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Key words: Pohutukawa; *Metrosideros excelsa*; *Vitex lucens*; Puriri; Coppermine Island; Hen and Chickens Islands; Biological Surveys.

AN ECOLOGICAL RECONNAISSANCE OF COPPERMINE ISLAND, HEN AND CHICKENS GROUP

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SUMMARY

The vegetation of Coppermine Island consists mainly of coastal scrub and pohutukawa-dominated forest on the steep slopes and kanuka scrub and forest on the upper ridges. Also present is a mahoe-puriri forest associated with a very friable soil that is burrowed by large numbers of flesh-footed shearwaters. This ecosystem has not been found elsewhere and appears to be related to the island's unusual geology. Both from a wildlife and a scientific standpoint it is particularly important to prevent European rats reaching this island or any other islands of the Chicken group.

An ecological reconnaissance of Coppermine Island was made between 19 and 22 November 1965 by me in company with Mr D. V. Merton (Wildlife Branch, Department of Internal Affairs) and Mr J. Hopkins (Geology Department, University of Auckland), to both of whom I am grateful for help. This note is published because of the current interest in the island arising from a proposal to prospect and mine it for copper.

Coppermine Island is the most easterly of the four largest islands of the Chicken Group. It lies 10 miles east of Bream Head (Whangarei Heads), $4\frac{3}{4}$ miles north-east of Hen Island and approximately 180 yd east of Whatupuke Island. Coppermine Island is 91 chains long, 13–30 chains wide, and covers 180 acres.

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GEOLOGY AND TOPOGRAPHY

Brothers and Hopkins (1967) report that the original greywacke basement of Coppermine Island has been intruded and metamorphosed to hornfels by a diorite-granodiorite stock. Subsequent andesite dikes have intersected both the diorite stock and the hornfels giving a complex pattern of rock types. This complexity is well shown on maps published by Thompson and Wodzicki (1967) who give a detailed account of rock composition and copper mineralisation.

Cliffs or very steep slopes form the seaward faces of the island. These rise to the three rounded summits and narrow connecting saddles that form the main ridge. The western summit (c. 607 ft) is the highest. An automatic lighthouse is situated on the eastern summit. A small stream that probably dries up during summer is located at the south-western end of the island. The best places for landing are on the beach facing Whatupuke Island and in the small bay on the southern side from whence a track leads to the lighthouse. Most of the remaining shoreline is so cliffed that landings are not possible.

HISTORY

Coppermine Island, like most off-shore islands, was extensively modified during Maori times. The remains of two oven sites and a number of terraces were found on the main ridge. The exact date when the Maori ceased to use the island regularly is not known but it was probably during the early part of the last century.

In 1849 and again in 1896 attempts were made to mine the island for minerals but failed because mining was uneconomic. At some time during this period part of the vegetation was burnt. However, the plant cover and animal life at the western end appear to have developed for c. 150 years without significant disturbance.

In 1956, access to the island was restricted to people with permits and since then it has functioned as a flora and fauna sanctuary though classified as a scenic reserve. In 1965 the Conzinc-Rio Tinto Co. indicated to the Government that it was interested in prospecting on the island. Two surveys have since been made by geologists of the New Zealand Geological Survey but at the time of writing the future of the island is uncertain.

FLORA

The 152 species of plants recorded during the visit are listed in Appendix 1. This list includes 49 species of native trees and shrubs, 20 species of ferns, and 33 other species of native herbaceous flowering plants not including grasses and sedges. Rare plants growing on the island with distributions mainly or wholly restricted to islands are the parapara (*Heimerliodendron brunonianum*), pukanui (*Meryta sinclairii*), broad-leaved maire (*Nestegis apetala*), large-leaved milk-tree (*Paratrophis banksii*), and tawapou (*Planchonella novo-zelandica*).

FAUNA

Tuatara (*Sphenodon punctatus*) appear to be common on the island. During our first night ashore 10 were caught and measured, their lengths indicating a fair proportion of young animals. The Polynesian rat or kiore (*Rattus exulans*) is present; only three were encountered.

Lizards present included the large gecko (*Hoplodactylus duvaucelli*) and at least one species of skink (*Leiopisma* spp.).

There are 23 species of birds known to be breeding on the island:

Tui (*Prothemadera novaeseelandiae*)
 Bellbird (*Anthornis melanura*)
 Grey warbler (*Gerygone igata*)
 Pied fantail (*Rhipidura fuliginosa*)
 White-eye (*Zosterops lateralis*)
 Starling* (*Sturnus vulgaris*)
 Blackbird* (*Turdus merula*)
 Hedge sparrow* (*Prunella modularis*)
 Red-crowned parakeet (*Cyanoramphus novaeseelandiae*)
 Kaka (*Nestor meridionalis*)
 New Zealand pigeon (*Hemiphaga novaeseelandiae*)
 Morepork (*Ninox novaeseelandiae*)
 Harrier (*Circus approximans*)
 Shining cuckoo (*Chalcites lucidus*)
 Kingfisher (*Halcyon sancta*)
 New Zealand pipit (*Anthus novaeseelandiae*)
 Northern blue penguin (*Eudyptula minor*)
 Allied shearwater (*Puffinus assimilis*)
 Fluttering shearwater (*Puffinus gavia*)
 Sooty shearwater (*Puffinus griseus*)
 Flesh-footed shearwater (*Puffinus carneipes*)
 Pycroft's petrel (*Pterodroma longirostris*)
 White-fronted tern (*Sterna striata*)

The invertebrates have not been surveyed.

COMMUNITIES

The distribution of the island's communities (soil-plant-animal system) is shown in Fig. 1 and a transect from the central ridge to the south coast is shown in Fig. 2. The island's geology and consequently the soil pattern is complex and because of the short time spent on the island the following correlations between vegetation and soils are tentative:

1. Coastal scrub with pohutukawa } on steep land soils from a
2. Pohutukawa forest } variety of rocks.
3. Kanuka scrub on soils from hornfels and adamellite.
4. Kanuka forest on soils from diorites and altered greywacke.
5. Mixed forest on soils from fine-grained diorite.
6. Mahoe-puriri forest on burrowed soils from altered greywacke and coarse-grained diorite.

* Introduced birds.

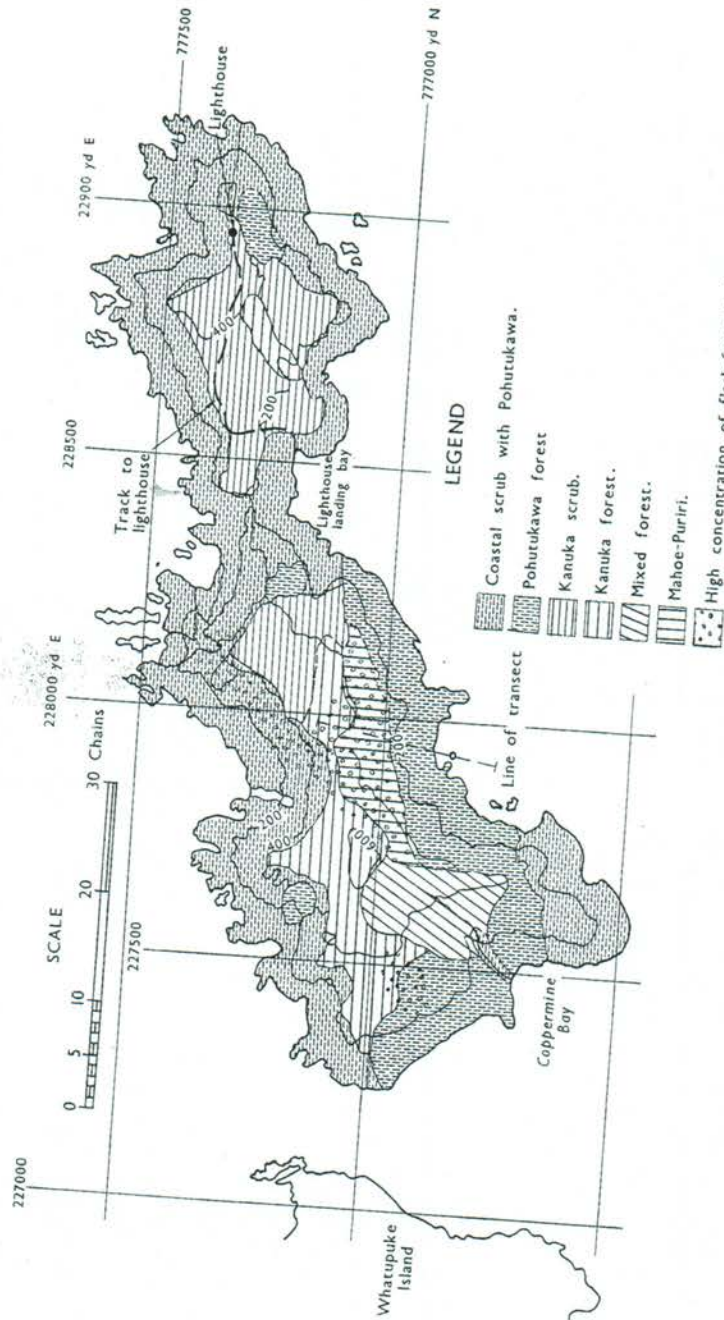


FIG. 1—Coppermine Island. Topographical data from Lands and Survey Aerial Plan 715. Vegetation: I. A. E. Atkinson. Contours in feet. The second to last item in the Legend should read "Mahoe—Puriri forest".

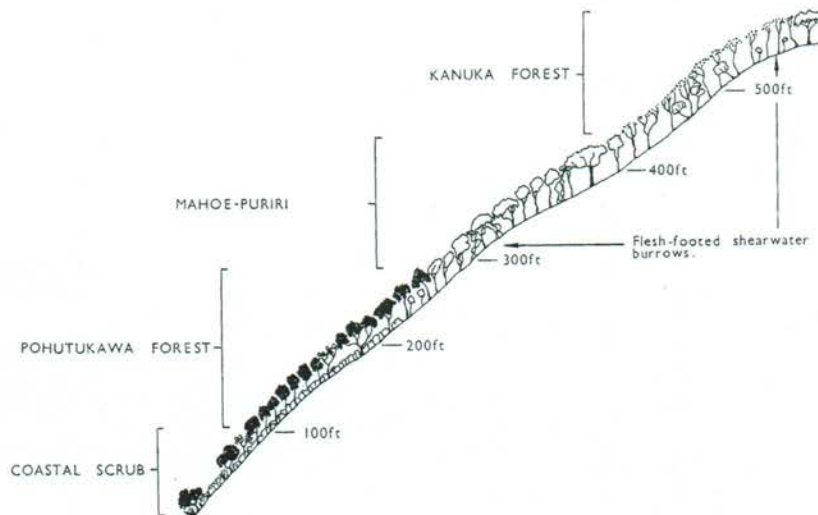


FIG. 2—Transect on the southern slope of Coppermine Island (see Fig. 1).

1. COASTAL SCRUB WITH POHUTUKAWA

This covers most seaward slopes and consists of dense thickets of flax, the shrubs kawakawa, ngaio, and taupata, and emergent pohutukawa. The scrub is difficult to penetrate and appears to be very effective in stabilising the clay loam soils of these very steep slopes against erosion. The slopes are mostly greater than 33° . Red-crowned parakeets were frequently seen in this community. On moist slopes associated with seepage, there are extensive banks of renga lily (*Arthropodium cirrhatum*), a feature much more developed here than on other islands of the group.

2. POHUTUKAWA FOREST

This is mostly young forest rarely more than 40 ft tall with an undergrowth of kawakawa and large-leaved coprosma. Soils are stony clay loams. Tuis and bellbirds were prominent here during November.

3. KANUKA SCRUB

This community covers most of the upper eastern half of the island and varies between 10 ft and 20 ft in height. It has developed following fire last century. Apart from kanuka, this scrub contains large numbers of cabbage trees and pukanuis as well as saplings of other forest trees. In the eastern sector of the island where the soils are stiff clays, the changes going on are very slow; for example, parts of some valleys lack regenerating trees. There are only low numbers of petrel burrows here, probably because of the compact soils. However, it is in the kanuka scrub of the eastern section of the island where tuataras are most common.

4. KANUKA FOREST

This forest varies between 20 and 35 ft in height and occurs mainly in the upper western half of the island. It too is the result of regeneration following fire, and like kanuka scrub it is vulnerable to fire. The direction of change here is towards forest dominated by mapou, mahoe, and kohekohe but in some parts (Fig. 1) there are dense concentrations of shearwater burrows.

5. MIXED FOREST

This covers most of the catchment at the south-western end of the island, is from 40 to 45 ft in height, and appears to have been little disturbed since Maori times. It is more varied in composition than any other stand of forest found so far on the Chicken Islands. Twenty-two species were recorded in the canopy alone. These included the largest pukanui (*Meryta sinclairii*) known from the Hen and Chickens (20 in. in diameter and over 45 ft high) and the first record of white maire (*Nestegis lanceolata*) from these islands. The undergrowth is also varied in composition. Soils are heavy clays weathered from diorite.

6. MAHOE-PURIRI FOREST

This community is of particular interest because it appears to be the main New Zealand breeding ground of the flesh-footed shearwater (*Puffinus carneipes*), a seabird about the size of a muttonbird. The forest canopy consists largely of mahoe and puriri about 25 to 35 ft high. Dense tangles of parsonsia and clematis vines are a notable feature. Apart from a few ferns there is little undergrowth because of bird trampling.

Counts were made of burrows by Mr D. V. Merton and the writer in the high-density area shown in Fig. 1. In 20 quadrats, each of 10 sq. m, randomly spaced along a contour, we found densities up to 1.2 burrows per sq. m with a mean value of 0.6 burrows per sq. m. The majority of these burrows were occupied (laying is just beginning in November) but even by cutting the mean value given above by half, it is apparent that there cannot be less than 17,000 burrows in the area of mahoe-puriri and kanuka forests shown as densely burrowed on Fig. 1 (c. 17 acres).

Part of the burrowed area is associated with a brownish yellow very friable sandy loam that is weathered from altered greywacke. The concentration of bird burrows can be related to the friability of the soil and hence to a particular type of weathered rock the exact character of which has not been identified.

DISCUSSION

Some of the communities of Coppermine Island are similar to those of other northern islands of New Zealand. However, the flesh-footed shearwater colony associated with the mahoe-puriri and kanuka forests is a forest-soil-seabird system unique to this island. Skegg (1964) drew attention to the fact that flesh-footed shearwaters were common on

important breeding centre for the species in the Hauraki Gulf; the bird occurs only in small numbers on other islands. The next largest concentration of this seabird is that on Karewa Islet, Bay of Plenty, which is only 9 acres in size (Sladden, 1924). The presence of the Coppermine colony can be directly related to the easily burrowed friable soil which in turn reflects the island's geology.

Flesh-footed shearwaters use their burrows for six months every year during which time there is continual traffic of birds between sea and land. Some of the phosphates, nitrates, and other minerals deposited in droppings are returned to the sea in streamwater and run-off. What effect the resulting increased fertility of the sea-water has on seaweed and local fish production has not been investigated. Hutchinson (1950) points out that in some cases increased fish production, even if local, can be of economic importance. Thus the distribution of seabird colonies on Hauraki Gulf islands in relation to feeding grounds or breeding localities of various fish species is a topic worthy of study.

Coppermine Island is one of the few New Zealand coastal islands that exceeds 100 acres in size, has not been damaged by goats, pigs, opossums, or recent fires, and that lacks both cats and European rats. The other northern islands in this category are Tawhiti Rahi of the Poor Knights group, Lady Alice and Whatupuke of the Chicken Islands, Hen Island and Red Mercury Island. The communities of these islands are in many cases very different but taken together they could form a control area from which information about the effects of introduced mammals on the mainland can be gained. In this context it is customary to think of deer, opossums, and goats as the main browsing mammals. However, European rats are distributed throughout the mainland and the way in which they have modified the forest and its indigenous fauna cannot be understood fully without reference to these islands which lack them.

Introduction of European rats to Coppermine Island would allow their spread to the remaining Chicken Islands since only short distances separate them. Fires or other physical destruction could damage their vegetation severely but from a long-term viewpoint this damage would not necessarily be irreparable. The introduction of European rats, however, would permanently decrease both the scientific and wildlife value of the Chicken Islands.

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1 - local

m = many

* = introduced species

TREES AND SHRUBS (49 species)

Scientific Name	Common Name	Abundance
<i>Beilschmiedia tarairi</i>	taraire	l
<i>B. tawa</i>	tawa	l
<i>Brachyglottis repanda</i>	rangiora	a
<i>Carmichaelia cunninghamii</i>	broom	a
<i>Coprosma australis</i>	raureka	l
<i>C. macrocarpa</i>	broad-leaved coprosma	a
<i>C. repens</i>	taupata	a
<i>C. rhannoides</i>		a
<i>C. robusta</i>		a
<i>Cordyline australis</i>	karamu	l
<i>Coriaria arborea</i>	cabbage tree	m
<i>Corynocarpus laevigata</i>	tutu	l
<i>Cyathodes fraseri</i>	karaka	a
<i>Dysoxylum spectabile</i>	patotara	l
<i>Entelea arborescens</i>	kohekohe	l
<i>Geniostoma ligustrifolium</i>	whau	l
<i>Hebe parviflora</i>	pigwood	m
<i>H. stricta</i>		l
<i>Hedycarya arborea</i>	koromiko	m
<i>Heimerliodendron brumonianum</i>	pigeonwood	l
<i>Hoheria populnea</i>	parapara	l
<i>Hymenanthera novae-zelandiae</i>	hohere	m
<i>Knightia excelsa</i>	hymenanthera	m
<i>Leptospermum ericoides</i>	rewarewa	l
<i>Leptospermum scoparium</i>	kanuka	a
<i>Macropiper excelsum</i>	manuka	m
<i>Melicope ternata</i>	kawakawa	l
<i>Melicytus ramiflorus</i>	wharangi	l
<i>Meryta sinclairii</i>	mahoe	a
<i>Metrosideros excelsa</i>	pukanui	m
<i>Myoporum laetum</i>	pohutukawa	a
<i>Myrsine australis</i>	ngaio	a
<i>Nestegis apetala</i>	mapou	a
<i>N. lanceolata</i>	broad-leaved maire	a
<i>Olearia furfuracea</i>	white maire	l
<i>Paratranchea kaimati</i>	akepiro	l

CLIMBERS (7 species)

Scientific Name	Common Name	Abundance
<i>Calystegia turguriorum</i> (?)		a
<i>Clematis paniculata</i>	clematis	a
<i>Metrosideros perforata</i>		l
<i>Muehlenbeckia complexa</i>	pohuehue	m
<i>Parsonsia heterophylla</i>	parsonsia	a
<i>Ripogonum scandens</i>	supplejack	l
<i>Sicyos angulata</i>		l

FERNS (20 species)

<i>Adiantum cunninghamii</i>		l
<i>A. hispidulum</i>		l
<i>Arthropteris tenella</i>		l
<i>Asplenium bulbiferum</i>		l
<i>A. falcatum</i>		l
<i>A. flaccidum</i>		a
<i>A. lucidum</i>		a
<i>Blechnum aggregatum</i>		m
<i>B. filiforme</i>		l
<i>Cyathea dealbata</i>	silver tree fern	l
<i>C. medullaris</i>	manuka	l
<i>Doodia media</i>		a
<i>Pellaea rotundifolia</i>		m
<i>Phymatodes diversifolium</i>		a
<i>Polystichum richardii</i>		a
<i>Pteridium aquilinum</i> var. <i>esculentum</i>		a
<i>Pteris comans</i>		a
<i>P. tremula</i>		l
<i>Pyrrosia serpens</i>		a
<i>Thelypteris pennigera</i>		l

SEDGES (9 species)

<i>Carex breviculmis</i>	l	<i>Mariscus ustulatus</i>	a
<i>C. dissita</i>	a	<i>Scirpus cernuus</i>	a
<i>C. vacillans</i>	a	<i>S. nodosus</i>	a
<i>Gahnia lacera</i>	a	<i>Uncinia uncinata</i>	a
<i>Lepidosperma australe</i>	m		

GRASSES (16 species)

<i>Aira caryophyllea</i> *	a	<i>D. crinita</i>	m
<i>Anthoxanthum odoratum</i> *	m	<i>Holcus lanatus</i> *	a
<i>Briza minor</i> *	m	<i>Microlaena polynoda</i>	l
<i>Bromus diandrus</i> (<i>B. gussonii</i>)*	m	<i>Notodanthonia unarede</i>	m
<i>B. mollis</i> *	m	<i>Oplismenus undulatifolius</i>	m
<i>Cortaderia toetoe</i>	m	<i>Poa anceps</i>	a
<i>Dactylis glomerata</i> *	m	<i>Sporobolus capensis</i> *	m
<i>Deyeuxia billardieri</i>	a	<i>Trisetum</i> sp.	m

<i>Arthropodium cirrhatum</i>	a	<i>Urobanche minor*</i>	m
<i>Astelia banksii</i>	a	<i>Oxalis corniculata</i>	l
	a	<i>Parietaria debilis</i>	l
			m
<i>Brassica campestris*</i>	m	<i>Pelargonium inodorum</i>	l
<i>Centaureum erythraea (C. minus)*</i>	m	<i>Peperomia urvilleana</i>	l
<i>Cerastium sp.*</i>	m	<i>Phormium tenax</i>	a
<i>Cirsium vulgare (C. lanceolatum)*</i>	m	<i>Phytolacca octandra*</i>	m
<i>Collosspermum hastatum</i>	l	<i>Plantago lanceolata*</i>	m
<i>Conyza canadensis*</i>	m	<i>Polycarpon tetraphyllum*</i>	l
<i>Dianella intermedia</i>	m	<i>Pterostylis banksii</i>	m
<i>Dichondra repens</i>	m	<i>Ranunculus hirtus</i>	l
<i>Disphyma australe</i>	a	<i>Rhagodia triandra</i>	a
<i>Drosera auriculata</i>	l	<i>Salicornia australis</i>	a
<i>Geranium solanderi (?)</i>		<i>Samolus repens</i>	a
<i>(G. pilosum)</i>		<i>Senecio argutus</i>	m
<i>Gnaphalium collinum</i>	m	<i>S. hispidulus</i>	m
<i>G. luteo-album</i>	m	<i>S. laevis</i>	m
<i>G. purpureum*</i>	m	<i>Solanum nodiflorum*</i>	a
<i>Haloragis erecta</i>	m	<i>Sonchus oleraceus</i>	a
<i>Hydrocotyle elongata</i>	l	<i>Stellaria parviflora</i>	a
<i>Hypochoeris radicata*</i>	a	<i>Taraxacum officinale*</i>	a
<i>Lepidium sp.*</i>	l	<i>Tetragonia trigyna</i>	m
<i>Linum monogynum</i>	m	<i>Thelymitra longifolia</i>	a
<i>Lobelia anceps</i>	m	<i>Wahlenbergia gracilis</i>	m