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Controller,
Wildlife Service,
WELLINGTON.

Attention: Senior Conservation Officer

THE ORNITHOLOGICAL SOCIETY OF NEW ZEALAND

KERMADEC ISLANDS EXPEDITION

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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.

Two years earlier the Society had sent a similar expedition to the Kermadecs but only two days after its arrival volcanic activity on Raoul resulted in total evacuation, and so the project had been postponed.* Of the thirteen members comprising this earlier expedition, only four were available to join the 1966/67 party. They were D.E. Crockett, Science Advisor to the Tangata Education Board, J.A. Peart, Science Lecturer, Palmerston North Teachers' Training College, W.R. Sykes, Botany Division, D.S.I.R., Christchurch and D.V. Merton, Wildlife Service, Department of Internal Affairs, Wellington (Leader). Other members were: Dr. J.C. Batt, Entomology Division, D.S.I.R., Nelson, (Senior Scientist), Dr. M.F. Soper, Registered Medical Practitioner, Tapanui, J.F. Anton, retired, Taupo, W.V. Ward, retired, Nelson and C.A. Veitch, Wildlife Service, Rotorua.

OBJECTS

The main object of the expedition was to carry out ornithological surveys on Raoul and as many other islands in the Kermadec group as possible, (see appendix III). The last comprehensive survey of this nature was that of Oliver and Iredale who in 1908 spent 10 months based at Denham Bay, Raoul Island, during which time Meyer, Napier and Bayrell of the Herald Islets were briefly visited, as well as Macauley and Curtis Islands and French Rock. (See Oliver 1909, 1910(a) & (b), 1911 & 1912 & Iredale 1910, 1912 & 1914.)

Other more specific projects undertaken included:

1. A population and breeding biology study of sooty tern (Sterna fuscata). (J.A.P.)
2. Distribution and breeding biology study of wedge-tailed shearwater (Puffinus pacificus pacificus). (D.E.C.)
3. Distribution and breeding biology of grey ternlet (Procelsterna cerulea albivitta), white-capped noddy (Anous tenuirostris minutus) and observations on behaviour of Kermadec parakeet (Cyanoracphus novaezelandiae cyanurus) and spotless crane (Porzana tabuensis plumbea). (M.F.S.)
4. Foods and feeding stations of native bush birds. (D.V.M.)
5. Bird collection and taxidermy. (D.V.M., C.R.V. and D.E.C.) (41 skins of 13 species were obtained - see appendix VIII).
6. Distribution and status of European passerines. (C.R.V.)
7. Notes on introduced mammals (on behalf of Wildlife Service, Department of Internal Affairs) (D.V.M. and C.R.V.)
8. Goats and their effects upon Raoul Island's vegetation. (W.R.S.) (See appendix X).
9. Census and notes on waders and migrants. (J.A.P.)

* (See account by Edgar, Kinsky and Williams (1963).)

10. Bird banding (on behalf of Wildlife Service). (A total of 5579 birds of 15 species was banded. See appendix VII).
11. O.S.N.Z. recording scheme, beach patrol and nest record cards. (J.F.A.) (The measurements of several hundred birds representing most of the Kermadec species were recorded and are held in the Society's recording scheme.)
12. Notes on the distribution, status and breeding biology of black-winged petrel (Pterodroma hypoleuca nigripennis) and Kermadec petrel (P. neoleuca) (J.F.A.)
13. Entomology (on behalf of Entomology Division, D.S.I.R.), with particular reference to arthropod inhabitants of birds' nests and burrows and bird and animal ectoparasites. Identification of gut contents of insectivorous birds. (J.C.W.)
14. Botanical collections and surveys of Raoul and adjacent islets, (on behalf of Botany Division, D.S.I.R.), (W.W.S.)
15. Still photography. (M.F.S.) (See appendix VI)
16. 16 mm movie colour film of expedition activity. (W.V.W.) (See appendix VI.)
17. Sound recording. (W.V.W.) (High fidelity recordings were obtained of fifteen bird and two invertebrate species. See appendix VI).
18. Other miscellaneous material was collected for Dominion Museum and a number of research workers. This included 49 birds, eggs of 11 species, a number of bird skeletons, seashells, petrel tissues, fat and stomach oil, goat stomachs, cat stomachs and droppings, tissues from starlings for detection of residual poisons and samples of protozoa from the Blue Lake mud flats (See appendices VIII and IX).

TRANSPORT

Return transport was provided by H.M.N.Z. Navy and a 12 foot 6 inch clinker dinghy and 9.5 h.p. out-board motor was used amongst the Herald Islets. H.M.N.Z.S. "Inverell" provided outward transport from Auckland on 10/11/66 and her sister ship "Kiama" returned the party to Auckland on 29/1/67. Favourable seas prevailed during both voyages and bird-logs kept. (See appendix II).

It was unfortunate that neither Curtis nor Macaulay Islands could be visited even briefly and our course did not take us close enough for useful observations to be made.

STORES AND EQUIPMENT

All items were purchased in Auckland where they were sorted into three lots according to their ultimate destination, i.e., Base Camp, Denham Bay or North Meyer Islet. Most were then sealed in plastic bags before being packed in wooden crates. Stores arrived in good order and lasted well. A list of stores and general equipment taken is attached (see appendix XI).

On arrival at Raoul Island a base was established on Lee Flat and established camps on North Meyer (occupied from 19/11/66 to 20/1/67) and at Denham Bay (occupied from 14/11/66 to 24/1/67). Most stores and equipment for Meyer including three 44 gallon drums of drinking water, were landed directly

"Inverell"; the water proving adequate for the needs of three men for the nine week period.

GEOGRAPHY

The Kermadec are comprised of two large and over a dozen small islands, which are the summits of volcanic cones rising from a sub-oceanic ridge extending from New Zealand to the Tongan archipelago. They constitute the most northern and only sub-tropical islands within New Zealand's faunal 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° 57' E. Cape Brett is the nearest New Zealand landfall, 531 nautical (611 statute) miles to the south-west; the distance from Auckland is 585 nautical (674 statute) miles. Norfolk Island is 750 nautical miles due west, and the Tongan group 500 nautical miles to the north-north-east.

Macaulay (764 acres), is the second largest island and lies 60 nautical miles south-south-west of Raoul. 19 nautical miles south-south-west of Macaulay are Curtis and Cheeseman Islands (128 and 19 acres respectively), and 52 nautical miles south-south-west again is L'Esperance or French Fock (12 acres), the most southern of the Kermadec group. (Data from "The N.Z. Pilot" 1952) Raoul and Curtis are active andesitic volcanoes.

Most of the smaller islands are situated in the Herald group which lies between 1 and 2 miles off the north-eastern coast of Raoul (see appendix I).

The fauna and flora of the Kermadecs have a close affinity to those of New Zealand but with a strong sub-tropical element.

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 Thomas Bell, a well known settler, were gazetted "Reserves for the Preservation of Fauna and flora" (N.Z. Gaz. 1934, p.201) administered by the Lands & Survey Department. In 1937 the free-hold block was resumed by the Crown for use as an aeradio station (N.Z. Gaz. 1938, p. 275) and was until 1951, controlled by the Public Works Department.

Control then passed to the Air Department's Civil Aviation Administration, which in 1964 became an independent department and in 1968 became part of the Ministry of Transport. The area, together with the Aeradio Station sited upon it, is now administered by the Airports and Airways Section of the Ministry of Transport. (See appendix I.)

RAOUL ISLAND

TOPOGRAPHY

A roughly triangular shaped, active, andesitic volcano, 22 miles in circumference, approximately 5½ miles long by 3 miles wide, with an area of approximately 7,200 acres. The highest point, Mt. Mounakai (1694 feet above sea-level), is on the rim of the approx. 1½ miles in diameter crater. 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 Belle Flat, a terrace above the northern coast which is divided into eight paddocks comprising the approx. 50 acre M.O.T. farm; 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 center. The largest of these, Blue Lake, was prior to the 1964 eruption a source of water for the C.A.A. station, but is now polluted. Green Lake has apparently always had a high mineral content and Tui Lake, little more than pond size, is stagnant.

Volcanic activity of November 1964 has resulted in the formation of one large and ten smaller vents in the region of Green Lake (see appendix I). Ash showers did however, fall over most of the Island to a greater or lesser degree. The eruption was responsible for destroying pohutukawa (Metrosideros kermadecensis) forest on Devastated Ridge which separates Blue and Green Lakes, round the shores particularly at the eastern end of Blue Lake.

Raoul Island is poorly watered and with the volcanic pollution of Blue Lake permanent drinking water was available only from a spring at Lava Point, the Denham Bay Lagoon, drums at the three huts, i.e. Boat Cove, trig. V and Denham Bay, and from the M.O.T. establishment where it was piped from a small stream at the western end of the Terraces, as well as being collected from the roofs of buildings. When away from these areas it was therefore necessary that we carry water and this limited our time away to about three days.

CLIMATE

The prevailing wind cycle is west to south-west in the winter and east to north-east in summer and hurricanes occur infrequently. Temperatures range from about 47° in winter to 86° F. in summer. Humidity is generally high. Rainfall is usually evenly distributed, but summers can be dry.

Weather generally throughout our stay was good although the seasonally-prevailing north-easterly winds did not give the most favourable seas for travel amongst the Herald Islets, or landing on North Beach. A little rain fell during the early stages, and towards the end very humid conditions were followed by torrential rains.

VEGETATION

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 here are endemic. Some of these species together with natural plant associations, are threatened by the browsing of feral goats (see passage below headed "goats" and appendix K), 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 lanceolata at higher altitudes. Other more common forest species include karaka (Corynocarpus laevigatus), kawakawa (Malicope ternata), kawakawa (Macropiper excelsum), mahoe (Melastomaceae), tree-ferns Cyathea kermadecensis and C. wilsonii and nikau (Nyctelestis cheesemani) in parts, particularly near Boat Cove, nikau dominates large areas, forming almost pure stands. More open areas such as old lawns or coastal faces are clothed in native ferns, rushes and grasses. There are few places where the aroid Alocasia sacrorhiza is not flourishing, be it sea level or near the summit of Moumoukai, wet or dry. This plant was apparently introduced by the settlers for food, together with the taro (A. indicum) but unlike the latter which is now rare, it has dominated many areas forming dense growths of up to 7 feet high. It has also spread to both Moyer Islets.

On the flat behind the Barham Bay beach and north-west of the lagoon, where settlers' dwellings were once situated, another plant introduced from the Pacific islands threatens to take charge. This is a species of Caesalpinia, a thorny creeper. It has dominated several areas of this flat and its eradication, while its range is still somewhat confined, is highly desirable. A hormone spray would probably be the most practical means of eradication.

While traversing Devastated Ridge which separates Blue and Green Lakes we were amazed to find plants such as sweet william, carnation, carrot, turnip, tomato, radish, rye grass and clover growing in sheltered places among the eruption-killed puhukawa on the bare volcanic pumice. The problem of how they came to be growing in such an unlikely place was solved by Tony Blake, the farm manager, who was spending his second successive year on Raoul. He explained that a previous C.A.A. party had planted them to "brighten up the volcano scared crater area and to provide nourishment for goat-hunting parties!" The fact that the crater is within the Fauna and Flora Reserve and that such deliberate introductions contravene the Reserves and Domains Act 1953, seems to have been of little consequence.

One would expect that the "going" on Raoul would be easy with so many goats to open up the under-growth but such was not the case. The forest floor was often littered with wind-falls (a result of the occasional hurricane) through which a vigorous growth of aroid, Pteris comans fern and other unpalatable species had grown. The goats had formed tracks beneath this effective human barrier, which were of course of little use to a man with a pack. This combined with Raoul's comparatively high temperatures and humidity made the going slow and arduous. Walk-about's invariably ended in the grove where an almost inexhaustible supply of the most delicious oranges grew.

W.R.S. is shortly to publish a comprehensive account of the flora of the Kermadecs. On Raoul and the Herald Islets he recorded (and collected) over 300 species of vascular plants and mosses. This included three new records of native vascular plants, the total of such species having been reduced slightly however, since the removal of some of Oliver's from this category. Most of the latter Oliver himself had admitted being a little doubtful about including. *Adventives totalled over 150; well over twice as many as have been recorded previously. A large number of so far unidentified or undescribed lichens were also collected.

MAMMALS

The biggest biological disappointment of all was Raoul Island itself where the introduction of goats, cats and more recently Norway rats (Rattus norvegicus) has caused dramatic changes to the island's ecology. Goats, cats and rats were found throughout the island.

The sighting of a number of small rodents in the vicinity of the Met. station buildings and farm led us to believe that mice were also present. + However, four of these which were collected, proved to be young Kiore (P. exulans). Kiore are thought to have reached Raoul in the canoes of Polynesian voyagers and it was of considerable interest to find them co-existing here with the more aggressive Norway rat forty five years after the arrival of the latter.

Goats

These were apparently introduced in 1836, by the first European settler, James Reid, (Strauch 1954) and soon became numerous. They have played a major role in modifying the island's vegetation so that today the less palatable species alone are regenerating successfully.

* (See Oliver 1909) + (Morton 1968)

In their efforts to obtain foliage, bark and epiphytes, goats often climbed sloping pohutukawa trunks and limbs so that it was not unusual to find them 40 feet or more above the ground.

Early photographs show Tei Lake surrounded by numerous tree-ferns and described as "the most beautiful place on Raoul Island." Today however, few tree-ferns remain and the edges are choked with aroid.

In a memorandum dated 12/3/34 to the Under-Secretary, Internal Affairs Department, (I.A.D. file 52/1) Dr. R.R.B. Oliver, then Director, Dominion Museum, recommended the destruction of goats on the island in order to prevent further degeneration of plant and bird life. Davison, (1938) of the Aeradio Expedition endorsed this recommendation and after experimenting with various methods including poisoning, was adamant that complete eradication could be achieved by shooting alone.

Between 1937 and 1951 when control of the Aeradio Station was vested in the Minister of Works, expeditions stationed on the island and comprising personnel under the control of the Commissioner of Works engaged in occasional goat hunting as a side-line to their normal duties. In 1944 however, when J.H. Sorensen was employed by P.W.D. to destroy pests, he, together with other personnel, accounted for 844 goats.

When Civil Aviation Administration of the Air Department assumed administrative control of the station on 1/12/51, an active policy of goat destruction was adopted.

From 22-31/12/54 L.C. Bell (1955) of the I.A.D. visited the island and in a report to the Senior Field Supervisor, Wildlife Division, strongly recommended that an attempt be made to exterminate the goats, as the island could not fulfill its function as a reserve and support a goat population estimated to be at least 2,000, and in a letter to the Minister of Internal Affairs, dated 24/6/55 (I.A.D. file 52/1), Sorensen advocated strongly the "destruction of cats and goats on any islands of the Kermadec Group, where such animals have become wild." Arising out of these and previous recommendations, C.A.A. agreed to more actively support conservation interests and to include pest destruction as part of its official programs on the island, however, this policy was short-lived.

In November 1955 two goat hunters from the Noxious Animals Div., New Zealand Forest Service accompanied the replacement Meteorological expedition, and were to remain until the following November. In August however, one of these hunters was evacuated when he sprained an ankle and in September his companion assumed duties as farm manager. Nevertheless, 1,422 goats and 45 cats were destroyed, and an estimated 300 to 400 goats remained.

Subsequently C.A.A. supplied its personnel with rifles and ammunition and with the concurrence of the Departments of Lands and Survey & Internal Affairs, encouraged expedition members to hunt.

The Officer in Charge of the 1958/59 expedition instigated a scheme which was subsequently adopted officially, when from his own resources, he offered a half bottle of whisky to the member who obtained the highest tally of goat kills. The success of this competition gave rise to the present scheme, instigated in 1960, whereby the Departments of Lands & Survey and Internal Affairs award a six-monthly prize of \$20 to the member who obtains the greatest number of goat kills.

*(Morton 1964)

Following are the total recorded tallies of expeditions:

<u>Civil Aviation Administration Expedition</u>	<u>Goats Destroyed</u>
1956/57	125
1957/58	54
1958/59	261 (Unofficial competition commen
1959/60	215 (Official competition commence
1960/61	351
1961/62	544
1962/63	372
1963/64	475
1964/65	926
1965/66	339
1966/67	122
1967/68	230

From the above it can be seen that tallies have varied considerably but I believe that this is a reflection of hunting effort rather than the prevalence of goats. (At the time of our visit (1966/67) we estimated the population to exceed 3,000 individuals).

Of note is the remarkably high tally of the 1964/65 party, obtained in spite of a routine disrupted by volcanic activity, evacuation, a hurricane, and the extra duties thus imposed, including the necessity of having to find and tap a new source of drinking water for the station. This gives an indication of what can be achieved by such a scheme.

In my opinion a prize of \$20 each six months is inadequate to create a keen spirit of competition amongst the staff and should be raised to \$50, i.e. \$100 per annum. It has already been shown that the control exercised has been beneficial to vegetation in localised areas (see passage above headed "Vegetation" but if additional expenditure will result in more effective control then it will have been money well spent on what would still be an inexpensive conservation measure.

Such a scheme as this however is not the final solution to the goat problem and must be regarded as merely a temporary means of control until eradication can be effected.

It is apparent that the turning point has been reached; either the goats are removed or many of the endemic plant species will be lost, and the natural plant associations will suffer drastic changes. For instance the Kermadec pouhutukawa is one of the more palatable species which is not being permitted to regenerate satisfactorily. Since this species is the main canopy tree its eventual disappearance over large parts of the Island will obviously result in dramatic changes to the rest of the vegetation as well.

In my opinion extermination is not impractical and I most strongly urge that this policy be adopted.

Should this recommendation be implemented it would first be necessary to have good access tracks cut along all main ridges and to have rainwater catchments and reservoirs placed in the more remote waterless areas. A team of four professional hunters should then be employed for a year, after which time it may be necessary to engage two hunters for a further period.

CATS

These too had found their way to every part of Raoul Island including such inaccessible places as below Smith Bluff and the Hutchinson Bluff sooty tern colony. From signs found it would seem that cats are moderately abundant and universal.

A number of droppings were collected on behalf of the Zoology Department, Auckland University College, for food analysis studies. (See appendix IX). In most cases they appeared to be packed with rat fur but bird remains were not uncommon.

In 1944 Sorensen (1944) and other Raoul Island personnel accounted for 92 cats but apparently made little impression upon the population. This may give some indication of what the present population might be.

Cats in certain localities were feeding to a large extent on petrels as they came ashore to nest and it would be reasonable to assume that in the past cats have played a major role in virtually exterminating the Island's vast Kermadec petrel nesting population. (See Kermadec petrel notes below). At the present rate of predation it would seem that both black-winged petrel and wedge-tailed shearwater must share a similar fate in the very near future. The Kermadec parakeet is known to have vanished from the Island soon after the arrival of cats towards the middle of last century, and the extinction of the endemic pigeon at about the same time may also have been a direct result of the introduction of cats (Smith 1887).

In order to exercise a measure of control over cat numbers I would suggest that N.O.I. staff be supplied with gin-traps and the new Officer-in-Charge be instructed in their use prior to his departure each year. Cats could then be included in the present "goat competition" so that the prize money is paid to the member with the highest combined tally of goats and cats.

Should my recommendation regarding the extermination of goats be implemented and a party of hunters sent to the island, it might be possible to live-trap cats at the same time. If sufficient were caught they could be infected with Feline enteritis virus and then released to convey this deadly disease to the remainder of the population, as was recently accomplished with success on Little Barrier, an island of approximately the same area as Raoul.

RATS

Our trapping confirmed the continued existence of kiore, the last previously recorded being in 1944 by Sorensen (Watson 1961). Of 19 rats collected, 9 were kiore. (See appendix VIII). No obvious pattern of distribution was apparent, both kiore and Norway rats being widespread. Rats heard at night in nikau crowns at Smith and Hutchinson Bluffs were thought to have been kiore.

Norway rats reached Raoul in 1921 (Watson 1961) when the "Colombia River" was wrecked on the Island's southern coast. We found this species plentiful and particularly so in the vicinity of the Met. Station rubbish-tip, farm and buildings as well as at the Denham Bay, trig V and Boat Cove huts.

Norway rats were found over all parts of Raoul and had an almost universal and unlimited food supply in the nikau fruit. As one would expect they made good use of sooty tern eggs at the two large colonies and J.A.F. who studied the Denham Bay colony recorded interesting details of rat predation within the confines of his study areas. In a single night 46 eggs were taken from one 25 square yard quadrat and over a period thousands were lost, some sub-colonies being completely wiped out. Eradication on an island of this size would be impractical, if not impossible, however, it may soon become necessary to control rats in the vicinity of the sooty tern colonies.

DOMESTIC STOCK

After visiting Raoul briefly in November 1964 and seeing numbers of free-ranging pigs it was gratifying to return and find that this situation no longer existed. Whereas 50 plus were present in 1964 a total of 12 were now confined to the farm and no sign of feral pigs could be found.

It was however a little disturbing to find a small herd of free-ranging cattle living on Low Flat. The matter was brought to the attention of the Officer-in-Charge and subsequently all but two were returned to the farm. The others defied all attempts to recover them proving too wild and were still at large when we departed, however we understood that they were to be shot. Needless to say cattle can be most destructive and are undesirable in a Fauna and Flora Reserve. Low Flat has in the past been used as a run-off for dry cattle and dairy cows are often grazed along the roads. Although within the area controlled by M.O.T. such stock have unrestricted access to the adjacent Fauna and Flora Reserve.

The following stock were held at the time of our visit:

25 Run cattle
6 milking cows (plus 3 dry cows, 1 heifer, 3 calves and 1 bull.)
200 Sheep
12 Pigs.

The total fenced area of the farm is approximately 50 acres so it would seem inevitable that additional grazing must be sought particularly during dry periods, and Low Flat, being the only other readily accessible, partially cleared flat, is the obvious alternative. It is part of the 275 acre block under M.O.T. control, however if it is to continue to be grazed, as seems essential if stock numbers such as the above are to be maintained, then this area too must be fenced. Failing this stock will continue to trespass in the adjoining Fauna & Flora Reserve, with the inevitable damage to vegetation and the risk of their becoming feral. It is highly desirable that this vegetation be free from browsing, as it is in this area alone that some of the more palatable endemic plants, browsed virtually to extinction elsewhere by goats, have escaped the attention of these animals.

I must therefore recommend that M.O.T. be asked to ensure that in future domestic stock be confined by fences at all times.

OTHER MAMMALS

Although watched for, bats were not seen and as they have never been recorded from the Kermadecs it seems doubtful that they occur here.

Humped-back whales (Megaptera boops) were plentiful during the early part of our stay.

BIRDLIFE

Native birdlife on Raoul was most disappointing and it was obvious that dramatic changes to the islands ecology had occurred since 1908 when Oliver and Iredale spent 10 months ashore. Following is a list of species encountered, together with notes on their status:-

Wandering Albatross (Diomedea exulans exulans)

One wing-bone found on Denham Bay beach. (See appendix VIII).

Wedge-Tailed Shearwater.

Small breeding colonies were found on all headlands and along the tops of many coastal cliffs. The often vast numbers of unoccupied burrows would indicate that these were no more than remnants of a much greater population. Cats and Norway rats have probably been responsible for this decline. Freshly cat-predator carcasses, often in quite large numbers being found 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.

Sooty Shearwater (*Puffinus griseus*)

One storm-wreck found on Denham Bay beach on 24/1/67 (see appendix VIII).

Kermadec Allied Shearwater (*P. assimilis kermadecensis*)

A rather unexpected discovery was made when the cat-eaten remains of three juveniles were found on Rayner Point. (See appendix VIII). The species has not previously been recorded breeding on Raoul although it is known to breed on most other islands in the group.

Sunday Island Petrel (*Pterodroma externa cervicalis*)

Despite our efforts to locate this rare endemic, which was known to breed in small numbers high on Raoul early this century, none was found. On 5/1/67 W.R.S. did however find a storm-wreck of this species on Bell's Beach, proving that this handsome petrel still exists. (See appendix VIII).

Kermadec Petrel

Iredale (1914) estimated the breeding population in 1908 at about half a million individuals and the young known locally as "boobies" were harvested in large numbers (12,000 in 1889 according to Cheeseman (1891)), by the settlers. The species bred on the surface at a density of up to 800 nests per half acre early this century according to Venables (1937), but it is now rarely seen on Raoul, and during our stay evidence of only 2 nests could be found (see appendix V).

What part the kiore played in bringing about this decline is not known, however, according to Roy Bell (1911) these rats did prey to a considerable extent upon the young of this species, 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."

The extraordinary placid nature of these birds would make them most vulnerable to attack by cats, but it is apparently only since the arrival of Norway rats in 1921 that numbers have declined so spectacularly. Their extinction on Raoul, as predicted by Davison (1938), when in 1937 he noted heavy predation by both cats (adult birds) and rats (eggs), is therefore virtually complete.

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, but on 27/3/67 K. Wickens (pers.comm.) and other C.A.A. staff saw a chick in this nest.

According to Iredale (1914) in 1908 birds began coming ashore in numbers on Faoul in August, and laying commenced 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 Hutchinson Bluff, (one bird) on 15/12/66 and Smith Bluff (2 birds) on 12/1/67 where nesting was suspected but not proven. On 17/1/67 one downy chick, (approximately 2 weeks old) was found dead well above high-tide mark at the base of cliffs approximately $\frac{1}{2}$ of a mile north of Smith Bluff. It had almost certainly been washed from its nest by recent heavy rain.

The remains of one adult were found near the tip of Smith Bluff on 12/1/67 and areas of exceptionally lush growth and obviously of unusually high fertility for such situations were seen here but more particularly above the Denham Bay cliffs and on the ridge leading to Hutchinson Bluff. These were thought to have been former sights 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), the fertility would have been unusually high, and such were the findings of Wright & Retson (1959) in their soil survey. They comment that "Generally organic matter is remarkably high for such young soil---" but this they attribute 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 & Retson also found unusually high organic phosphorus ratios in older soils and that the distribution of organic matter was of interest, abrupt changes in the nitrogen figures being noted, and these again may have been influenced by former concentrations of breeding petrels.

Black-winged Petrel

No burrows containing eggs were located during our stay, although T. Blake who was on Faoul for his second successive year assured us that small numbers of juveniles were fledged and 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 c.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 end on 23/1/67 contained the remains of 44 individuals within a 10 yard radius. Other smaller middens were commonplace in areas frequented by this species.

Kermadec Storm Petrel (*Pelagodroma marina albicollis*)

No sign of storm petrels was found on either Faoul, the Herald or Milne Inlets nor were any seen at sea during our stay. On 12/11/66 J.F.A. saw through binoculars from Boat Cove Road what he took to be a group of a dozen storm petrels feeding over broken water near the Milne Inlets in Boat Cove about half a mile distant. Other members including myself who saw these birds had little doubt that they were gray ternlets.

Red-Tailed Tropic Bird (*Phaethon rubricauda roseotincta*)

First seen on 13/11/66 when 2 were cavorting high on the northern cliffs near Hutchinson Bluff. Numbers increased daily over the next few days; c.20 being counted in the same locality on 25/11/66. 42 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 (see notes on these Islets for further details), small numbers were nesting on Raoul, generally in inaccessible coastal cliff situations. Most birds had laid by 27/12/66 and no eggs had hatched when nests were finally visited on 25/1/67.

Masked Booby (*Sula dactylatra personata*)

Small numbers always present feeding off-shore.

Frigate Bird (*Fregata* sp.)

No confirmed sightings made although J.F.A., and T. Blake each reported seeing what may have been Frigate Birds; once in Denham Bay and off Bell's Beach.

Grey Duck (*Anas superciliosa*)

Blue Lake and to a lesser degree the Denham Bay swamp were the only places where ducks were recorded, other crater lakes apparently proving unsuitable. The largest count made on Blue Lake was of 26 adults plus broods of 5 class IV, three class I and 5 Class II ducklings on 19/12/66. One other brood of 6 class I ducklings was seen on the road near Ngalo 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, are listed below.

Number 69, collected 19/12/66. Mainly grit with fragments of macerated plant material and fragments of *Solanum nodiflorum* and Cyperaceae seeds.

Number 110, collected 6/1/67. Mainly grit with macerated plant material, especially stalks and a single Coprosma seed. Fragments of at least two long-leg spiders.

Spotless Crane

We found no evidence of their presence on Raoul. Mist-nests 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 were seen or heard.

Pukeko (*Porphyrio porphyrio*)

Recorded on Blue Lake and in the Denham Bay swamp. Largest count on Blue Lake was of 8 adults plus a clutch of 3 half-grown young on 6/1/67, and at least 3 are known to have been resident at Denham Bay. The stomach contents of two collected from near Blue Lake on 6/1/67 are listed below.

Number 111, an adult male, contained fibres of rush and sedge, and wool, long-legs spider, fragments of slater and considerable grit.

Number 112, an adult female contained unidentifiable vegetable debris (plant fibres and small roots) and a quantity of fine black sand.

Pacific Golden Plover (*Charadrius dominicus fulvus*)

Recorded on farm paddocks and Blue Lake but particularly the latter, where volcanic activity resulted in a large expanse of open mud flat at the eastern end, and smaller areas along the south-western shores of the Lake. 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 when a census of waders on the farm and lake was carried out. Attempts to mist-net waders at Blue Lake were unsuccessful.

Asiatic Whimbrel (*Numenius phaeopus variegatus*)

At least 2 present during the latter part of November and December on Denham Bay and North Beaches. During high tide on 26/12/66, I was present on Egeria Rocks.

The stomach of an adult male collected from North Beach on 23/12/66 contained two small crabs (*Ocypode* sp.) (Dr Dell who examined this material advised that the Kermadec species has not been determined.)

Eastern Bar-Tailed Godwit (*Limosa lapponica baueri*)

Small numbers were present throughout with Golden Plover on Blue Lake mud flats and on the farm paddocks. The largest count was 6, on both 3/12/66 and 23/1/67.

Wandering Tattler (*Heteroscolus incanus incanus*)

Single birds were recorded at the D'Arcy Point rock pools (twice), near Smith Bluff and on Milne Islets during high tide on 30/12/66.

Turnstone (*Arenaria interpres interpres*)

Small numbers were present with the golden plover on the Blue Lake mud flats. The highest count was 9 on 16/11/66, after which numbers declined until none were present on 20/12/66. On 3/1/67 three were present and these remained until our departure.

Knot (*Calidris canutus rogersi*)

The dried remains of one was found on the Blue Lake mud flats on 20/12/66. (See appendix VIII).

Southern Black-backed Gull (*Larus dominicanus*)

A single adult, observed on 4/12/66 (Denham Bay) 6/12/66 (North Beach) and 7/12/66 (Denham Bay), was the first confirmed sighting of this species at the Kermadecs.

Red-Billed Gull (*L. novae-hollandiae*)

On 15 and 16/11/66 a small lone gull was observed from a distance on Denham Bay Beach by J.A.P. It was almost certainly a juvenile *L. n. scapularius*, having a heavy black bill and legs, but unfortunately it was not observed at close enough quarters for positive identification.

Sooty Tern

A breeding colony at Denham Bay, estimated to possess 40,000 nests, was studied by J.A.P., and another of a similar size was discovered on 15/12/66 along the southern coast of Hutchinson Bluff. Nesting had apparently begun earliest at the western part of this colony, as on 4/1/67 70% to 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 and at Denham Bay, laying commenced 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 being complete destroyed within days. J.A.P. was able to study rat predation of tern eggs within his 150 25 square yard quadrates in some detail, and his findings are soon to be published in "Notornis".

He found that of 5,537 colour-coded eggs, 1,578 hatched, 170 were predated by rats, 968 were deserted as a result of the rats' depredations and the remainder were lost through other natural causes. Of the 1,578 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 flying in March and 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 flying age) of 98.3% from 6,500 eggs. Mortality at Denham Bay appeared to be lower than this, possibly as a result of the virtual absence of avian predators and a more reliable food supply. The latter is apparently not always so, for during a brief visit to Denham Bay on 13/4/29, Lindsay (1929) found large numbers of young dying from starvation.

M.O.T. personnel who have in the past banded young at the Denham Bay colony have reported high mortality following banding operations and I suggest that in future they be asked to count and report chick losses.

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 from Denham Bay on 24/1/67 and 103 by M.O.T. 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 recovered dead, (92 on 18/1/67 and 21 on 27/3/67), giving a mortality rate of 7.5% for this older age group. In each case 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 would seem from this that close to hatching is not the best time to band and that the advantages of banding once the chicks are old enough to avoid trouble and the period of highest natural mortality has passed, are considerable. I would strongly recommend that in future all banding at this colony be carried out during February, preferably late in the month, when chicks are in roving groups and well able to avoid the aggression of the adults.

Three banded adults were seen by J.A.P. who unfortunately was unable to read their numbers or to catch them. One band seen was very worn and had partially opened.

White-capped Noddy

None found nesting on Raoul. Below Smith Bluff where a grove of *Agave* 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.

Examination of the gut contents of 2 adult females collected on North Beach on 13/12/66 revealed (No. 66) 4 small dark pebbles; 1 small piece of white *Mollusc* shell and 1 dark feather, and (No. 64) 12 fragments of white *Mollusc* shell (various shapes and sizes) and 4 small *Nematode* worms.

White Tern (*Gygis alba rostrata*)

Breeding only on Raoul Island where they were most often seen frequenting *pohutukawa* trees on the flat north-west of the Denham Bay Lagoon. Highest count this area was 15 together in flight on 13/1/67. On 5/12/66 a bird was seen apparently incubating at 45 feet on a *pohutukawa* limb in this area and on 16/1/67 a chick of approximately one week of age was seen perched on this nesting limb. On 24/1/67 ectoparasites were removed from this chick for identification, 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 no nest was located. Few other observations were made and no other nests found.

Grey Ternlet

Not uncommon along the coasts of Raoul, and on the exposed cliffs of Smith Bluff nesting had apparently taken place. On 17/1/67, 47 were counted on ledges or rock holes high in this bluff's southern face while 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. This species has not previously been recorded breeding on Raoul, although it is known to breed in numbers on other islands in the Kermadec group.

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.

Kermadec Parakeet

Once plentiful on Raoul (Straubel 1954) but apparently vanished soon after the arrival of cats towards the middle of last century (Smith 1887). The only evidence of them that we found was chewed feathers at Sawyer Point on 13/12/66. This is the nearest Raoul Island landfall to Meyer, about one mile distant, where parakeets are plentiful. This bird had obviously been a new arrival from Meyer.

Shining Cuckoo (*Chalcites lucidus lucidus*)

Rare at the Kermadecs. On 17/11/66 one was heard calling in the vicinity of Low Flat by W.V.Z.

Long-tailed Cuckoo (*Eudynamis taitensis*)

Small numbers present throughout our stay, but few calls heard.

Kingfisher (*Haleyon sancta verana*)

Widespread on Paouli and plentiful on the northern coast where the fern and road cuttings provide suitable habitat and nesting sites. Breeding continued throughout our stay.

Skylark (*Alauda arvensis*)

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

Song Thrush (*Turdus ericetorum*)

Relative abundance sampling of passerines on Paouli, showed the thrush to be one of the most plentiful and widespread species (see appendix IV), but it was not recorded from the Herald Islets. Recently fledged young were commonly seen at lower levels during the early part of our stay, and two were recorded near the highest point on the Denham Bay track on 10/12/66 and 14/12/66.

Full song could be heard throughout the day in most parts of the island during November and early December, after which a gradual decline was noticed. During January, song tended to be confined to early mornings and evenings with occasional sub-songs during the day. At Smith Bluff full song commenced at 04.10 hours on 13/1/67 but had become spasmodic by 06.00 hours.

Blackbird (*T. merula*)

An early note in our camp log stated that blackbirds were more frequently seen on Paouli than thrushes and mist-netting success (39 blackbirds and 12 thrushes were caught in one set over the same period), also suggests this. However, relative abundance counts indicated that although blackbirds were plentiful and widespread, they were less common on Paouli than thrushes (see appendix IV).

Fledglings were plentiful during November and early December.

Song appeared to be identical to that of New Zealand blackbirds, however minor dialectic differences in the alarm calls were detected. Full song could be heard, mainly during mornings and evenings in November and early December. Song then declined so that during January, but for occasional sub-songs at dawn and dusk, blackbirds were virtually silent.

They were present in small numbers on both Meyer islets, but were not recorded from others of the Herald group.

Pipit (*Anthus novaezeelandiae novaezeelandiae*)

A bird thought to have been of this species was flushed by C.B.V. 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 such suitable pipit habitat exists on Paouli and was often visited by expedition members, none were seen or heard.

Tui (*Prosthemadera novaezeelandiae novaezeelandiae*)

Recorded only from Paouli where it was plentiful throughout. Fledgling birds were such in evidence during our stay. In the absence of a fly-catcher, tui appeared to occupy this niche to some degree, both aerial and ground feeding being observed frequently. Song was similar to that heard in New Zealand although rather subdued. At Hutchinsea Bluff, tui had a most unusual dialect, one call resembling that of the Indian Mink (*Acridotheres tristis*).

Redpoll (*Carduelis flammea*)

Not seen, but on 30/11/66, D.V.M. heard flight-calls over D'Arcy Point ridge.

Yellow Hammer (*Emberiza citrinella citrinella*)

Recorded only from Raoul, where it was in moderate numbers in more open areas and in small flocks near the C.A.A. station's fowl-run and pig-sty.

Starling (*Sturnus vulgaris*)

Probably the most numerous and widespread species on Raoul (see appendix IV). Most abundant in the parts of the crater disturbed by the 1964 volcanic activity, especially Blue Lake's islands and coastal zone and particularly the north-eastern shore, where they fed upon the prolific invertebrate life (mainly midges (*Chironomus* sp.) and their larvae). In wooded areas, flocks fed noisily in nikau crowns, presumably upon invertebrates. The c.50 acre pastoral farm was also a favourite haunt.

Occupied nesting holes in trees and cliffs were commonly found in many areas during November. Most young had flown by the end of November and no occupied nests were found after the end of December. Flocks frequenting the crater and farm increased from c.50 on 3/12/66 to a maximum of c.1,500 on 5/1/67. The size of flocks flying to roosts on Meyer, similarly increased and was still increasing when we departed in late January.

The finding of 14 dead, mainly juveniles, on North Meyer gave rise to the question of whether insecticides had been used on Raoul, and enquiries revealed that D.D.T. was used on the vegetable garden. A composite sample of breast tissue from 21 birds collected from the crater, garden and farm was examined at Wallaceville Animal Research Station and found to contain sub-lethal quantities of 0.2 parts per million D.D.E., 0.014 p.p.m. D.D.D., but no D.D.T. was detected. It was therefore concluded that with such large numbers of young birds roosting on Meyer, deaths of this order from natural causes could be expected.

34 starlings taken on Raoul between 27/11/66 and 8/1/67 gave an adult: juvenile ratio of 1:2.4.

REPTILES

Towards the latter stages of our stay green turtles (*Chelone mydas*) were often seen grazing just beyond the breaker-line, and one was shot by C.A.A. staff from Fleetwood Bluff on 29/12/66. Lizards were watched for, but none found and as they have never been reported, it would appear that they do not occur at the Kermadecs.

INVERTEBRATES

The variety of forms is not great, however, life generally is prolific.

On Meyer a vicious variety of brackish-water mosquito abounded near the coast. Mosquitoes were seldom encountered on Raoul; not even at the Denham Bay fresh-water lagoon.

Stable-flies (*Muscina stabulans*) were a recent arrival, and are reputed to have travelled in straw in the crate of a young bull brought from N.Z. They had found optimum conditions and had increased accordingly. With care it should be possible to prevent further accidental introductions such as this from occurring.

J.C.W. is preparing a full account of his entomological findings for publication.

HERALD GROUP

MEYER ISLETS

It was not until 19/11/66 that the seas abated sufficiently to allow a crossing to Meyer, after which the northern islet was in continuous occupation until 20/1/67. A radio-telephone link was maintained with the C.A.A. station on Raoul throughout this period.

PHYSIOGRAPHY

Meyer, the largest of the Herald Islets, is comprised of two rounded hummocks of similar features separated by a narrow chasm which, under ideal conditions, can be waded at low tide. It is located approximately one mile north east of Rayner Point, Raoul Island, and is orientated on a north-north-east/south-south-west axis (see appendix I). The northern islet is approximately 600 metres long with an average width of about 250 metres and rises to 403 ft above sea level. The southern islet is approximately 400 metres long with an average width of about 200 metres 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 of volcanic origin and are composed of beds of compact, yellow, andesitic tuff, intruded by a series of lava dykes. The north-western aspects, 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 approximately 300 ft above sea level and measures approximately 150 metres 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 metres with an average width of about 20 metres. 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 15' x 10' 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", and which M.V.E. found invaluable when recording bird calls. Its acoustics were outstanding yet wind and sea noises were often hardly audible.

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 camp-site; 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 depression of approx. 10' x 5' x 2' deep in rock 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 bird-polluted so that one would not have drunk it by choice. By mid-December this pond was dry. Other smaller depressions were found on the two Meyer islets but these would be of little use except after rain.

VEGETATION

The Meyer Islets support a coastal scrub association of pohutukawa, karaka, ngaio (Myoporum laetum) parapsara (Peinertiodendron brucei var.) and Lyraine kermadecensis 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 light to enter. At the time of our arrival (19/11/66) the rocky coastal zone supported a lush growth of Cyperus petiolatus, Sicyos angulata, Cyperus setulosus, Tetragonia tetraconioides, Asplenium obtusatum, Samolus repens, Isobria angusta, Lichyns australis, etc., but with the onset of a hot dry summer, much of this was transformed into parched brown straz by early January.

(W.R.S. is to include a full account of his botanical findings on Meyer, and others of the Herald group, in his paper on Kermadec vegetation.)

BIRDLIFE

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 fourteen 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 a result of the virtual absence of avian predators as apparently no birds-of-prey breed at the Kermadecs and hence their rarity here during spring and early summer.

Wandering Albatross.

One seen by D.E.C. on 30/11/66 north of North Meyer.

Giant Petrel. (Macronectes giganteus)

One seen by D.E.C. on 1/12/66 well off-shore.

Wedge-tailed Shearwater.

The breeding population was considered to be many thousand pairs, and burrows, although widespread appeared to be most abundant at lower levels where the coastal scrub began. 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, however, few were deserted as a result.

Kermadec Allied Shearwater.

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 adult recorded was ashore on North Meyer on the night of 29/11/66.

A small number of dead adults and young were found on each islet.

Kermadec Petrel.

In 1908 Iredale (1914) found that this species arrived at Meyer about January, laying took place in late February & March and all young had departed by early August. No birds were found ashore in late November.

On 19/11/66 however, we found that some had laid and several young were present, one of which was almost of flying age. These few summer breeders are perhaps remnants of the vast population which formerly bred on Raoul at this season. Unseasonal breeding on Moyer appears to have been a recent innovation; the only other references being those of Forensen (1964), who found an egg & young all ages in August 1944, and Edgar, et.al. (1965) who recorded 3 nests on 20/11/62 of which contained eggs. 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 *Agave* and *Coprosma* understory; shade apparently being an important factor in the selection of a nest-site.

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 24 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 (4/5 acre) and this order of density was considered representative, so that the total breeding population of the Moyer 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, as 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 Moyer.

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, according to plumage, colouration, as others have 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, upperparts 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% of an intermediate form, so confirming Iredale's supposition that the extremes may be rarer on Moyer.

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 Moyer 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.

Black-winged Petrel.

Many thousands were present on 19/11/66, but even greater numbers were apparent 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 eggs. 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 & 15/1/67 resulted in some burrows in dry friable soil on the lower western slopes being blocked with rubble or collapsing. Subsequently the displaced birds sat about on the surface or attempted to open up burrows, however, there was nothing to suggest that re-nesting occurred.

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 3 to 22, with a mean of 15.6. Burrow density of this order was considered representative over much of the two islets.

Kermadec Storm Petrel.

North Meyer was in continuous occupation for 9 weeks but no sign was found on this or the southern islet; nor were storm petrels seen at sea.

Red tailed tropic bird.

6 seen cavorting off Meyer on 22/11/66 were the first recorded here during our visit, but following this numbers increased daily until a maximum of 87 was counted in flight together on 22/12/66. 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 while 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 on South Meyer 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.

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. It was re-banded (K.2551) but the original band, although well worn, was not removed. 81 breeding adults were banded on South Meyer.

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 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 re-layed.

Lashed Booby.

No nests were situated on the two main islets, although an addled dwarf egg (55mm x 39mm), thought to have been of this species, was found on 27/12/66 on the southern most 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.

Spotless Crake.

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 c.20 pairs.

Birds were commonly seen by day and night foraging for invertebrates in litter. Other feeding stations included the tideline, Cyperus ustulatus clumps, petrel burrows, (particularly freshly excavated soil), branches, foliage and noddy nests. One was observed eating the contents of a Kermadec petrel egg, in an unguarded nest.

Two unoccupied nests were found in Digitaria adscendens on 9/1/67 and 19/1/67, and one with 4 newly hatched chicks in Leucalum evergreen with Sicyos on 27/12/66. 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 7-10 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 (see appendix VIII) one was captured at night while perched on a Cyperus inflorescence, but it is not known whether it was feeding or roosting here.

Grey Plover, (Charadrius squatarola)

On 18/12/66 one in winter plumage was seen on the North Meyer rock-shelf. This was the first recorded occurrence of this species at the Kermadecs.

Pacific Golden Plover.

Two seen on the wave-platform of the northern islet on 25/1/67 were the only birds recorded on Meyer.

Asiatic Phimbrel.

One was recorded on North Meyer on 13/12/66.

Wandering Tattler.

A single bird frequented the coasts of both islets throughout our stay.

Sooty Tern.

Numbers frequenting North Meyer increased from 6 on 20/11/66, 32 on 30/11/66 (when territorial behaviour was first apparent) to c.2,500 on 24/12/66. On 20/12/66 laying had begun and competition for available nesting space was intense.

The normal clutch was 1, but 2, each of 2 eggs were noted on 2/1/67.

On 24/12/66 c.450 eggs were on the rock-shelf at the south-western end of North Meyer but smaller colonies at the northern end, and on the summit ridge, were not counted.

On 27/12/66 c.2,000 birds were breeding at the southern end of South Meyer and on an off-shore rock. 521 (excluding 52 broken) eggs were at the southern end but smaller colonies, situated on the north-western and north-eastern slopes, were not counted.

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, 19/1/67 37, when observations ceased.

Egg and chick mortality on both islets was high.

White-capped Noddy.

Found breeding only on Meyer where the population was considered to be less than 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 with 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, although we were unable to ascertain whether the nest building seen at these later dates, was followed by successful breeding.

Nests were constructed of sticks, leaves, litter and occasionally seaweed, cemented together with guano and often with a large green karaka leaf in the bowl. They were situated at between 2 feet and 15 feet above the ground on horizontal or near horizontal pohutukawa, ngaio or karaka limbs. Contrary to Oliver's (1955) statement, that most nests on Meyer are in *Pisonia* (parapara), none were in trees of this species. Parapara was found to be rare on North and more common on South Meyer, but few had suitable branches for nesting.

Colonies of about a dozen nests were in sheltered, sunny situations mainly on the north-western slopes. Both courtship feeding and copulation were seen to occur at the nest.

The incubation period of an egg laid on 22/11/66 was 36 days.

Nesting success appeared low, e.g. of 12 nests under observation, 5 were deserted during building, 4 eggs were lost, 1 hatched and 2 (presumably added) were still being incubated 6 weeks later.

For the first 3 days after hatching chicks were guarded continuously by a parent.

On 28/12/66 most nests on the north-eastern slopes of South Meyer contained an egg, but one 3 week old chick was seen. Most nests still contained eggs on 25/1/67, however young of all ages were present.

The mean dimension of 32 eggs from North Meyer was 43.6 mm x 30.9 mm and their range was from 40.3 mm to 47.9mm in length (standard deviation 2.1) and 28.9 mm to 32.6 mm. in width (standard deviation 0.9).

Grey Ternlet

Although breeding on all islets in the Herald group, greatest numbers were found on Napier & 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. Nests were in loose colonies confined to the coastal zone. No nesting material was used; the single egg being laid on a rock ledge, crevice, peck-hole or under vegetation and was often inaccessible or well concealed. All day shade appeared to be an important consideration in the selection of a nest site.

On 21/11/66 27 nests contained an egg and 14 non-flying young were present on Camp Flat. An unknown number of flying young were also present. The last egg known to hatch on North Meyer did so on 2/1/67, by which time most young could fly.

Laying had virtually ceased at the time of our arrival so the incubation period was not determined.

From first chipping of the egg to hatching, took about 3 days. Chicks were hatched with their eyes open and were quite active. They were brooded continuously for the first 3 days; thereafter they were left for increasing periods. At 8 days they were unguarded most of the day, and at 17 days they were still downy but pin feathers were showing through. At 25 days they had more feathers than down, and when the nest location permitted, they wandered freely. At 31 days they could just fly and at 36 days they were flying frequent short distances, though wing and tail feathers were noticeably short and tufts of down adhered to various parts of the body. At 42 days they were virtually down-free but it was evident that they were being fed by their parents for further considerable periods before becoming fully independent.

Young of all ages were fed upon regurgitated material, older chicks being fed at about 3 hourly intervals.

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

Flocks of adults, often in the company of noddies, fed upon plankton after the manner of storm petrels, off all coasts of Raoul.

The entire gut contents of an adult male (No. 73) collected on North Meyer on 20/12/66 was composed of debris from surface plankton, mainly small crustacea, possibly Euphausia, but not identifiable as to species.

Both aerial and terrestrial displays were common throughout our stay.

By late December some adults were moulting.

Of 21 eggs measured on North Meyer their mean was 42.9mm x 28.9mm. They ranged from 40.9mm to 45.7mm in length (standard deviation 1.1) and from 27.1mm to 30.2mm in width (standard deviation 0.6).

Kermadec Parakeet

Plentiful and unusually tame. Small flocks trafficked freely between the two 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 the following foods:-

Terminal (1") shoots of pohutukawa, what appeared to be an orange Coprosma berry was fed, by an adult, to a juvenile, and Cyperus (numerous observations) and Polycarpon tetraphyllum seeds.

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

No.85, a male contained seeds of Chenopodium allenii, Solanum nodiflorum, Cyperus sp; unidentifiable fragments of grass seed and grit.

No.86, a female; contained seeds of Solanum nodiflorum, 2 or 3 of Chenopodium allenii and about equal proportions of small grit particles.

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

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

Kingfisher

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 was of one near the southern end of North Meyer on 13/1/67.

Blackbird.

Resident, but by no means plentiful, on either islet. Birds were noticeably "wild", but on 18/12/66 one male was observed foraging in damp soil recently excavated from a wedge-tailed shearwater burrow.

Two used nests, apparently of the current breeding season, were found on North Meyer.

Starling

Present in small numbers and breeding on both islets.

As stated earlier, Meyer was used as a roost by birds from Raoul. The size of flocks seen flying to roosts on Meyer increased during December and was still increasing when we departed in late January. These evening flights were remarkably regular with all birds arriving within a period of approximately 15 minutes. In mid-January, flights of from 3 to 50 birds would begin to arrive on the western slopes of the northern islet at about 18.30 hours and had all arrived by 18.45 hours. There were two lines of flight; by far the greater number coming from the southwest (crater and South Meyer), with smaller numbers from the west (Fleetwood Bluff and farm). Roosting took place on the leeward sides of the summit ridges of both islets.

At 06.00 hours on 26/12/66 small flocks were seen arriving at Low Flat from the direction of Meyer.

Small patches of aroid, found growing on each islet, were thought to have been introduced as a result of starlings bringing seed from Paoul.

On 28/12/66 an adult was observed on the ground, under a low pohutukawa/ngalo canopy, near the summit of South Meyer, feeding upon small butterflies.

NAPIER ISLET

An andesitic lava stack 300 metres long, by 175 metres wide, situated 700 metres north of Meyer. It has a north-northeast/south-southwest 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 & bluffs exist at each end of the islet. Blocks of coral were commonly found embedded in the lava.

On the western face where sufficient shelter and depth of soil permitted, a stunted, wind-swept pohutukawa/ngalo association exists, and *Cyperus* dominates the exposed summit ridge. (See Sykes in press(a) for further botanical data.)

The islet is waterless.

Landings were made on 26/11/66 (E.K.S. & D.V.M. for approx. 2 hours) and 2/1/67 (E.K.S. & C.D.V. for approx. 2 hours).

Like Oliver (Chilton 1910), we too attributed the pieces of coral, shells and small stones found high on Napier, to having been carried there by land crabs.

BIRDLIFE

Pedge-tailed Shearwater

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

Kermadec Allied Shearwater.

Remains of adults and juveniles found.

Kermadec Petrel

All colour phases represented. Of c. 50 occupied nests on 2/1/67, several contained an egg, but most birds had not laid. This, together with the finding of several partially dried corpses of half grown young on 26/11/66, was proof that the breeding season is protracted and is of a similar pattern to that on Meyer.

Fleck-winged Petrel

The breeding population 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.

Red-tailed Tropic Bird.

No nests were found, but on 2/1/67 1 of 8+ frequenting the southeastern cliffs was seen to land.

Grey ternlet

Napier had the greatest breeding population of the Herald Islets, many thousands being present. Nests were situated over all parts of the islet; even under the low scrub and near the summit. Breeding had virtually ceased on 2/1/67, however a number of pre-flying-age young, and several eggs were seen.

Kermadec Parakeet.

Present and breeding. At least 8 adults were known to be present on 2/1/67.

Sterling.

Present and breeding.

NUGENT ISLET

A conical, volcanic stack, 150 metres in diameter at sea level and rising to 190 feet, 425 metres east-northeast 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 W.R.S. and D.V.M. spent approx. 2 hours ashore.

Fragments of coral and shells, similar to those found on Napier, were present near the highest point, and again these were attributed to the activities of land crabs. Pieces of cortz were commonly found embedded in the rock.

BIRDLIFE

Kermadec petrel

One intermediate phase brooding an empty nest and the remains of 2 eggs were found.

Red-tailed tropic bird.

2 occupied nests located.

Grey ternlet.

Although only 3 non-flying young remained, it was apparent that a considerable breeding population had recently occupied this stack. A flock of several thousands fed nearby, off the western coast.

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 approximately 300 metres long by 200 metres 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.

The islet is waterless.

On 26/12/66 a landing was made on the north-eastern coast and D.V.M., W.R.S. J.F.A., spent 2 hours ashore.

BIRDLIFE

Wedge-tailed Shearwater.

Plentiful and breeding. Some burrows were unusually short and several birds were incubating beneath a shallow over-hang. All nests contained an egg.

Kermadec Allied Shearwater.

Remains of 6 adult and 6 juveniles found.

Kermadec Petrel

Plentiful and breeding, and all colour phases were represented. The breeding pattern is apparently similar to that on Meyer; some nests containing an egg, but most birds had not laid. A c.2 month old corpse of a large chick was evidence that some breeding had occurred during spring months.

Black-winged petrel

Plentiful and breeding. Most burrows examined contained an egg.

Red-tailed tropic Bird.

About 60 were in flight off the south-western cliffs, where they were breeding in small caves. No accessible nests were located, but several birds seen at a distance were apparently incubating.

Masked Booby.

Two occupied nests were present. One contained a newly hatched chick and the other, an almost fully fledged juvenile.

Sooty Tern

Breeding at the eastern and western ends wherever space permitted, and even a short distance under the scrub. c.3,000 birds were present, but many of these appeared to be non-breeders. A large percentage of eggs were broken or pecked, and no chicks were seen.

Grey Ternlet

It was apparent that a large breeding population, had until recently, occupied this islet. Several hundred, including chicks of all ages were still present.

Kermadec Parakeet.

Present in moderate numbers and breeding.

Starling.

Small numbers breeding.

CHANTER ISLETS

This group of two islets and one stack lies $2\frac{1}{4}$ miles east of Rayner Point and 400 metres south-southeast of Dayrell. The northern islet is approx. 350 metres long by 250 metres wide and rises to 177 feet a.s.l. The second islet, 50 metres to the south is approx. 225 metres by 200 metres and reaches 184 feet. The 171 feet high stack lies 200 metres 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.

The islets are waterless.

They were inspected from the sea on 26/12/66 and on 1/1/67 we spent 2½ hours ashore on each. D.V.M., F.R.S. & M.Y.S. landed on the northern coast of the southern islet, and with some difficulty, scaled the eastern cliffs and C.R.V., F.R.S., & M.F.S., landed on the eastern coast of the northern islet. No landing was attempted on the stack.

BIRDLIFE

Sedge-tailed Shearwater

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

Kermadec Allied Shearwater.

The dried remains of adults and juveniles were collected from each islet.

Kermadec petrel.

The breeding pattern was similar to that found on others of the Herald Group, and although nesting birds were in moderate numbers throughout both islets, eggs were recorded only from North Chanter. Semi-fresh remains of half-grown young were evidenced of spring breeding.

Dark and intermediate colour phases were recorded on South, and all forms of which intermediate were predominant, on North Chanter.

Black-winged Petrel.

Plentiful and breeding on both islets. All burrows examined contained an egg.

Red-tailed Tropic Bird.

Numerous in the vicinity of the Chanters, where they were breeding on inaccessible cliff-ledges of the southern islet.

Naked Booby.

12 occupied nests and 16 adults present on South Chanter, i.e. 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 flying-aged young.

7 juveniles and 10 adults were banded.

While banding the above, several flying-fish were regurgitated; the largest being 16½ inches long.

No unemployed birds were present.

20 occupied nests were found on North Chanter i.e. 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.

17 juvenile 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.

Nests were scattered singly in small clearings, and consisted of depressions with slightly raised rims of soil, guano and often a little vegetation.

Grey Ternlet

Several hundreds present and breeding had occurred on both islets. An abandoned egg was found on the northern, and egg shells and several non-flying young were recorded from each islet.

Kermadec Parakeet.

Moderately abundant. 6 was the greatest number seen at any one time and 3 were observed to fly from the southern to the northern islet. Two were observed feeding on Cyperus seeds and 1 on Coprosma shoots.

Starling

Small numbers present.

MILNE ISLETS

A group of low, wave-swept andesitic rocks, 400 metres off the coast near Boat Cove. The highest reaches 45 feet, and it alone supports vegetation.

On 30/12/66 D.V.M. & W.R.S. landed, and near the summit found several stunted, prostrate pohutukawa and a patch of Disphyma. 6 other salt-tolerant species were represented.

A wandering tattler, apparently using the rocks as a high tide roost, flew off as we approached and 2 grey ternlets frequented the summit, where droppings were numerous, but breeding was not proven.

SUMMARY

From 13/11/66 to 27/1/67 7 members of the Ornithological Society of New Zealand, a botanist and an entomologist, comprising the 1966/67 O.S.N.Z's. 25th Anniversary Kermadec Islands Expedition, were based on Raoul 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.

Wildlife and botanical surveys were carried out on Raoul and all adjacent islets and more detailed studies conducted on Raoul and North Meyer, but opportunity did not permit landings to be made on others of the Kermadec Group.

Over 300 species of vascular plants and mosses were collected, including 3 new records of native vascular plants, and over 150 adventives; more than twice as many as have been recorded previously.

The status of goats on Raoul, and the goat control scheme sponsored by the Departments of Lands & Survey and Internal Affairs, whereby a six-monthly prize is awarded to the M.O.T. staff member with the highest tally of goat kills, are discussed.

Control exercised by this scheme has been beneficial to vegetation in localised areas, however it is suggested that more effective control might be achieved if the six-monthly prize were increased. This scheme is not the solution to Raoul's goat problem however and must be regarded merely as a means of control until eradication can be effected.

Of the Kermadecs, Raoul is the only island which supports anything more than purely a coastal forest association, and due to browsing by goats, its vegetation was found to be actively degrading. The natural plant associations, together with a number of endemic species, are threatened. It is therefore highly desirable that goats be removed as soon as possible.

Kiore, last recorded on Raoul in 1944 were found to be widespread; having co-existed with Norway rats since 1921.

Further fences, or a change in present farming practice are required in order to prevent domestic stock from the M.O.F. farm, trespassing onto the adjacent fauna and flora reserve.

Greater precautions are required if further introductions of plants, animals and invertebrates to the Kermadecs, and from Raoul to Meyer, are to be prevented.

Allied shearwater and ternlet; neither of which has previously been recorded breeding on Raoul, were found to have recently bred here, and they, together with remnant breeding colonies of wedge-tailed shearwater and black-winged petrel on this island, are endangered as a result of heavy predation by feral cats. Ternlets were found breeding in greatest numbers on Napier Islet.

A storm-wreck 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 months, is now virtually extinct as a breeding species on this island; evidence of only 2 nests being found. Predation by cats and rats is known to have contributed to this spectacular 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 birds 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 Kermadec petrel.) 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.

Red-tailed tropic birds were nesting in greatest numbers on Dayrell and South Meyer, while masked boobies were breeding in numbers only on the Chanter Islets. 36 occupied booby nests were located on the Herald Islets.

A grey plover on Meyer, and a southern black-backed gull on Raoul, were the first confirmed records of these species from the Kermadecs.

Besides the well known Pukem Bay colony, sooty terns were found breeding at Hutchinson Bluff and on Meyer and Dayrell Islets, the total population being approximately 80,000 pairs. Mortality of chicks banded at between 1 & 3 days was considerably greater than that of older chicks.

White-capped noddies, found breeding only on Meyer, had a more protracted breeding season than that recorded by earlier observers.

Relative-abundance sampling of passerines on Raoul showed the starling to be the most numerous species, followed by thrush, blackbird, tui and yellow banger.

RECOMMENDATIONS

1. A determined effort should be made to exterminate goats from Raoul. Mr Sykes (botanist) and I are adamant that in the interests of both flora and fauna conservation, this is of highest priority.
2. In order to exercise a greater measure of control over goat numbers until extermination can be effected, the present six-monthly prize of \$20, offered by the Departments of Lands & Survey and Internal Affairs to the M.O.T. officer with the highest tally of goat kills, should be raised to \$50. If after a trial period the overall kill does not increase significantly, the sum could be reduced.
3. In order to exercise a measure of control over the cat population, M.O.T. staff should be supplied with gin-traps and the Officer-in-Charge instructed in their use prior to his departure from N.Z. Cats could then be incorporated in the above "goat competition". Should recommendation number 1 above be implemented, extermination of cats, by using a combination of biological and mechanical means, should be attempted at the same time.
4. M.O.T. should be asked to ensure that in future all domestic stocks are confined by fences at all times. This may entail either the reduction of stock numbers, or the fencing of Low Flat.
5. Every endeavour must be made to prevent the introduction of further plants, animals and invertebrates to the Kermadecs, and from one island in the group to another.

Perhaps the most imminent danger is that of rats from Raoul reaching Meyer. (The M.O.T.'s dinghy, which is kept near the station out-buildings, where rats are prevalent, could easily harbour rats beneath its floor-boards or amongst gear. The boat-harbour on North Meyer, a favourite haunt of fishing parties, provides shelter in which a dinghy can be moored with shore-lines. Recent history has shown that rats will readily negotiate a mooring-line, or even swim from a craft to reach land, and the subsequent devastating effects such an introduction can have upon an unmodified island ecosystem (Blackburn 1965, Gray 1967). Should this occur on Meyer, two of the world's most fascinating, unspoiled bird-islands will be lost for all time. I therefore consider it necessary that M.O.T. be asked to place the Meyer Islets out-of-bounds to its staff.

6. Caesalpinia decapetala, a thorny tropical creeper established on parts of the Denham Bay flat northwest of the lagoon, should be eradicated while its range is still somewhat restricted. A hormone spray would probably prove most effective.
7. M.O.T. staff should be asked not to band sooty tern chicks prior to early February, by which time the period of highest natural mortality has passed. In late March, after the young have departed, banding should be followed-up by counting dead chicks, and returning bands recovered from them.
8. When opportunity permits, ducks on Raoul should be trapped, (this could most easily be accomplished on the Blue Lake mud-flats) banded and their sub-specific status confirmed. Subsequent trapping may show that the population is sedentary, and unlike that of other parts of N.Z., has entirely escaped the influence of mallards (A. platyrhynchos platyrhynchos). This being so, efforts should be made to retain this as a pure population by removing any mallards which may appear.

9. The Officer-in-Charge should be appointed a ranger under the Wildlife Act 1953. At present he is automatically appointed a ranger under the Reserves & Domains Act 1953, but as such, is not empowered to deal with wildlife offences committed outside of the Fauna and Flora Reserve.
10. *We should brief him.* Regardless of whether recommendation 9 above is implemented or not, the Officer-in-Charge should be thoroughly briefed in relevant sections of both the Reserves & Domains Act 1953 and the Wildlife Act 1953. Had this been done in the past, certain, mainly minor infringements of these acts, by both staff and visitors, would have been avoided. Copies of these Acts should be held at the station.
11. Legal aspects of entry and hunting, by M.O.T. staff, within the Reserve for the Preservation of Fauna and Flora, seem to require attention. Permits do not appear to have been issued.
12. Since its instigation in 1938 the establishment on Raoul has been used almost exclusively for meteorological and geophysical investigation; its biological potential being largely ignored. In order to help overcome the dearth of biological information from the Kermadecs, it is recommended that a permanent biological unit be attached to the M.O.T's. Scientific Station. Such a unit, as well as affording unique opportunities for research, could provide much-needed ecological data, essential for the effective management of the Kermadec Islands Fauna & Flora Reserves.

A biologist and a technician, not necessarily from a government institution, could be seconded to the M.O.T's. expeditions, and remain throughout the normal hours of duty i.e., about 12 months. Investigations could include any branch of biology or other of the natural sciences, but perhaps the most pressing need is for research into the ecology of cats, rats and breeding seabirds on Raoul.

ACKNOWLEDGEMENTS

I wish to record the appreciation and thanks of expedition members and myself to those who made the venture possible. Foremost amongst these are the Secretary for Defence (Navy), for provision of transport, the Minister of Lands, for permission to visit the Kermadec Islands Fauna & Flora Reserves and to make representative collections of plants and animals, and the many sponsors within the Society. The Secretary for Internal Affairs granted permission to collect protected fauna, and the District Officer and staff, Department of Internal Affairs, Auckland, the Controller, Wildlife Service and Messrs A. Blackburn, A.T. Edgar and B.D. Bell, all gave valuable assistance with organisation.

We are grateful to the commanding officers, officers and crews of H.M.N.Z. Ships "Inverell" and "Kiama" for kind hospitality during transit, and to the Secretary for Civil Aviation and his scientific team on Raoul, whose excellent co-operation and hospitality contributed directly to the success of the expedition.

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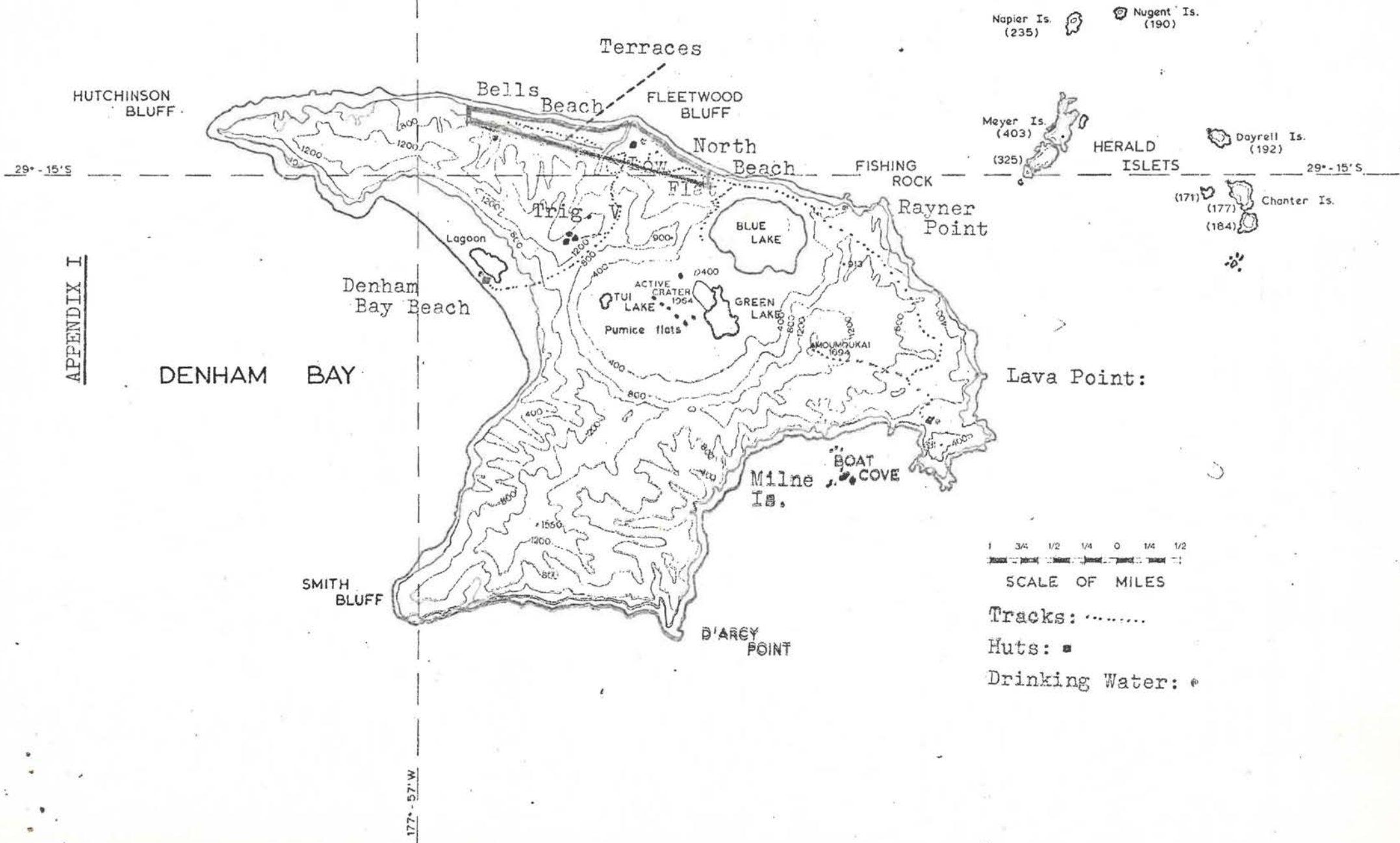
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(D.V. Merton)
Fauna Conservation Officer.

177° - 57' W

Raoul Island and the Herald group showing places referred to in the text. Area under Ministry of Transport control edged in red.



APPENDIX I

177° - 57' W

APPENDIX II

BIRDS OBSERVED WHILE EN-ROUTE BETWEEN
AUCKLAND AND RAGUEL ISLAND

<u>DATE & TIME</u>	<u>BIRDS</u>	<u>POSITION, WEATHER AND</u> <u>REMARKS.</u>
<u>10 November 1966</u>		
1700 hrs	1 Giant petrel	Off Motutapu Island
1800 hrs	1 Bullers shearwater 2 White-fronted tern 20+ Fluttering shearwater 1 Flesh-footed shearwater	
<u>11 November 1966</u>		
0600 hrs	Nil	34.6°S by 176.6°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	33.9°S by 177.4°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	33.2°S by 178.8°E Wind - S.E. 10 knots Seas - Moderate

<u>DATE & TIME</u>	<u>BIRDS</u>	<u>POSITION, WEATHER AND REMARKS</u>
1900 hrs	2 Juvenile wandering albatross 1 Adult wandering albatross 1 Adult black-browed mollymawk 1 Giant petrel	
<u>12 November 1966</u>		
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	
1200 hrs	1 Black-winged petrel 5 Juvenile wandering albatross	30°58'S by 179°32'W Wind - S.W. 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 Starbo Wind - 10 knots S.E. Seas - Moderate
<u>27 January 1967</u>		
1100 hrs	6 Black-winged petrel	Off Hutchinson 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	

DATE & TIME	BIRDS	POSITION, WEATHER AND REMARKS
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
1900 hrs	6 Black-winged petrel	1845 hrs - Wedge-tailed shearwater and sooty ter still being seen occasio ally.
<u>28 January 1967</u>		
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 wanderi 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 see 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
<u>29 January 1967</u>		
0700 hrs	1 Black-backed gull	
0800 hrs	6 Black-backed gull 1 Flesh-footed shearwater	Little Barrier Island starboard. Calm sea, very light winds.
0900 hrs	3 Black-backed gull	

<u>DATE & TIME</u>	<u>BIRDS</u>	<u>POSITION, WEATHER AND REMARKS</u>
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.

RELATIVE ABUNDANCE OF PASSERINES ON NAUUL ISLAND

Number of observation stations on each transect	38		39		27		
	<u>Stations Involved</u>	<u>Birds Recorded</u>	<u>Stations Involved</u>	<u>Birds Recorded</u>	<u>Stations Involved</u>	<u>Birds Recorded</u>	<u>Stations Involved</u>
Starling	14	25	18	56	9	28	
Thrush	18	23	17	19	8	8	11
Blackbird	9	10	13	14	9	11	13
Tui	10	10	8	9	17	23	8
Yellow hammer	4	4	4	4	1	1	2
<u>Date & Time</u>	<u>12.1.67</u> 08.05 - 11.10 hours		<u>14.1.67</u> 07.00 - 10.10 hours		<u>14.1.67</u> 14.35 - 17.20 hours		<u>16</u> 07.40
<u>Location and Topography</u>	Mt Prospect - Smith Bluff via Mt. Mahoe and intervening ridge tops.		Smith Bluff - D'Arcy Pt via Mt Mahoe and intervening ridge tops		Beet Cove - Low Flat via formed road N/E aspect.		Hutchinson farm, v ridge a spur (K track).
<u>Altitude range and habitat type</u>	1000' - 1600' Pohutukawa, nikau <u>Ascarina</u> rain forest.		800' - 1500' Pohutukawa, nikau, <u>Ascarina</u> rain forest.		200' - 200' Pohutukawa, nikau, <u>Myrsine</u> coastal forest and grassed road edges.		400' - Pohutukawa mahoe r
<u>Weather Conditions</u>	Fine and cool with light northerly wind.		Fine and warm with light northerly wind.		Overcast and mild with light northerly wind.		Overcast with mod easterly

APPENDIX IV

RELATIVE ABUNDANCE OF PASSERINES ON RACUL ISLAND

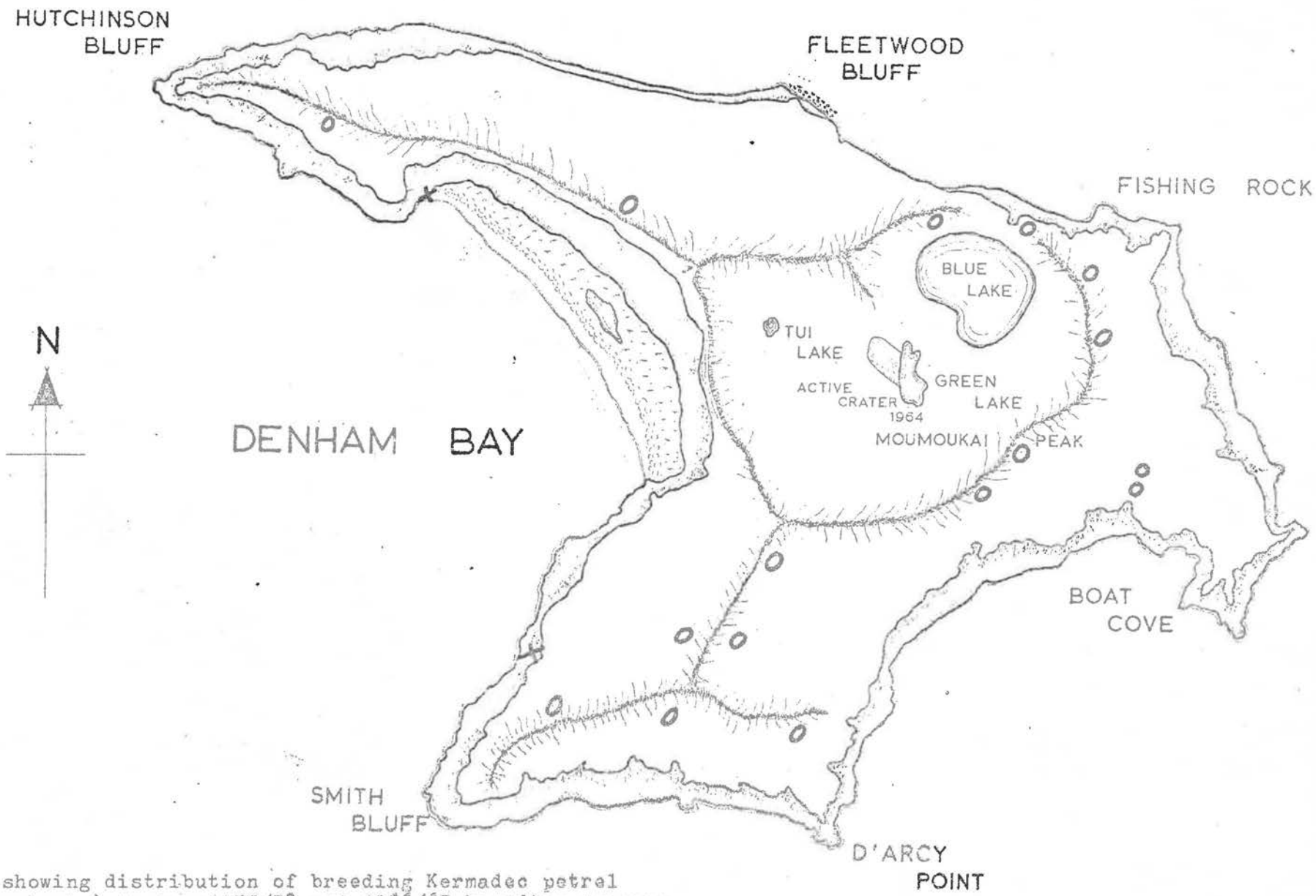
Method

Pauses of one minute's duration were made at four minute intervals on transects, and all birds seen or heard within a radius of approximately 50 yards, recorded. Care was taken not to record the same bird twice.

Song was poor during the period covered by these observations, the most vocal species being thrush and yellow hammer, so that results may be biased in favour of these.

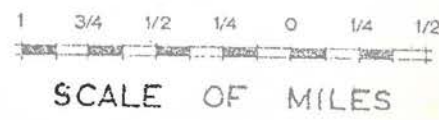
Starlings were heard more often than seen, as they fed noisily in the canopy. Blackbirds and small flocks of starlings were widespread.

Certain habitat preferences were indicated. Thrushes were not recorded in the lower altitude coastal associations and tui seemed to prefer the drier low altitude forests. Yellow hammers recorded were all on the open seaward slopes.



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

1937/38 colonies: 0
2 nests located 1966/67: X



APPENDIX VISOUND RECORDING AND PHOTOGRAPHY(Tapes & Movie Films are deposited in the O.S.N.Z. Library.)

<u>SPECIES</u>	<u>PHOTOGRAPHED</u>			<u>SOUND RECORDED</u>
	<u>B. & W.</u>	<u>COLOUR</u>	<u>MOVIE</u>	
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 crane	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
Yellow hammer				x
Sterling				x
Kermadec cicada				x
Black Australian cricket				x

APPENDIX VIISUMMARY OF BANDING RESULTS

Sooty tern, Denham Bay	Pul. 1508	
	Juv. 1347	
	Ad. 109	
Sooty tern, Hutchinsons Bluff	Ad. 184	
	<u>3148</u>	3148
Black-winged petrel (Meyer & Napier Islets).		986
Ternlet (Meyer Islets)		21
Noddy (Meyer Islets)		7
White tern (Denham Bay)		1
Parskeet (North Meyer Islet)		6
Blackbird (Low Flat)		22
Thrush (Low Flat)		9
Tui (Low Flat)		23
Starling (Crater)		1
Kermadec petrel (Meyer Islets)		944
Booby (Chanter Islets)		40
Tropic bird (Sth. Meyer Islet)		81(+ 1 recapture)
Allied shearwater (Nth. Meyer Islet)		4
Sedge-tailed shearwater (Meyer Islets)		286
	TOTAL	<u>5579</u>

APPENDIX VIII

SPECIMENS DEPOSITED AT DOMINION MUSEUM

A. BIRD SKINS.

Species	Sex.	Age.	Specimen. Number	Date.	Locality.	Collector.	Total
Kermadec petrel	M	Ad.	96	31.12.66	Nth. Meyer	D.V.M.	
" "	M	Ad.	97	"	" "	"	
" "	M	Ad.	98	"	" "	"	
" "	F	Ad.	144(pale)	20.1.67	" "	"	
" "	-	Ad.	170	9.1.67	" "	D.E.C.	5
Blackwinged petrel	M	Ad.	68	19.12.66	North Beach	C.R.V.	
" "	M	Ad.	70	20.12.66	Nth. Meyer	D.V.M.	
" "	M	Ad.	74	20.12.66	" "	"	
" "	M	Ad.	157	20. 1.67	" "	"	4
Wedge-tailed shearwater	M	Ad.	76	20.12.66	" "	"	
" shearwater	F	Ad.	158	20. 1.67	" "	"	
" shearwater	F	Ad.	171	3. 1.67	" "	D.E.C.	3
Sooty tern	M	Ad.	49	15.12.66	Denham Bay	C.R.V.	
" tern	F	Ad.	50	15.12.66	" "	"	
" tern	F	Ad.	51	16.12.66	" "	"	
" tern	F	Ad.	52	"	" "	"	
" tern	M	Ad.	53	"	" "	"	5
Noddy	F	Ad.	64	18.12.66	North Beach	D.V.M.	
"	F	Ad.	66	18.12.66	" "	"	
"	F	Ad.	67	19.12.66	" "	C.R.V.	3
Ternlet	M	Ad.	73	20.12.66	Nth. Meyer	D.V.M.	
"	F	Ad.	75	20.12.66	" "	"	2
Asiatic whistrel	M	Ad.	80	23.12.66	North Beach	"	1
Spotless crane	F	Ad.	83	26.12.66	Sth. Meyer	"	
" "	M	Ad.	84	27.12.66	" "	C.R.V.	2
Pukeko	M	Ad.	111	6.1. 67	Blue Lake	D.V.M.	
"	F	Ad.	112	"	" "	"	
"	F	Juv.	113	"	" "	"	3
Grey duck	F	Juv.	69	19.12.66	" "	C.R.V.	
Grey duck	F	Juv.	110	7. 1.67	" "	D.V.M.	2
Kingfisher	F	Ad.	62	18.12.66	Ngaio Point	C.R.V.	
"	M	Ad.	79	22.12.66	Farm	"	
"	M	Ad.	93	29.12.66	"	"	
"	F	Ad.	99	1. 1.67	"	"	
"	F	Ad.	101	3. 1.67	"	"	5
Tui	M	Ad.	28	11.12.66	Low Flat	C.R.V.	
Tui	M	Ad.	29	27.11.66	" "	"	
Tui	M	Ad.	31	11.12.66	" "	"	
Tui	M	Juv.	159	22. 1.67	" "	"	4
Parakeet	M	Ad.	85	27.12.66	Sth. Meyer	"	
"	F	Ad.	86	27.12.66	" "	"	2

41 of
13 species

B. BIRDS' EGGS.

<u>Species</u>	<u>Specimen Number</u>	<u>Date</u>	<u>Locality</u>	<u>Collector</u>	<u>Number</u>	<u>Total</u>
Kermadec petrel	150	7. 1.67	Nth. Meyer	J.F.A.	2(Fresh)	
" "	152	9. 1.67	" "	"	1 "	
" "	155	19. 1.67	" "	"	1 "	4
Blackwinged petrel	105	1. 1.67	Sth. Chanter	D.V.M.	1 "	
" "	148	4. 1.67	Nth. Meyer	J.F.A.	2 "	
" "	151	8. 1.67	" "	"	1 "	
" "	153	11. 1.67	" "	"	1 "	
" "	154	19. 1.67	" "	"	1 "	6
Wedgetailed shearwater	89	28.12.66	Sth. Meyer	D.V.M.	1 "	
" "	145	3. 1.67	Nth. Meyer	D.E.C.	2 "	
" "	146	4. 1.67	" "	"	2 "	5
Sooty tern	35	6.12.66	Denham Bay	D.V.M.	2(deserted)	
" tern	46	13.12.66	" "	C.R.V.	4 "	
" tern	143	14. 1.67	" "	J.A.P.	5 "	11
Noddy	32	22.11.66	Nth. Meyer	D.V.M.	1(fresh)	
" "	147	4. 1.67	" "	D.E.C.	2 "	3
Ternlet	33	21.11.66	" "	D.V.M.	1 "	
" "	34	22.11.66	" "	"	1 "	2
White tern	59	16.12.66	Denham Bay	C.R.V.	1(portion of shell)	1
Booby	82	27.12.66	Sth. Meyer	"	1(Addled)	
" "	103	1. 1.67	Nth. Chanter	"	2(addled clutch)	5
" "	106	1. 1.67	Sth. Chanter	D.V.M.	2 " " "	5
Tropic bird	88	28.12.66	" "	"	1(fresh)	1
Grey duck	172	18. 1.67	Low Flat	C.R.V.	3(addled)	3
Kingfisher	78	22.12.66	Farm	"	1(addled)	
" "	92	29.12.66	"	"	4(addled clutch)	
" "	102	3. 1.67	"	"	1(addled)	6
Tui	115	8. 1.67	Low Flat	D.V.M.	4(addled clutch)	4

51 of 12
species

C. MISCELLANEOUS

<u>Species</u>	<u>Description</u>	<u>Date</u>	<u>Specimen Number</u>	<u>Locality</u>	<u>Collector</u>
Wandering albatross	King bone	17.11.66	13	Denham Bay Beach	J.A.P.
Wedge-tailed shearwater	2 mandibles	13.12.66	38	Rayner Pt.	D.V.M.
Sooty shearwater	Storm-wreck	24. 1.67	168	Denham Bay Beach	"
Allied shearwater	Cat eaten remains	13.12.66	40	Below Rayner Pt.	"
" "	5 wings from 3 cat eaten fledglings	13.12.66	41	Rayner Pt.at 300'asl. "	
" "	Storm-wreck	14.11.66	72	Below Fleetwood Bluff	J.F.A.
" "	Dried remains	26.12.66	118	Sth. Meyer	C.R.V.
" "	" "	1. 1.67	119	Sth. Chanter	D.V.M.
" "	" "	2. 1.67	122	Nth. Meyer	J.F.A.
" "	" "	26.12.66	123	Sth. Meyer	C.R.V.
Sunday Island petrel	Storm-wreck	5. 1.67	116	Bell's Beach	D.V.M.

<u>Speci</u>	<u>Description</u>	<u>Date</u>	<u>Specimen Number</u>	<u>Locality</u>	<u>Collector</u>
Kermadec petrel	Skull	1.12.66	11	Crater rim west	
" "	"	3.12.66	12	Mt. Prospect	C.R.V.
" "	Remains	12. 1.67	138	Low Flat	"
" "	Downy chick, (spirit specimen)	17. 1.67	141	Above Smith Bluff	"
Black-winged petrel	Cat eaten remains	16.12.66	58	Smith Bluff (coastal)	W.R.
" "	" " "	8. 1.67	114	Denham Bay below cliffs	C.R.V.
" petrel	Dried remains	25.12.66	120	Low Flat	D.V.M.
" petrel	" " "	30.12.66	121	Nth. Meyer	W.R.S.
" petrel	" " "	25.11.66	5	" "	J.F.A.
Tropic bird				Farm	"
Spotless crake	2 newly hatched chicks (spirit specimens)	28.11.66	173		
Golden plover	1 wing	2.12.66	7	Nth. Meyer	D.E.C.
" "	1 wing	12.12.66	36	Blue Lake	D.V.M.
Knot	Dried remains	20.12.66	71	Nth. Beach	"
Parakeet	Cat disgorged feathers	13.12.66	39	Blue Lake	"
"	Dried remains	26.12.66	117	Rayner Pt.	"
"	" " "	25. 1.67	169	Sth. Meyer	C.R.V.
Unidentified	Bone	11. 1.67	160	Nth. Meyer	J.A.P.
Land crab	4 spirit specimens	20.1. 67	174	" "	D.E.C.
(<u>Geograpsus grayi</u>)				" (3)	D.V.M.
Sea shells	Assorted	-	-	Hostel grounds(1)	C.R.V.
				Denham Bay & Nth. Beaches.	J.F.A.

D. DISTRIBUTION OF RATS COLLECTED.

(But for 4, i.e., 2 of each species - all were caught during January 1967).

	<u>Low Flat</u>	<u>Hostel Grounds</u>	<u>Farm</u>	<u>Trig V</u>	<u>Denham Bay Track (northern aspect)</u>	<u>Denham Bay Flats</u>	<u>Boat Cove Hut</u>	<u>Boat Cove Road</u>	<u>Total</u>
Kiore	3	1	2		1	1		1	9
						(dried remains)			
Norway Rat	7			1			1	1	10

In addition to the above, which were retained as specimens, an unknown number of rats attacking stores was trapped and poisoned near each of the two Raoul Island camps.

The above specimens were deposited at Dominion Museum where identification was confirmed by Messrs D.J. Campbell and J. Moreland.

APPENDIX IX

OTHER SPECIMENS COLLECTED

A. ZOOLOGY DEPARTMENT, AUCKLAND UNIVERSITY COLLEGE.

<u>Description</u>	<u>Specimen Number</u>	<u>Date</u>	<u>Locality</u>	<u>Collector</u>
Cat dropping	1	18.11.66	Mt. Moumoukai	D.V.M.
"	2	19.11.66	Roadside near fuel-dump	"
"	3	20.11.66	North Beach	"
"	4	25.11.66	Summit Denham Bay track	J.A.P.
"	6	30.11.66	D'Arcy Point	D.V.M.
"	8	30.11.66	South rim of crater	C.E.V.
"	9	29.11.66	Near Mahoe trig	"
"	10	4.12.66	Denham Bay track (cliff)	"
Cat stomach	15	5.12.66	Boat Cove (road)	"
Cat pellet	17	5.12.66	" "	"
Cat dropping	18	5.12.66	" "	"
"	19	7.12.66	Watershed south of Boat Cove	"
"	20	7.12.66	Boat Cove (road)	"
"	25	8.12.66	Denham Bay beach	D.V.M.
"	27	10.12.66	" " cliffs	"
Cat pellet	42	12.12.66	" " track	C.E.V.
Cat dropping	43	12.12.66	" " "	"
Cat pellet	65	16.12.66	Hutchinson Bluff ridge	D.V.M.
Cat dropping	107	29.12.66	Denham Bay beach	J.A.P.
"	129	12. 1.67	Mahoe-Prospect ridge	C.E.V.
"	130	12. 1.67	Smith Bluff	"
"	131	12. 1.67	" "	D.V.M.
" (fresh)	132	12. 1.67	Mahoe trig	"
"	133	12. 1.67	Smith Bluff	"
"	134	13. 1.67	D'Arcy Point	"
"	135	13. 1.67	Beach between D'Arcy Point & Smith Bluff	"
" (fresh)	136	14. 1.67	Titi Knob	"
"	142	17. 1.67	Below Smith Bluff	"

B. GOAT AROMASMS COLLECTED ON BEHALF OF J. ANDREW, ZOOLOGY DEPARTMENT, VICTORIA UNIVERSITY COLLEGE, WELLINGTON.

<u>Specimen Number</u>	<u>Date</u>	<u>Locality</u>	<u>Collector</u>
16	6.12.66	Near Boat Cove	C.E.V.
21	9.12.66	Crater	"
22	9.12.66	"	"
23	9.12.66	"	"
24	10.12.66	Near farm	"
26	9.12.66	Denham Bay beach	D.V.M.
37	13.12.66	Rayner Point	"
44	12.12.66	Denham Bay	C.E.V.
45	12.12.66	" "	"
47	14.12.66	" "	"
48	14.12.66	" "	"
54	16.12.66	" "	"
55	16.12.66	" "	"

<u>Specimen Number</u>	<u>Date</u>	<u>Locality</u>	<u>Collector</u>
56	16.12.66	Denham Bay	C.R.V.
57	17.12.66	" " track	"
81	24.12.66	Beet Cove road	"
94	30.12.66	" " "	"
95	30.12.66	" " "	"
124	13. 1.67	Near D'Arcy Point	"
125	13. 1.67	" " "	"
126	13. 1.67	" " "	"
127	13. 1.67	D'Arcy Point	"
128	14. 1.67	Judith Peak	"
156	20. 1.67	Crater	D.V.M.
161	23. 1.67	Ridge above West Flat	C.R.V.
162	23. 1.67	Ridge above West Flat	"
163	23. 1.67	" " " "	"
164	23. 1.67	" " " "	"

C. PROTECTOR FROM BLUE LAKE MUD-FLATS, ON BEHALF OF DR. BROWN OF
MANCHESTER UNIVERSITY COLLEGE.

D. PETREL TISSUES, FAT & STOMACH OIL FROM NORTH MEYER, ON BEHALF OF
MR J. GANHAM, ECOLOGY DEPARTMENT, CANTERBURY UNIVERSITY COLLEGE.

APPENDIX X

GOATS AND THEIR EFFECTS UPON RAOUL ISLAND'S VEGETATION

Superficially it appears that a state of equilibrium exists between goats and plants but in reality this is not so, for changes in the composition of the vegetation are taking place slowly (see Sykes, in press(b)).

Although the Island has a fairly dense covering of plants in most places, it seems that all the parts accessible to goats are frequently browsed. Generally the common species which occur where it is possible for goats to browse, i.e. up to about five feet above ground level and up all the aloping tree trunks to considerable heights; are unpalatable. This means that a palatable tree species is usually rare as a small seedling and therefore regeneration is poor.

Species of trees palatable to goats and thus with few seedlings are:-

Petrosideros kermadecensis (pohutukawa) Raoul's commonest tree is rare in the seedling stage, apart from a few restricted open grassy slopes where for unknown reasons it is common. Goats climb into the old leaning trees to eat any accessible young shoots.

Heliccytus ramiflorus (mahoe) - the mahoe is rarely seen in the seedling stage apart from some areas in the crater where fallen branches are very numerous.

Cyathea species (tree ferns) - hardly any young plants were seen.

Hemalanthus polyandrus - not very common and goats stopping regeneration.

Boehmeria dealbata - not very common and goats stopping regeneration.

Pseudopanax kermadecensis (fivefinger) - young plants mostly seen as epiphytes and this is the usual way for a fivefinger to reach maturity.

Pittosporum crassifolium (karo) - restricted to steep faces because of goat activity.

Other palatable or partially palatable species include:-

Hebe breviracemosa - this may be extinct now due to goat activity. It was not seen.

Asplenium species - these ferns are usually epiphytes and were browsed where possible for goats to climb.

Blechnum species - terrestrial ferns which are partially palatable; the young fronds being eaten.

Rhopalostylis choesemanii (nikau) - in many parts of Raoul nikau are present as very young seedlings abundantly with the adult trees above, but intermediate stages are uncommon. The goats seem to browse all the older plants where possible, and if a mature tree blows over it is soon eaten.

Siegerbeckia orientalis - a common composite herb but heavily browsed in the crater.

Frigeron canadensis - this common composite weed is also heavily browsed in the crater.

Coriaria arborea - var. kermadecensis (tutu) - young plants eaten especially.

(Appendix X contd.)

Non palatable species of woody plants are:-

Myrsine kermadecensis
Ascarina lanceolata
Myoporum laetum (ngaio)
Caesalpinia species (Denham Bay)
Corynocarpus laevigatus (Karaka)
Probably Melicope ternata (Wharangi)
Macropiper excelsum var majus
Cassia laevigata (Legume introduced)

Unpalatable herbaceous plants which are common include:-

Alocasia macrorrhiza (aroid)
Pteris comans
Pteris tremula
Rumohra aristata
Hymenophyllum demissum
Histiopteris incisa
Doodia menia
Pellaea folcata
Ipomoea pescaprea
Sporobolus capensis
Scirpus nodosus
Carex kermadecensis
Cyperus ustulatus
Ageratum conyzoides
Bidens pilosa
Oplismenus undulatifolius
Psilotum nudum
Scaevola gracilis

W.R. Sykes
(Botanist)
Botany Division,
D.S.I.R.

APPENDIX XI

ITEMS OF GENERAL EQUIPMENT TAKEN ON 1966/67 KERNADEC ISLANDS EXPEDITION.

Spades	3	Tool kits	2
Axes (2 1/2 lb)	3	Clothes pegs (doz)	3
Axe handles (26")	3	Fish slide	3
Slashers	4	Potato peelers	3
Saws (24" bow)	2	Hose (plastic) (ft.)	500
Claw hammers	2	Hose couplings (assorted)	
Nails assorted		Low pressure taps	2
Pliers (pair)	2	Tea towels (doz.)	1
Rope -- Climbing with karabiners	2	Dish mops	6
General purpose 100 yds		Pot mits (doz.)	1
String (ball)	3	Steele soap pads (pkts.)	6
Baskets	4	Clothes lines	8
Water containers (2 1/2 gal. plastic)	6	Tin openers	6
4 1/2 gal. drums	3	Egg beaters	3
Drum coaks	2	12'6" dinghy & accessories	
Camp ovens	3	9.5 h.p. outboard motor & spare parts	
Billies (assorted sizes)	15	Petrol containers 2 x 2 1/2 gals.	
Drypans (large)	1	Rat traps	6
(small)	3	10" Mill.bast.files	3
Plastic bags (assorted sizes) (gross)	1	Compass	2
Armethane plastic sheeting (6' wide)(roll)	1	Lilo repair outfit	1
Tilley lamps	4	Assorted funnels	6
Primus (double burner)	3	Gun & rifle cleaning gear	
Basins	6	Medical supplies	
Tents 15' x 10'	4	Tele-radio set	1
Tent flies small	5	12-volt batteries	2
Tarpaulins	2		
Fish hooks and lines		STORES (675 MAN/DAYS)	
.22 rifle & ammunition		Meat (assorted 16 oz tins)(doz.)	10
.410 shot gun & ammunition		Salmon (large) (doz.)	3
Life jackets	6	Sardines (large) (doz.)	2
Meat safes	2	Assorted freeze dried meats (doz.)	4
Mantles for lamps (dozen)	2	Herrings in tomato sauce (doz.)	4
Candles (pkts)	12	Spaghetti (16 oz tins) (doz.)	3

APPENDIX III

DISTRIBUTION OF SPECIES FOUND BY 1966/67 ENTOMOLOGICAL SOCIETY EXPEDITION
ON RAOUL ISLAND AND ADJACENT ISLANDS

[illegible]