slater and considerable grit.

D.M. 13299; unidentifiable vegetable debris (plant fibres and small roots) and a quantity of fine black sand.

Following are their measurements (in millimetres).

	Sex	Bill			Mid-toe and claw	Tarsus	Wing	Tail	Gonads
		Length	Depth	Width					
D.M.13298	M	71	31.5	19	110	93	270	108	18x7,20x7.5
D.M.13299	F	69	25.5	18	102.5	88	269	108	

Note: Wing measurements are below the range of those of New Zealand birds given by Oliver (1955), viz. 280 - 300 mm.

Grey Plover *Charadrius squatarola*

On 18/12/66 one in winter plumage was seen on the North Meyer rock-shelf. This species has not previously been recorded from the Kermadecs.

Pacific Golden Plover *Charadrius dominicus fulvus*

Not seen by Cheeseman (1890), but Bell reported that it visited the island. In 1908 13 were present on the Denham Bay beach from late September to early November, and a flock of 13 waders — mainly of this species — was recorded off Macauley Island on 12 November (Iredale 1910 and 1912). The largest flock seen on Raoul by Sorensen (1964) in 1944 was of 15 birds on 2 November, and Edgar *et al.* (1965) reported 36 on the farm paddocks on 19/11/64. In August 1966 3 were present on Macauley (O'Brien 1966).

We recorded it on the farm paddocks and at Blue Lake, particularly the latter, where volcanic activity had resulted in a large expanse of open mud-flat at the eastern end and smaller areas along the southwestern shores. The water level encroached and receded irregularly according to wind direction and velocity and rainfall, but on no occasion were the flats completely submerged. These conditions provided suitable feeding and roosting areas for a small flock of mixed waders composed mainly of Golden Plover. The largest count of 34 was made on 16/11/66, after which numbers gradually dwindled until only 12 were present on 7/1/67 and 16 on 23/1/67. Two seen on the wave-platform of the northern islet on 25/1/67 were the only birds recorded on Meyer.

Asiatic Whimbrel *Numenius phaeopus variegatus*

At least 2 were present during the latter part of November and December on Denham Bay and North Beaches. One was recorded on North Meyer on 13/12/66 and during high tide on 26/12/66, one was present on Egeria Rock. But for one seen on Meyer by the 1964 party (Edgar *et al.* 1965), the only other Kermadec record is that of Iredale (1910 and 1912), who stated that one of five seen on Raoul in late September 1908 was collected by Oliver.

The stomach of an adult male (measurements in millimetres below) collected from North Beach on 23/12/66, contained two small

crabs *(Ocypode sp.)*. Dr. R. K. Dell, who examined this material, advised that the Kermadec species has not been determined.

	Bill			Mid-toe and claw	Tarsus	Wing	Tail	Gonads
	Length	Depth	Width					
D.M. 12397	75	14	13	39	60	230	100	5.5x3.0,6.0x2.5

Eastern Bar-tailed Godwit *Limosa lapponica baueri*

Not seen by Cheeseman (1890) but he included it on the authority of Bell, who told him that small numbers visited the shores of Raoul each spring and autumn. The 1908 expedition failed to record it (Iredale 1910) however Oliver (1912) stated that 12 specimens were taken by Bell during the months of October and November — one in 1909 and the remainder in 1910. These had been seen singly or in small flocks, in the crater or at Denham Bay. During October 1937 10 - 12 were present (Davison 1938). The greatest number seen by Sorensen (1964) in 1944 was 3, and he found that they were " much commoner on the grassy flats than along the coastline." L. C. Bell (1955) reported 4 on the farm paddocks in December 1954, and one was seen there, with Golden Plover, on 19/11/64 (Edgar *et al.* 1965).

Throughout our stay small numbers were present with Golden Plover on the Blue Lake mud-flats and on the farm paddocks. The highest count was 6, on both 3/12/66 and 23/1/67.

Wandering Tattler *Heteroscelus incanus*

Single birds were recorded at D'Arcy Point (7/12/66 and 13/1/67), near Smith Bluff (17/1/67) and on the Milne Islets (during high tide on 30/12/66), and frequented the coasts of both Meyer islets throughout our stay. The only other records of this species at the Kermadecs are Oliver's (1930 and 1955) reference to one collected on Raoul by W. S. Bell in 1913, and of two seen on Macauley in August 1966 (O'Brien 1966).

Turnstone *Arenaria interpres*

Small numbers were present with Golden Plover on the Blue Lake mud-flats. The highest count was 9 on 16/11/66, after which numbers declined until none was present on 20/12/66. On 5/1/67 three were present and two remained until the time of our departure. The only other records of this species from the Kermadecs are of a single bird on North Meyer on 20/11/64 (Edgar *et al.* 1965) and of 8 on Macauley in August 1966 (O'Brien 1966).

Knot *Calidris canutus*

The dried remains of one was found on the Blue Lake mud-flats on 20/12/66. Measurements (in millimetres) are given below. The only other record from the Kermadecs is that of a bird collected at Denham Bay on 17/10/1910 (Oliver 1911 and 1912) — not 29/7/1910 as stated by Sorensen (1964).

	Bill			Mid-toe and claw	Tarsus	Wing	Tail
	Length	Depth	Width				
D.M.12501	32.5	7.5	5.5	25.5	29	159	66

Southern Black-backed Gull *Larus dominicanus*

A single adult was observed on 4 and 7/12/66 at Denham Bay and on 6/12/66 at North Beach. Although no other record from the Kermadecs appears to exist, Oliver (1930 and 1955) and Fleming (1953) stated that it is " accidental " and a " straggler " there.

Red-billed Gull *L. novaehollandiae*

On 15 and 16/11/66 a small lone gull was observed from a distance on Denham Bay beach. It was almost certainly a juvenile *L. novaehollandiae* as it had a robust dark bill and legs. It was not observed at close enough quarters for positive identification. The only other small gulls known from the Kermadecs are in the Otago Museum and bear the name " *Bruchigavia jamesonii* " but, according to Gurr (Sorensen 1964), these may well be *L. gunni* from Tasmania, and a " red-billed gull " frequented Raoul during November and December 1963 (R. G. Lovegrove pers. comm.).

Sooty Tern *Sterna fuscata*

Cheeseman (1890) did not see this species in August 1887, however he was informed by Bell that " --- it is one of the commonest sea-birds --- (during spring and summer months), although very rarely seen during the winter ---.--- its first act on arriving (in late August) --- is to drive off the few hawks ---. (It breeds) in immense colonies both on the main island and the adjoining rocks, one of the largest - - - being on the sandy beach of Denham Bay." Cheeseman also recorded that Capt. Fairchild obtained birds on Curtis Island. In 1908 Iredale (1910 and 1912) found it breeding " abundantly on the Denham Bay beach, and sparingly on the rocks off the north-west corner and on Meyer Island." He also recorded that eggs were " very abundant " on Curtis Island on 13/11/1908.

Subsequent visitors to Raoul during summer months have reported vast numbers breeding at Denham Bay. Approximately 40,000 breeding pairs were present there during the 1966/67 season (Peart, in prep.) and a colony of a similar size was discovered along the southern coast of Hutchison Bluff on 15/12/66. Nesting had apparently first begun at the western part of the latter colony, as on 4/1/67 70% - 80% of eggs had hatched and some chicks were approximately two weeks old; whereas no chicks were present at the eastern part of this colony. At Denham Bay laying started on 1/12/66 and the first chicks appeared on 30/12/66.

It was found that cats and Norway Rats were predating both colonies, the cats taking adults and young and the rats, eggs. Although accounting for quite large numbers of birds over a period (two adults per cat per night on an average) the cats would probably have had little effect upon a nesting population of this size. Rats, however, were more destructive and seemed to increase rapidly as the breeding season progressed. Sub-colonies and parts of the major colony, consisting of many thousands of eggs, were completely destroyed within days. Peart was able to study rat predation of tern eggs within his quadrats in some detail.

He found that of 5,537 colour-coded eggs, 1,578 hatched, 170 were predated by rats, 988 were deserted as a result of the rats'

depredations and the remainder were lost through other natural causes. Of the 1,578 chicks which hatched, 336 (21.3%) had died at the time of our departure from Denham Bay on 24/1/67, giving an overall mortality rate of 77.5%, but further deaths would have occurred prior to fledging in March. Furthermore, in those parts of the colony where rats were more active the mortality rate would have been greater.

On Ascension Island, however, Ashmole (1963), in his classic study of this species, recorded overall mortality (laying to *fledging*) of 98.3% from an estimated 6,500 eggs. Mortality at Denham Bay appeared to be lower than this, possibly as a result of the virtual absence of birds-of-prey and of the presence of a more reliable food supply. The latter is apparently not always available; for, during a brief visit to Denham Bay on 13/4/29, Lindsay (1929), Pycroft (1929) and Guthrie-Smith (1936) found large numbers of young dying from starvation.

Meteorological station staff who have banded young at the Denham Bay colony have reported high mortality following banding. The adults are most pugnacious at nesting time and will quickly kill any young chick driven from its nest. Of a total of 1,512 chicks we banded at between 1 and 3 days of age, 438 were subsequently recovered dead (335 prior to our departure and 103 by meterological station staff on 27/3/67), giving a mortality rate of 28.9%. However, of 1,500 chicks of up to 17 days of age banded on 16/1/67, only 113 were subsequently recovered dead (92 on 18/1/67 and 21 on 27/3/67). This is a mortality rate of 7.5% for the older age group. On each occasion a thorough search was made and, although not every dead chick would have been recovered, those who searched were confident that very few would have escaped their notice.

It appears that chicks should not be banded when recently hatched and that there are considerable advantages in banding after they are old enough to avoid trouble and the period of highest natural mortality has passed.

Numbers frequenting North Meyer increased from 6 on 20/11/66, 32 on 30/11/66 (when territorial behaviour was first apparent) to about 2,500 breeding birds on 24/12/66. Although most of these occupied rock-shelves at the south-western end, nesting occurred in open areas throughout the islet wherever the gradient permitted. However, those considerable numbers of birds breeding in inaccessible situations at the northern end and on stacks off the northern and eastern coasts, were not included in the above estimate. On 11/12/66 laying had begun and competition for available nesting space was intense, and on 26/12/66 c. 450 eggs were present. The normal clutch was one, but two nests, each with two eggs, were noted on 2/1/67.

The population of South Meyer was estimated, on 27/12/66, to exceed 4,000 birds. Over 2,000 were breeding at the southern end, where 521 (plus 52 broken) eggs were counted, and on a detached rock. The remainder were in colonies on the north-western and north-eastern slopes. No chicks were present.

The first (2) chicks appeared on North Meyer on 8/1/67. On 9/1/67 9 had hatched, 12/1/67 16, 15/1/67 22, 16/1/67 27, 17/1/67 28, 18/1/67 35 and 19/1/67 37. Observations then ceased. Egg and chick mortality on both islets was high.

The species was breeding at the eastern and western ends of Dayrell, wherever space permitted. It even nested a short distance under the scrub. About 3,000 birds were present on 26/12/66, but many of these appeared to be non-breeders. A large percentage of eggs was broken or pecked and no chicks were seen.

White-capped Noddy *Anous tenuirostris minutus*

Cheeseman (1890) did not record this species in 1887; however he subsequently received two skins from Bell, who informed him that " it is tolerably common during the spring and summer months, but disappears at the commencement of autumn. So far as he knows, it only breeds on Meyer Island. --- Usually it selects a closely-branched *Pisonia* for this purpose, but the ngaio and pohutukawa are also made use of." Iredale (1910 and 1912) found that it did not breed on Raoul, but that " an increasing colony bred on Meyer Island and one of the other outlying islets," and on 29/2/1908 he noted " a few fully-feathered young --- sitting in their huge nests " on Meyer. Guthrie-Smith (1936) saw about 10 nests occupied by full-grown birds there on 14/4/29, and although the species was present in September 1944, Sorensen (1964) found that nesting had not started. In November 1908 Iredale recorded a flight at Macauley Island, but in the absence of trees, did not think that it bred there. However, in August 1966 B. D. Bell (pers. comm.) reported that about 20 pairs were breeding on rock-ledges and in caves on Macauley, and that laying began about the middle of the month.

None was found nesting on Raoul during our visit. Below Smith Bluff where a grove of ngaio and pohutukawa provided what appeared to be ideal nesting habitat, no indication of breeding having taken place could be found on 17/1/67, although 23 adults were perched on coastal boulders while others fished off-shore. A cat-eaten corpse was found nearby.

The species was found breeding only on Meyer (Soper 1969a) where the population was considered to be about 1,000 pairs.

According to Oliver (1955), laying takes place in October. However, a survey of nests on the mid-western slopes of North Meyer on 22/11/66 revealed 2 containing newly-hatched chicks and 32 with eggs, but the majority were still under construction. On 25/1/67 most nests contained eggs and a number were still being built, so the breeding season is a protracted one. We were unable to ascertain whether the nest building seen at these later dates was followed by successful breeding.

Contrary to Bell's (Cheeseman 1890) and Oliver's (1955) statements that most nests on Meyer are in *" Pisonia "* (parapara), we found none in trees of this species. Parapara was found to be rare on North and more common on South Meyer, but none had suitable branches for nesting. Nests were placed on horizontal or gently sloping ngaio, pohutukawa or karaka limbs — in that order of frequency — and colonies of about a dozen nests were in sheltered, sunny situations mainly on the north-western slopes.

On 28/12/66 most nests on the north-western slopes of South Meyer contained an egg, but one chick, about three weeks old, was seen. Most nests still contained eggs on 25/1/67; however young of all ages were present.

White Tern *Gygis alba royana*

This was not seen by Cheeseman (1888 and 1890), however, as a result of information and specimens supplied by Bell, he included it as a regular breeding species and was able to describe its breeding habits. Iredale (1910) observed that it arrived at the island in early October but no eggs had been found when his party departed on 11/11/1908.

In a delightful account of its breeding habits on Raoul, Bell (1912) stated that the birds usually arrived during the first week in September and laid — always in a pohutukawa — in November, but both its arrival date and time of laying was most irregular; a half-fledged young being found on 29/11/1908 and a new laid egg, on 10/1/1909. It bred in small colonies or in single pairs scattered along the east, south and south-west coasts, but was not found on any of the out-lying rocks, nor, as far as he was aware, on any other island of the Kermadec Group. He observed that it was commonly preyed upon by cats and that as many as 8 pairs, eaten by cats, had been found beneath one tree.

In 1937 Davison (1938) first recorded it in early October, and in late October 1944 Sorensen (1964) " located many pairs in the forest at the back of Denham Bay."

We found this species only on Raoul Island where it was most often seen frequenting pohutukawa trees on the flat north-west of the Denham Bay lagoon. The highest count for this area was 13 in flight together on 13/1/67. On 5/12/66 a bird was seen, apparently incubating, 45 feet up on a pohutukawa limb and on 16/1/67 an unattended chick, about one week old, was seen perched on this limb. On 24/1/67 ectoparasites were removed from this chick for identification (Watt, in press), and it was banded.

Six were seen to fly into pohutukawa forest at the south-eastern end of Denham Bay and below Mt. Mahoe on 29/11/66, and up to 7 birds were noticed frequenting a certain pohutukawa behind Low Flat, but breeding was not confirmed.

Grey Ternlet *Procelsterna cerulea albivitta*

The first reference to this species at the Kermadecs is probably that of Capt. Sever (Watts 1789) who, on 1/6/1788, following the discovery of Curtis and Macauley on the previous day, landed on the latter and reported that one of the inhabitants was " the light-grey bird."

In August 1887 Cheeseman (1887 and 1890) found it plentiful throughout the Kermadec Group and collected several specimens. Bell informed him that it bred in October and November. Iredale (1910 and 1912) found it breeding " very sparingly " on the cliffs at each end of Denham Bay and on 29/2/1908 he saw flying young and other signs of there having been a " fair-sized " breeding colony on Meyer. He visited Meyer again on 3/8/1908 and found " fair numbers " of birds but no eggs. He recorded it breeding on both Macauley and Curtis Islands, and on 13/11/1908 found hard-set eggs on the latter. In April 1929 Lindsay (1929) recorded it from Macauley, Curtis and L'Esperance Rock. O'Brien (1966) reported that it was a common bird on Macauley in August 1966 and that breeding was in " full swing "; eggs were apparent, but none had hatched by 22/8/66 when the party departed.

The species was not uncommon along the coasts of Raoul during the current expedition, and on the exposed cliffs of Smith Bluff nesting had taken place. On 17/1/67, 47 were counted on ledges or in pock-holes high on this bluff's southern face, but those in a similar situation on the western aspect were not counted. About 50 were in the air or fishing with noddies off-shore. Much guano was present beneath the bluff where the cat-eaten remains of 87 fresh and semi-fresh, mainly juveniles and nestlings, were found. A cat was disturbed stalking 24 ternlets perched on a cliff ledge, one quarter of a mile north of Smith Bluff on 17/1/67.

Although breeding on all islets in the Herald Group, greatest numbers were found on Napier and Meyer, and the breeding population of the latter was estimated to exceed 2,000 pairs. Breeding was well advanced on 13/11/66; eggs and young of all ages being present on North Meyer. (Sorensen (1944), who visited Meyer on 24/9/44, found that laying had just started.) Nests were in loose colonies confined to the coastal zone. No nesting material was used, the single egg being laid on a rock ledge, in a crevice, pock-hole, cave, or under vegetation, and was often inaccessible and well concealed. All day shade appeared to be an important consideration in the selection of a nest site (Soper 1969b).

Laying had virtually ceased at the time of our arrival so the incubation period was not determined. The last egg known to hatch on North Meyer did so on 2/1/67, by which time most young could fly. By late December some adults were moulting.

Of interest were the parasitic habits of the land-crab *Geograpsus grayi* which often lived in shallow burrows near a ternlet's nest and apparently fed upon food dropped by the parent bird while feeding the chick.

Of the Herald Islets Napier had the greatest breeding population, many thousands being present on 26/11/66. Nests were everywhere — even under the low scrub and near the summit. Breeding had virtually ceased on 2/1/67; however, a number of unfledged young, and several eggs were seen. Although only 3 unfledged young remained on Nugent on 2/1/67, it was apparent that a considerable breeding population had recently occupied this stack. A flock of several thousands fed nearby, off the western coast. A large breeding population had obviously occupied Dayrell. Several hundred, including chicks of all ages, were still present on 26/12/66. On 1/1/67 several hundred were present and breeding had occurred on both Chanter islets. An abandoned egg was found on the northern islet and egg shells and several unfledged young were recorded from each islet. On 30/12/66 two adults were found frequenting the summit of the highest Milne islet, where droppings were numerous, but breeding was not confirmed.

Kermadec Parakeet *Cyanoramphus novaezelandiae cyanurus*

This was first mentioned by Bowes (1788), when, on 1/6/1788 a party from the " Lady Penrhyn " landed on Macauley and " knock'd down some Parroquetts, several of which they brot (sic) on board - -." Plentiful on Raoul in 1836 (Rhodes, in Straubel 1954) this subspecies was, according to Bell (Cheeseman 1887), exterminated there by cats. A specimen was collected by Macgillivray in 1854 and although

[M. F. Soper

Plate XVIII — Kermadec Parakeet.

labelled " Raoul Island," Iredale (1912) considered that it was probably procured on Meyer. From this specimen Salvadori described and named the subspecies in 1891. It was numerous on Meyer and Macauley in 1887 (Cheeseman 1887) and 1908 (Iredale 1910), and, presumably upon Bell's authority, Iredale stated that it was occasionally heard on Raoul in the autumn. One was seen on the latter by Pycroft (1929) in April 1929. Buller (1905) mentioned one which was obtained by Bell on Curtis Island where it was also seen by Pycroft (1929) in April 1929. In August 1966 O'Brien (1966) considered it to be the most common land bird on Macauley, and estimated that the population would probably exceed 1,000 individuals. He observed that the birds fed upon the carcases of goats which the party was exterminating (Williams & Rudge 1969).

On 13/12/66 feathers disgorged by a cat were found on Rayner Point, the nearest Raoul Island landfall to Meyer, about one mile distant, where we found parakeets plentiful and unusually tame, and from where they are known to occasionally visit Raoul (Bell, in Oliver 1955). This bird had obviously been a vagrant from Meyer. Small flocks trafficked freely between the two Meyer islets, but no birds were seen to cross to others of the Herald Group.

Breeding was in progress at the time of our visit and 3 nests were found on North Meyer. One in a hole in a bank contained 5 small naked chicks on 22/11/66, and these fledged on 24/12/66. The second nest was at the base of a hollow pohutukawa trunk and contained 2 chicks on 7/12/66. These had flown on 8/1/67. A third nest in a hollow ngaio stump contained 2 large chicks on 7/1/67 and these fledged on the following day. Numerous family parties of from 3 to 5 young were encountered in late December on each islet and a noticeable increase in the population at this time was attributed to this influx of juveniles.

Birds were observed taking terminal (1") shoots of pohutukawa and *Coprosma,* and seeds of *Cyperus* (numerous observations) and *Polycarpon tetraphyllum.* What appeared to be an orange *Coprosma* berry was fed, by an adult, to a juvenile.

Analysis of gut contents of 2 adults collected from South Meyer on 27/12/66 revealed the following:—

D.M. 12407, a male, contained seeds of *Chenopodium allanii, Solanum nodiflorum, Cyperus sp.,* unidentifiable fragments of grass seed and grit.

D.M. 12408, a female, contained seeds of *Solanum nodiflorum,* 2 or 3 of *Chenopodium allanii* and about equal proportions of small grit particles.

Prior to identification of the above material, *Chenopodium allanii* was unknown from the Kermadecs.

The highest count of parakeets was made at dusk on 19/1/67, when 6 out of a loose flock of about 20, at the northern end of North Meyer's summit ridge, were mist-netted for measuring and the collection of ectoparasites. These birds, and another 30 or so nearby, were apparently congregating to roost. None could be located at lower levels immediately afterwards.

The subspecies was present and breeding on Napier (at least 8 adults were known to be present on 2/1/67) and Dayrell. It was moderately abundant on the Chanters. Six was the greatest number seen at any one time, and 3 were observed to fly from the southern to the northern islet.

TABLE V

Summary of measurements (in millimetres) of adult Parakeets banded or collected on the Meyer Islets between 27/12/66 and 19/1/67. (Females in parenthesis).

	Number	Mean	Range
Bill length	4 (4)	16.9 (15.3)	15-18.7 (14.5 - 17)
depth	3 (4)	18.2 (16.2)	16.75 - 19.25 (15.75 - 17)
width	3 (4)	10.8 (9.7)	10.25 - 11.5 (9 - 10)
Longer fore toe and claw	4 (4)	26.6 (26.4)	24.75 - 29 (24.5 - 28)
Tarsus	4 (4)	22.2 (22)	21.1 - 23 (21 - 22.75)
Wing	4 (4)	138.6 (132)	134 - 143.5 (127 - 135)
Tail	4 (4)	155.1 (148)	148 - 166 (139 - 159)

Shining Cuckoo *Chalcites lucidus lucidus*

According to Bell (Cheeseman 1887 and 1890) this is an "occasional visitor" to Raoul and, but for the following, I know of no other record. On 17/11/66 one was heard calling in the vicinity of Low Flat.

Long-tailed Cuckoo *Eudynamis taitensis*

Cheeseman (1890) did not see this species. However, Bell showed him the tail feathers of one which he had recently shot and informed him that it was a permanent resident of Raoul, although it was my no means common. In 1908 Iredale (1910 and 1912) recorded birds in every month (except December), and observed that it was most numerous in October. Davison (1938) recorded it in October 1937 and Sorensen (1964) sighted it in most of the winter months of 1944 and obtained a specimen in June.

Small numbers were present on Raoul throughout our stay. An apparent fledgling was seen on 6/12/66 being mobbed by Tuis.

Kingfisher *Halcyon sancta*

This was plentiful on Raoul in 1887 (Cheeseman 1887 and 1890), and in 1908 Iredale (1910 and 1912) observed that it was common all over the island and that it appeared to be more vocal and more retiring than those inhabiting the New Zealand mainland: calls were heard throughout the year but the birds were unapproachable. Sorensen (1944 and 1964) found it common in 1944, and in August noted a few about the tidal pools of Meyer. He was of the opinion that the Kermadec bird was more closely allied with Pacific forms than with that of New Zealand.

We found it widespread on Raoul and plentiful on the northern coast where the farm and road cuttings provided suitable habitat

and nesting sites. Breeding continued throughout our stay; one clutch of 2 eggs, three of 4 eggs and one of 6 eggs being found. The mean dimensions of seven eggs measured were 27.5 x 23.2 mm., and they ranged from 26.9 - 28.8 mm. in length and from 22.6 - 23.8 mm. in width. Clutches of 2 and 3 nestlings were seen. Two half-grown young observed from a hide were fed at half to three quarter-hourly intervals throughout the day; both parents participating. Foods offered to the nestlings included cicadas, dragon flies, earthworms and large green and brown caterpillars.

Sorensen (1964) stated that it is rarely if ever found near water. However, we, like Iredale (1910), noticed that it frequented the sea-shore where it fed upon littoral animals. We also found that it was unusually vocal and that the territorial call appeared to be given at a slower tempo than that of mainland birds.

Two were seen on the eastern side of North Meyer on 19/11/66, and on 21/11/66 a single bird was recorded burrowing in a bank at the northern end of the western slopes. The only other observation from Meyer was of one near the southern end of the northern islet on 13/1/67. Apparently it has not been recorded from others of the Kermadec Group.

TABLE VI

Summary of measurements (in millimetres) of adult Kingfishers collected on Raoul Island between 18/12/66 and 3/1/67.

	Number	Mean	Range
Bill length	5	41.6	39 - 45
depth	4	13.3	13 - 14
width	5	17.5	17 - 18
M.t.c.	5	21.1	18.5 - 23
Tarsus	5	14.9	14 - 15.5
Wing	5	96.1	90 - 102.5
Tail	5	63.6	62 - 64.5

Note: Middle toe and claw measurements are below the range of those of New Zealand mainland birds (24 - 27 mm.) given by Oliver (1955), and systematic status may warrant investigation.

Skylark *Alauda arvensis**

Two were reported on the farm in early January by T. Blake (meteorological station staff) but subsequent searches by expedition members failed to confirm this.

* The history and status of European passerines occurring at the Kermadecs have been reviewed by Merton and Veitch (in press).

Song Thrush *Turdus philomelos**

Sampling of passerines on Raoul, according to relative abundance (Merton and Veitch in press), showed this to be one of the most plentiful and widespread species, but it was not recorded from the Herald Islets.

Blackbird *T. merula**

Plentiful and widespread on Raoul and in small numbers on both Meyer islets, but not recorded from others of the Herald Group.

Pipit *Anthus novaeseelandiae*

Cheeseman (1887 and 1890) considered it " not uncommon " on the flat grassy surface of Macauley in August 1887, but he did not see it on Raoul. However Bell informed him that it occurred there occasionally, usually in pairs, but he had never found it breeding. In 1908 Oliver (Sorensen 1964) observed three on Low Flat and one in the crater, but the species was not found on Curtis or Macauley (Iredale 1912). However in 1929 Pycroft (1929) reported six on Curtis Island. On 8/6/44 Sorensen (1964) saw one at Wilson Point, Raoul Island, and on 21/11/64 two birds on the north-western side of Blue Lake were tentatively identified as this species (Edgar *et al.* 1965). The pipit was not recorded on Macauley between 28/7/66 and 22/8/66 (B. D. Bell, pers. comm.).

A bird thought to have been of this species was flushed from the Denham Bay track near its highest point on 11/1/67. It was not seen well enough for positive identification and did not call. Although much suitable pipit habitat exists on Raoul and was often visited by expedition members, none was seen or heard.

Tui *Prosthemadera novaeseelandiae*

This is known only from Raoul where it was reported by Milne (1855) in 1854, and in 1887 was considered by Cheeseman (1887 and 1890) to be " the commonest bird " on that island. He observed that its song differed slightly from that of the mainland form, and he was told by Bell that its numbers had " been much thinned by the wild cats." Nevertheless it was " very abundant " in 1908 when Iredale (1910 and 1912) considered it to be identical with the mainland bird except that it had " lost its voice." In his latter account, however, he stated that " as no series was collected I do not know whether it was subspecifically separable from mainland forms. As it had lost its voice, it seems certain that it would be." He qualified his statement concerning its voice thus: " To make up for this loss it endeavours to produce musical sounds all the year round. (The) clear bell-note (of the New Zealand bird) was only heard on two occasions, whilst, though I believe each bird honestly endeavoured to bring out some striking notes, none ever succeeded." He also found that it was inquisitive and that some night singing occurred throughout the year — especially on moonlight nights. Like all subsequent observers Sorensen found it common, and he, like Bell and Iredale, noted that breeding began in September.

* The history and status of European passerines occurring at the Kermadecs have been reviewed by Merton and Veitch (in press).

[M. F. Soper

Plate XIX — Tui and young, Raoul Island.

We found it plentiful throughout wooded parts of Raoul and, of the 5 species of passerine inhabiting the island, it was third in order of relative abundance (Merton and Veitch, in press). Fledglings were much in evidence during our stay and a nest containing 4 well-grown young was found on 24/11/66. Chicks observed were fed, mainly by the female (distinguishable because of her less well developed white throat plumes), upon cicadas, green caterpillars, *Coprosma* berries, a stick insect and nectar. Adult Tuis fed upon a wide variety of nectars, fruits (including the flesh of ripe oranges, as noted by Sorensen (1944) in 1944 and Edgar *et al.* (1965) in 1964) and invertebrates (Merton unpubl.), and in the absence of a flycatcher, appeared to occupy this niche to some degree, both aerial and ground feeding being observed frequently.

Between 4 and 20/12/66 an adult visited the Denham Bay camp at least once daily, and often at about 2-hourly intervals, in order to obtain pieces of broken goose barnacle *(Lepas)* shell from on the ground. Up to 8 fragments, each of about 5 mm. in diameter, were swallowed during each visit, and others it carried directly to a nest containing young.

Song was similar to that heard in New Zealand, although rather subdued, and like Iredale, we too found that some night singing occurred. At Hutchison Bluff, Tuis had a most unusual dialect, one call resembling that of the Indian Myna *Acridotheres tristis.*

A clutch of 4 addled eggs, found on 8/1/67, had mean dimensions of 28.1 x 20 mm., and ranged in length from 27.5 - 28.5 mm. and in width from 20 - 20.25 mm.

TABLE VII

Summary of measurements (in millimetres) of live adult Tui captured on Raoul Island between 27/11/1966 and 5/1/1967.

	Number	Mean ± S.d.		Range
Bill length	22	25.6	2.00	23 - 30
depth	22	7.4	0.65	6 - 8.5
width	22	10.6	0.75	9 - 12
M.t.c.	22	28.2	2.05	23 - 31.5
Tarsus	20	36.0	2.11	33 - 39.5
Wing	22	133.7	8.69	121 - 149
Tail	21	111.0	6.24	101 - 122.5

Note: The ranges of wing and tail measurements are a little below those of New Zealand birds given by Oliver (1955) viz. wing 135 - 158 mm., tail 110 - 126 mm.

Redpoll *Carduelis flammea**

None was seen, but on 30/11/66 flight-calls were heard over D'Arcy Point ridge.

Yellowhammer *Emberiza citrinella**

We found this only on Raoul, where it was in moderate numbers in more open areas throughout the island and in small flocks near the meteorological station's fowl-run and pig-sty.

Starling *Sturnus vulgaris**

Probably the most numerous and widespread species on Raoul, the Starling was abundant in the parts of the crater disturbed by the 1964 volcanic activity, and on the farm. It was present in small numbers on the Chanters, and breeding on both Meyer islets and on Napier and Dayrell.

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APPENDIX 1 BIRDS RECORDED WHILE EN-ROUTE BETWEEN AUCKLAND AND RAOUL ISLAND

DATE & TIME	BIRDS	POSITION, WEATHER AND REMARKS
10 November 1966		
1700 hrs	1 Giant petrel	Off Motutapu Island
1800 hrs	1 Bullers shearwater 2 White-fronted tern 20+ Fluttering shearwater 1 Flesh-footed shearwater	
11 November 1966		
0600 hrs	Nil	34°36'S by 176° 36'E. Wind - S.E. 10 knots Seas - Moderate
0700 hrs	1 Juvenile wandering albatross 1 Juvenile black-browed mollymawk 1 Adult black-browed mollymawk 1 Cape pigeon 1 Grey-faced petrel	
0800 hrs	1 Grey-faced petrel 1 Bullers shearwater 1 Juvenile wandering albatross 1 Adult wandering albatross 1 Juvenile black-browed mollymawk	
0900 hrs	1 Juvenile black-browed mollymawk	
1000 hrs	1 Juvenile wandering albatross	
1100 hrs	Nil	
1200 hrs	1 Juvenile black-browed mollymawk 1 Adult wandering albatross 1 Grey-faced petrel	33° 54'S by 177° 24'E. Wind - S.E. 10 knots Seas - Moderate
1300 hrs	Nil	
1400 hrs	5 Juvenile wandering albatross	
1500 hrs	1 Juvenile black-browed mollymawk 1 Juvenile wandering albatross 1 Grey-faced petrel	
1600 hrs	1 Juvenile black-browed mollymawk 1 Juvenile wandering albatross	
1700 hrs	3 Juvenile wandering albatross	
1800 hrs	3 juvenile wandering albatross 1 Giant petrel	33° 12'S by 178° 48'E. Wind - S.E. 10 knots Seas - Moderate
1900 hrs	2 Juvenile wandering albatross 1 Adult wandering albatross 1 Adult black-browed mollymawk 1 Giant petrel	
12 November 1966		
0600 hrs	Nil	31° 12'S by 179° 51'E Wind - N.E. 12 knots Seas - Moderate
0700 hrs	1 Cape pigeon 3 Juvenile wandering albatross	
0800 hrs	4 Juvenile wandering albatross 1 Adult wandering albatross 1 Cape pigeon	
0900 hrs	6 Juvenile wandering albatross 2 Grey-faced petrel	
1000 hrs	3 Juvenile wandering albatross	1045 hrs - Last grey-faced petrel seen.
1100 hrs	7 Juvenile wandering albatross 1 Wedge-tailed shearwater	

APPENDIX 1 Cont.

DATE & TIME	BIRDS	POSITION, WEATHER AND REMARKS
1200 hrs	1 Black-winged petrel 5 Juvenile wandering albatross	30° 58'S by 179° 32'W Wind - S.E. 10 knots Seas - Moderate
1300 hrs	5 Juvenile wandering albatross	
1400 hrs	6 Juvenile wandering albatross 1 Cape pigeon	
1500 hrs	4 Juvenile wandering albatross	
1600 hrs	7 Juvenile wandering albatross 2 Adult wandering albatross	1645 hrs - 17 wandering albatross.
1700 hrs	13 Wandering albatross (adult & juvenile) 1 Wedge-tailed shearwater	1745 hrs - First sooty tern seen.
1800 hrs	11 Wandering albatross (adult & juvenile) 1 Wedge-tailed shearwater	Curtis Island to starboard, Wind - 10 knots S.E. Seas - Moderate
27 January 1967		
1100 hrs	6 Black-winged petrel	Off Hutchison Bluff, Raoul Island
1200 hrs	No check	
1300 hrs	15 Black-winged petrel	
1400 hrs	26 Black-winged petrel	
1500 hrs	10 Black-winged petrel 1 Sooty tern	
1600 hrs	19 Black-winged petrel	Approx. 15 miles west of Macauley Island
1700 hrs	30 Black-winged petrel 1 Sooty tern 3 Wedge-tailed shearwater	
1800 hrs	15 Black-winged petrel 1 Wedge-tailed shearwater	30° 36'S by 178° 50'W Approx. 15 miles west of Curtis Island. Calm sea, light S.W. breeze 1845 hrs - Wedge-tailed shearwater and sooty tern still being seen occasionally.
1900 hrs	6 Black-winged petrel	
28 January 1967		
0600 hrs	1 Black-winged petrel	32° 17'S by 179° 16'E Calm sea, light S.W. breeze
0700 hrs	Nil	0730 hrs. First wandering albatross seen.
0800 hrs	Nil	
0900 hrs	Nil	
1000 hrs	Nil	1045 hrs. Occasional black-winged petrels still being observed.
1100 hrs	Nil	
1200 hrs	Nil	33°04'S by 178° 23'E Calm sea, Wind - S.W. 10 knots
1300 hrs	Nil	
1400 hrs	1 Juvenile wandering albatross	This is the first wandering albatross seen since 0730 hrs
1500 hrs	1 Black-winged petrel	
1600 hrs	1 Black-winged petrel	
1700 hrs	1 Adult wandering albatross	
1800 hrs	3 Juvenile wandering albatross 2 Adult wandering albatross	33°51'S by 177°30'E Calm sea. Wind - S.W. breeze

APPENDIX 1 Cont.

DATE & TIME	BIRDS	POSITION, WEATHER AND REMARKS
29 January 1967		
0700 hrs	1 Black-backed gull	
0800 hrs	6 Black-backed gull 1 Flesh-footed shearwater	Little Barrier Island to starboard. Calm sea, very light winds.
0900 hrs	3 Black-backed gull	
1000 hrs	6 Black-backed gull 1 Caspian tern 1 Gannet 2 Red-billed gull 9 Fluttering shearwater 1 Flesh-footed shearwater 20+ Bullers shearwater	Tiritiri Island to starboard

APPENDIX II

SOUND RECORDING AND PHOTOGRAPHY

(Tape-recordings and movie films are deposited in the O.S.N.Z. Library.)

SPECIES	PHOTOGRAPHED			SOUND RECORDED
	BLACK & WHITE	COLOUR	CINE	
Wandering albatross	x	x	x	
Black-browed mollymawk	x	x		
Giant petrel	x	x		
Wedge-tailed shearwater	x	x	x	x
Allied shearwater		x	x	
Kermadec petrel	x	x	x	x
Black-winged petrel	x	x	x	x
Red-tailed tropic bird	x	x	x	x
Blue-faced booby	x	x	x	
Spotless crake	x		x	x
Sooty tern	x	x	x	x
White tern		x	x	
White-capped noddy	x	x	x	x
Grey ternlet	x	x	x	x
Red-crowned parakeet	x	x	x	x
Kingfisher	x	x	x	x
Song thrush				x
Blackbird			x	x
Tui	x	x		x
Yellowhammer				x
Starling				x
Kermadec cicada				x
Black Australian cricket				x

APPENDIX III

SUMMARY OF BANDING RESULTS

Species	Locality		Number banded
Wedge-tailed shearwater	Meyer Islets		286
Allied shearwater	North Meyer Islet		4
Kermadec petrel	Meyer Islets		944
Black-winged petrel	Meyer and Napier Islets		986
Tropic bird	South Meyer Islet		81 (plus 1 recapture)
Booby	Chanter Islets		40
Sooty tern	Denham Bay	Pul.1508 Juv.1347 Ad. 109	
	Hutchison Bluff	Ad. 184	3148
White tern	Denham Bay		1
Noddy	Meyer Islets		7
Ternlet	Meyer Islets		21
Parakeet	North Meyer Islet		6
Thrush	Low Flat		9
Blackbird	Low Flat		22
Tui	Low Flat		23
Starling	Crater		1
	Total		5579

APPENDIX IV

SPECIMENS DEPOSITED AT DOMINION MUSEUM

A. BIRD SKINS

Species	D.M. Number	Sex	Age	Date	Locality	Collector	Total
Kermadec petrel	12383	M	Ad.	31.12.66	North Meyer	D.V.M.	
" "	12382	M	Ad.	"	" "	"	
" "	13295	M	Ad.	"	" "	"	
" "	12384	F	Ad.	20.1.67	" "	"	
" "	12385	-	Ad.	9.1.67	" "	D.E.C.	5
Black-winged petrel	12380	M	Ad.	19.12.66	North Beach	C.R.V.	
" "	12381	M	Ad.	20.12.66	North Meyer	D.V.M.	
" "	13293	M	Ad.	20.12.66	" "	"	
" "	13294	M	Ad.	20. 1.67	" "	"	4

APPENDIX IV Cont.

Wedge-tailed shearwater	12386	M	Ad.	20.12.66	" "	"	
" "	12388	F	Ad.	20. 1.67	" "	"	
" "	12387	F	Ad.	3. 1.67	" "	D.E.C.	3
Sooty tern	12393	M	Ad.	15.12.66	Denham Bay	C.R.V.	
" "	12391	F	Ad.	15.12.66	" "	"	
" "	12390	F	Ad.	16.12.66	" "	"	
" "	12389	F	Ad.	"	" "	"	
" "	12392	M	Ad.	"	" "	"	5
Noddy	12394	F	Ad.	18.12.66	North Beach	D.V.M.	
"	12395	F	Ad.	18.12.66	" "	"	
"	12396	F	Ad.	19.12.66	" "	C.R.V.	3
Ternlet	13296	M	Ad.	20.12.66	North Meyer	D.V.M.	
"	13297	F	Ad.	20.12.66	" "	"	2
Asiatic whimbrel	12397	M	Ad.	23.12.66	North Beach	"	1
Spotless crake	12401.	F	Ad.	26.12.66	South Meyer	"	
" "	12400	M	Ad.	27.12.66	" "	C.R.V.	2
Pukeko	13298	M	Ad.	6. 1.67	Blue Lake	D.V.M.	
"	13299	F	Ad.	"	" "	"	
"	13300	F	Juv.	"	" "	"	3
Grey duck	12399	F	Juv.	19.12.66	" "	C.R.V.	
" "	12398	F	Juv.	6. 1.67	" "	D.V.M.	2
Kingfisher	12402	F	Ad.	18.12.66	Ngaio Point	C.R.V.	
"	12404	M	Ad.	22.12.66	Farm	"	
"	12403	M	Ad.	29.12.66	"	"	
"	12405	F	Ad.	1. 1.67	"	"	
"	12406	F	Ad.	3. 1.67	"	"	5
Tui	12409	M	Ad.	11.12.66	Low Flat	C.R.V.	
"	12412	M	Ad.	27.11.66	" "	"	
"	12411	M	Ad.	11.12.66	" "	"	
"	12410	M	Juv.	22. 1.67	" "	"	4
Parakeet	12407	M	Ad.	27.12.66	South Meyer	"	
"	12408	F	Ad.	27.12.66	" "	"	2

B. BIRDS' EGGS

Species	D.M. Number	Date	Locality	Collector	Number		Total
Kermadec petrel	12423	7. 1.67	North Meyer	J.F.A.	2(Fresh)		
" "	12424	9. 1.67	" "	"	1	"	
" "	12422	19. 1.67	" "	"	1	"	4
Black-winged petrel	12428	1. 1.67	South Chanter	D.V.M.	1	"	
" "	12426-27	4. 1.67	North Meyer	J.F.A.	2	"	
" "	12425	8. 1.67	" "	"	1	"	
" "	12429	11. 1.67	" "	"	1	"	
" "	12430	19. 1.67	" "	"	1	"	6
Wedge-tailed Shearwater	12420	3. 1.67	" "	D.E.C.	2	"	
" "	12421	4. 1.67	" "	"	2	"	4

APPENDIX IV Cont.

Sooty tern	12436-37	6.12.66	Denham Bay	D.V.M.	2(deserted)	
" "	12438-41	13.12.66	" "	C.R.V.	4 "	
" "	12442-46	14. 1.67	" "	J.A.P.	5 "	11
Noddy	12431	22.11.66	North Meyer	D.V.M.	1(Fresh)	
"	12432-33	4. 1.67	" "	D.E.C.	2 "	3
Ternlet	12434	21.11.66	" "	D.V.M.	1 "	
"	12435	22.11.66	" "	"	1 "	2
Booby	12418a-b	1. 1.67	North Chanter	C.R.V.	2(addled clutch)	
"	12419	1. 1.67	South Chanter	D.V.M.	2 " "	4
Tropic bird	12417	28.12.66	" "	"	1 (Fresh)	1
Kingfisher	12448	3. 1.67	Farm	C.R.V.	1(addled)	1
Tui	12447a-c	8. 1.67	Low Flat	D.V.M.	4(addled clutch)	4

C. MISCELLANEOUS

Species	Description	Date	D.M. Number	Locality	Collector
Wandering albatross	Humerus	17.11.66		Denham Bay Beach	J.A.P.
Sooty shearwater	Storm-wreck	24. 1.67		Denham Bay Beach	D.V.M.
Allied shearwater	Cat-eaten remains	13.12.66		Below Rayner Point	"
" "	5 wings from 3 cat-eaten fledglings	13.12.66		Rayner Point at c300' above sea level	"
" "	Storm-wreck	14.11.66		Below Fleetwood Bluff	J.F.A.
" "	Dried remains	26.12.66		South Meyer	C.R.V.
" "	" "	1. 1.67		South Chanter	D.V.M.
" "	" "	2. 1.67		North Meyer	J.F.A.
Sunday Island petrel	Storm-wreck	5. 1.67	12843	Bell's Beach	W.R.S.
Kermadec petrel	Skull	1.12.66		Crater rim west of Mt Prospect	C.R.V.
" "	"	3.12.66		Low Flat	"
" "	Remains	12. 1.67	11423	Above Smith Bluff	"
" "	Downy chick,(spirit specimen)	17. 1.67	12414	Smith Bluff (coastal)	W.R.S.
Black-winged petrel	Cat-eaten remains	16.12.66		Denham Bay below cliffs	C.R.V.
" "	" " "	8. 1.67	12478	Low Flat	D.V.M.
" "	Dried remains	25.12.66	12479	North Meyer	W.R.S.
" "	" "	30.12.66	12480	" "	J.F.A.
Tropic bird	" "	25.11.66		Farm	"
Spotless crake	2 newly hatched chicks (spirit specimens)	28.11.66	12413a-b	North Meyer	D.E.C.
Golden plover	1 wing	2.12.66		Blue Lake	D.V.M.
" "	1 wing	12.12.66		North Beach	"
Knot	Dried remains	20.12.66	12501	Blue Lake	"
Parakeet	Cat-disgorged feathers	13.12.66		Rayner Point	"
"	Dried remains	26.12.66		South Meyer	C.R.V.
"	" "	25. 1.67		North Meyer	J.A.P.

APPENDIX V

SPECIES REPORTED IN THE PAST, BUT NOT OBSERVED BY MEMBERS OF THE CURRENT EXPEDITION

Black-browed Mollymawk *Diomedea melanophris:* Off-shore, August 1887 (Cheeseman 1887 and 1890). Sight records (Oliver 1955).

Light-mantled Sooty Albatross *Phoebetria palpebrata:* Off-shore, August 1887 (Cheeseman 1887). Sight records (Oliver 1930 and 1955).

Cape Pigeon *Daption capensis:* " Plentiful at sea," August 1887 (Cheeseman 1887). Off-shore, 1908 (Iredale 1910).

Prion *Pachyptila sp.:* Raoul, 29/7/10, storm-wrecked juvenile. Oliver (1911 and 1912) identified this as *P. desolata,* however Falla (1940) believed that it may have been *P. salvini crozeti.*

Narrow-billed Prion *P. belcheri:* Raoul, July 1944, 1 storm-wrecked specimen (Sorensen 1964).

Fairy Prion *P. turtur:* " Kermadecs " (Oliver 1930).

Short-tailed Shearwater *Puffinus tenuirostris:* Raoul, 1 specimen (Hutton 1893; Iredale 1912). " Visitor " (Oliver 1911). " Specimens obtained " (Oliver 1930 and 1955).

Grey-faced Petrel *Pterodroma macroptera gouldi:* Raoul, storm-wrecked specimens; 1896, 1 (Ogilvie-Grant 1905); 25/7/08, 1; 7/8/08, 1 (Oliver 1911; Iredale 1912).
Macauley, off-shore, August 1966, 1 (O'Brien 1966).

Phoenix Petrel *P. alba:* Raoul, 1913, 1 collected (Sorensen 1964). 7/3/13, 4 ashore (Oliver 1930 and 1955; Fleming 1953).

Cook's Petrel *P. cooki cooki:* Range includes Kermadecs (Oliver 1930 and 1955).

White-bellied Storm Petrel *Fregatta grallaria:* Macauley, August 1966, breeding (O'Brien 1966).

Australian Gannet *Sula bassana serrator:* Raoul, alleged visitor (Cheeseman 1890).

Brown Booby *S. leucogaster plotus:* Raoul, 1 dead specimen (Bell, in Oliver 1911). 21/8/63, 1 (unconfirmed), C. M. Clark (pers. comm.).
Curtis, 28/7/66, 1 off-shore (B. D. Bell, pers. comm.).

Little Black Shag *Phalacrocorax sulcirostris:* Raoul and Macauley, " a small number . . . stayed for some years " (Bell, in Oliver 1911).

Reef Heron *Egretta sacra sacra:* Kermadecs, visitor (Bell, in Cheeseman 1890). " Accidental " (Oliver 1911).
Meyer, Sept. 1964, 1 " white " heron (R. G. Lovegrove, pers. comm.).

White-faced Heron *Ardea novaehollandiae:* Raoul, March and April 1965, 1 " blue " heron frequented farm (Phillips, C., " Biological reports: Raoul Island," extract from report to Secretary for Civil Aviation). 14/4/69 - 27/6/69, 1 (R. G. Lovegrove, pers. comm.).
Macauley, August 1966, 1 (O'Brien 1966).

Harrier *Circus approximans:* Raoul, August 1887, " not uncommon " (Cheeseman 1887; Smith 1887). 1908, plentiful (Iredale 1910 and 1912). 1937, recorded (Davison 1938). 1944, several (Sorensen 1964). 12/4/63, 1 (C. M. Clark, pers. comm.). 13/5/69 - 19/6/69, 1 (R. G. Lovegrove, pers. comm.).
Meyer, 1908, plentiful (Iredale 1910 and 1912). August 1944, 2 (Sorensen 1944).
Macauley, August 1887, " not uncommon " (Cheeseman 1887 and 1890; Smith 1887). 15/4/29, 2 (Pycroft 1929). 28/7/66 - 22/8/66, not seen (B. D. Bell, pers. comm.).
Curtis, 16/4/29, 2 (Pycroft 1929).

Mound Bird *Megapodius sp.:* Raoul, alleged to have inhabited the crater prior to the 1876 eruption (Cheeseman 1890).

Banded Rail *Rallus philippensis subsp.:* Raoul, 1887, uncommon (Cheeseman 1890).

Oystercatcher *Haematopus sp.:* Raoul, Feb.-May 1969, up to 3 " pied " oystercatchers frequented the farm (R. G. Lovegrove, pers. comm.).

Banded Dotterel *Charadrius bicinctus:* Raoul, Sept. 1913, 1 (Oliver 1955).

Oriental Dotterel *C. asiaticus veredus:* Raoul, 22/4/08, 1 collected (Iredale 1910 and 1912; Oliver 1955).

Bristle-thighed Curlew *Numenius tahitiensis:* Macauley, August 1966, 1 (O'Brien 1966).

Sharp-tailed Sandpiper *Calidris acuminata:* Raoul, 25/10/08, 1 collected (Iredale 1910 and 1912), and 29/10/10, 1 collected (Oliver 1912).

Curlew Sandpiper *C. ferruginea:* Kermadecs (Oliver 1930 and 1955; Fleming 1953).

Arctic Skua *Stercorarius parasiticus:* Off Raoul, 23/11/64, 1 (Edgar *et al.* 1965).

Caspian Tern *Hydroprogne caspia:* Kermadecs (Bell, in Cheeseman 1890).

Crested Tern *Sterna bergii cristata:* Raoul, 1/4/10, 1 collected (Oliver 1911 and 1912).

Kermadec Pigeon *Hemiphaga sp.:* Raoul, 18/12/1836, abundant (Rhodes, in Straubel 1954). Last reported about 1870 (Cheeseman 1887 and 1890).

Australian Tree Martin *Hylochelidon nigricans nigricans:* Raoul, 14/9/66, 1 seen, and another in an exhausted state was captured about this time. Unconfirmed (T. Blake, pers. comm.).

White-eye *Zosterops lateralis:* Raoul, August 1887, not plentiful (Smith 1887; Cheeseman 1887 and 1890). Vagrant (Iredale 1910 and 1912).
Macauley, August 1887, not plentiful (Smith 1887; Cheeseman 1887 and 1890). August 1966, about 60 present (O'Brien 1966).

Greenfinch *Chloris chloris:* Raoul, Nov. 1964, small numbers (Edgar *et al.* 1965).

Goldfinch *Carduelis carduelis britannica:* Raoul, 1885 (Bell, in Smith 1887). 17/5/09, 1 collected; 1940, 3 (Sorensen 1964).
Macauley, August 1966, 1 (O'Brien 1966).