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CONTENTS

VOL. 4, NO. 1.

A New Species of Microdictyon Decaisne in New Zealand.

By VIVIENNE DELLOW.

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Abstract.

A revision of the marine Chlorophyceae of New Zealand has involved a study of the plant which has previously been distributed as *Microdictyon umbilicatum* (Velley) Zanard. It soon became evident that the New Zealand species was not identical with *M. umbilicatum*, and was sufficiently different to merit the rank of a new species. A description of this species follows, together with a discussion of its affinities.

Microdictyon mutabile sp. nov. Figs. 1-4.

Thalo recenter carpto colore viridissimo, siccato atrovirescente forma pulvini vel rosulato; lato 2-7cm., alto 1-5cm.; marginibus frondium rosulatorum irregulariter lobatis; ramis distichis vel impariter dispositis, saepe ad peripherum in compluribus planis; flabellatis vel recte angulatis; venatione non conspicua; filamentis primis 3-5 eminentibus; ramis plerumque acuto angulo, ad peripherum frondis latescentibus; thallo adfixo angustis tenuibusque cellulis rhizoideis saepe elongatis; septis praesentibus vel absentibus; cellulis rhizoideis 300-400μ longis, simplicibus aut irregulariter bifurcis, ortis ab ima parte filamentorum principum aut deorsum ab articulo substrato paene recte linea adjacente; segmentis secundis anastomosis vel liberis; anastomose per anulos annularios in cacumine, non nunquam secundum muros adjacentes segmentorum; si quod textum, triquetrum plerumque, maxima latitudine 0.2-0.5mm.; segmentis primis 300-600μ longis, 100-160μ latis, a superiore parte paulo tumidis; cellulis plerisque ad marginem frondis decrescentibus; secundis segmentis coalescentibus 190-360μ longis, 50-90μ latis; minoribus diametro a termino ultimo segmenti; apicibus segmentorum obtusis; muris tenuibus; muris lateralibus 1.0-2.0μ crassis; muris terminalibus 3.0-6.5μ crassis; cellulis genitalibus insignibus projectibus conicis ad apicem cuiusque cellulae, unilatere dispositis.

Thallus bright green when fresh, dull blackish-green when dried, cushion-like or rosulate; 2-7cm. broad, 1-5cm. high; margins of rosulate fronds irregularly lobed; branching distichous to irregular, often in more than one plane at periphery, flabellate or rectangular; venation not conspicuous; 3-5 primary radiating filaments; angle of branching usually acute, becoming wider towards periphery of frond; attachment by narrow thin-walled, often elongated rhizoidal cells; septa present or lacking; rhizoidal cells 300-400μ long, simple or irregularly forked, growing either from base of main filaments or downwards from a joint lying more or less parallel and close to substratum; secondary segments anastomosing or free; anastomosis by annular rings at tips or occasionally along adjacent walls of segments; mesh when present usually triangular, 0.2-0.5mm. in longest diameter; primary segments 300-600μ long and 100-160μ broad, slightly swollen at upper ends; cells in general becoming smaller towards margin of frond; secondary anastomosing segments 190-360μ long, 50-90μ broad, smaller in diameter at distal end of segment; apices of terminal segments obtuse; walls thin; lateral walls 1.0-2.0μ thick, terminal walls 3.0-6.5μ thick; reproductive cells distinguished by conical projections near apex of each cell, unilaterally arranged.

Habitat: Locally abundant in dense or scattered clumps on *Corallina officinalis* (L) De Toni, between M.L.W.N. and M.L.W.S., flourishing on rocks of gentle slope in sheltered water, especially where there is a thin layer of silt or mud deposited on the coralline turf—a subordinate member of the *Corallina-Hormosira* association.

Type specimen No. 618 Herbarium U. V. Dellow (in Herbarium, Auckland Institute and Museum); No. 307, Fasc. XIII Herbarium V. W. Lindauer as *Microdictyon umbilicatum* (Velley) Zanard?

Distribution: Endemic. So far, *M. mutabile* has been recorded on the east coast of the North Island as far south as Mayor Island (37°20′ S. Latitude). On the west coast the only record is from Anawhata (almost due west of Auckland). Urupukapuka Island (Otehei Bay, Bay of Islands); No. 10962 Herb. Lindauer, S. A. Rose; Herb. Auck. Museum. Anawhata; S. A. Rose, Herb. V. J. Chapman. Taranga Island; L. M. Cranwell, Herb. Auck. Museum. Opo Bay, Mayor Island; R. P. Bell, Herb. Auck. Museum. Leigh; No. 618 Herb. U.V.D. Whangaparaoa Peninsula; No. 469 Herb. U.V.D. Long Bay, Hauraki Gulf; No. 658 Herb. U.V.D. Narrow Neck; No. 693 Herb. U.V.D.

In most localities where this species occurs, two distinct growth forms can be found: one markedly spongiose, forming a firm, compact cushion, the other displaying the more typical features of *Microdictyon*, with flat, expanded laminae aggregated into a rosulate thallus. Fewer anastomoses occur in the spongiose growth form. There is also less variation in the number of primary radiating filaments, three acute-angled branches usually being present at each joint. In addition, cells at the base of primary filaments are slightly larger than those at the base of reticulate fronds. The distinction between the two forms is by no means clearly defined, since plane reticulate fronds have been found growing out from the base of spongiose cushions. On the other hand, when reticulate fronds have been grown in culture for several months, the whole thallus has been found to develop into a lax series of filaments in which there is not a single anastomosis.

The plant has been named "mutabile" on account of its extreme plasticity both in culture and in its natural habitat.

AFFINITIES (a) *Generic*

Plants of the cushion-like growth form show a certain affinity to *Rhipidiphyllon* in their acute-angled, flabelliform branching, together with a relatively low percentage of segments anastomosing by annual rings, but they are separated unquestionably from this genus by their much greater size (*Rhipidiphyllon* is only 2-4mm. broad—Boergesen, 1924, p. 250), the occurrence of septa in the thin-walled rhizoidal cells, and also by the fact that branching occurs in more than one plane.

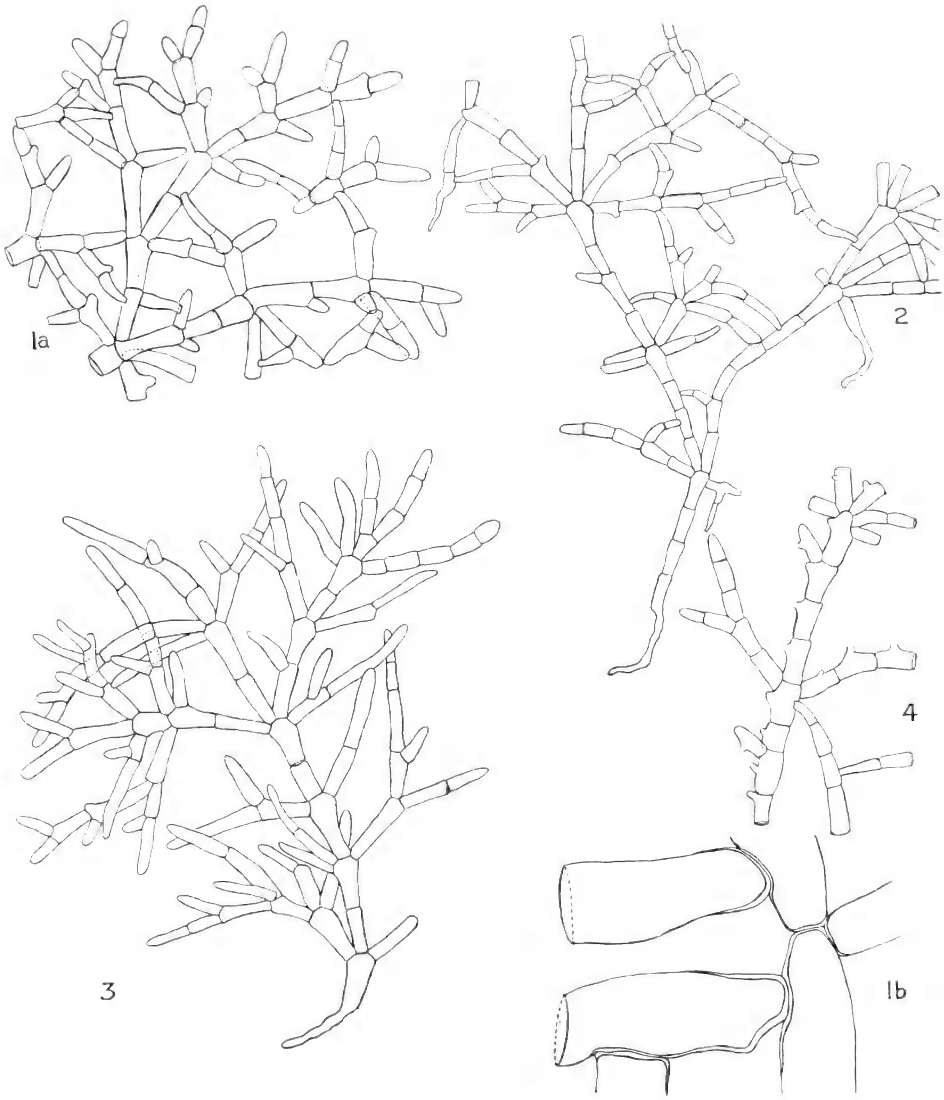

Fig. 1. (a) *Microdictyon mutabile*—portion of periphery of reticulate frond (type specimen). x 17.
(b) Two secondary anastomosing segments, showing annular form of attachment. x 130.

Fig. 2. *M. mutabile*—basal portion of type specimen. x 11.

Fig. 3. *M. mutabile*—young plant of cushion form, from material collected at Whangaparaoa Heads, Hauraki Gulf (No. 469, Herb. U.V.D.). Note absence of anastomoses and polystichous branching. x 17.

Fig. 4. *M. mutabile*—branch with small conical projections through which liberation of swarmers has taken place. x 17.

A likeness to *Boodlea* is seen in the spongiose habit and cell size. Apart from these two points of resemblance, *Boodlea* differs from *Microdictyon* in general in its lack of true distichous branching, and in its incurving ramuli; and from this species in particular in its tenaculoid anastomosing segments.

The occurrence of occasional adhesions of parallel segments along the longer axis of the cells (Fig. 2a) is reminiscent of *Anadyomene*.

(b) *Specific*

The importance of the nature of the structures of attachment in subdividing the different species of *Microdictyon* has been emphasized both by Reinbold (1913) and by Setchell (1929). Setchell groups the species primarily according to their mode of attachment, and secondarily according to the nature of ramification and resultant meshwork. *Microdictyon mutabile* fits most readily into the Calodictyon section of the genus, as defined by Setchell (1929, p. 502). Like other species in this section, it anastomoses by annual rings born on the tips of unmodified segments, it lacks regular venation, the branching is chiefly flabellate and acute-angled with meshes tending towards triangular, and there is a limited area of attachment.

Further evidence in favour of placing *M. mutabile* in this group is furnished by the known geographic distribution of the Section Calodictyon (Setchell, 1929, pp. 502, 580-584), which is represented by a greater number of species in the Pacific Ocean than in any other part of the world. Within the Calodictyon group the closest relationship of *M. mutabile* seems to be in the sub-group Atrovirescentes with *M. calodictyon* itself, which it resembles in cell size, in the nature of the reticulate frond, and in the lack of distinct venation. Characters which separate *M. mutabile* from *M. calodictyon* are the spongiose growth form, the branching in more than one plane with fewer anastomoses, the lack of a truly umbilicate base, and the presence of branched rhizoidal cells.

M. mutabile differs strikingly from other members of this group, and indeed from most of the known species of Microdictyon, in the spongiose form with its cushion-like habit and branching in several planes, together with the lack of a truly umbilicate base; but Setchell notes in connection with *M. montagnei* of the Boodleioides section (op. cit. p. 577), that specimens from the South Pacific "show a tendency to depart from the strict plane characteristic of the genus." This may be a homoplastic response to the set of environmental conditions peculiar to the above-mentioned geographical region, although it is just as likely to be an ecological response by the plants to exposure during low spring-tidal periods. The majority of hitherto described species appear to grow relatively deep down in the sublittoral region (Setchell, op. cit. pp. 471-473). It is of interest to note that the *Microdictyon spongiolum* of Berthold, which grows near the lowest level of the intertidal region at Naples and which shows polystichous branching, was held by Bitter (1900) to be identical with the true deep-water *Microdictyon* of that locality. He regards the change in habit and mode of branching to be due to the increase both in temperature and in light intensity.

M. mutabile differs from *M. umbilicatum* in possessing the following features: (a) a much smaller frond; (b) predominantly flabellate branching; (c) smaller primary segments, which are 3-4 times as long as broad; (d) smaller secondary segments; (e) thin, unstratified walls.

In the herbarium of the Auckland Institute and Museum there are a number of dried specimens assigned to *Microdictyon* which have been collected in different parts of the North Island of New Zealand. Microscopic examination shows that the majority belong without doubt to the *M. mutabile* assemblage. They include plants collected at Otehei Bay, Bay of Islands, by Miss S. A. Rose and Mr. V. W. Lindauer, and at Opo Bay, Mayor Island, by R. P. Bell. In some of the latter specimens, cells of the peripheral branches are shorter and broader in relation to their length than is customary for *M. mutabile*—100-140μ long and 100μ broad in many cases. The same holds for the minute (and probably incomplete) specimen found at Taranga Island by Miss L. M. Cranwell. This plant is notable for the abnormally great number of small, peripheral segments anastomosing both terminally and along lateral walls, the whole giving an appearance rather like *Anadyomene*. However, a portion of the reticulate material of the type specimen of *M. mutabile* when grown in culture for several weeks produced a similar close network with an abnormally high percentage of short anastomosing segments. It is probable, therefore, that Miss Cranwell's plant is an ecological variant of the typical reticulate frond with a more open mesh.

ACKNOWLEDGMENTS.

The writer is indebted to Miss R. F. de Berg, M.Sc., who originally started this work, for many valuable suggestions about its continuance. She would also like to thank the following: Mr. R. C. Cooper, for making available material in the Auckland War Memorial Museum; Mr. V. W. Lindauer, for the loan of specimens from his herbarium and for helpful criticism of the text; Professor V. J. Chapman, under whose guidance the work was carried out; and, lastly, Mr. K. J. Dellow, M.A., for patient assistance with the Latin translation.

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New Records of Miridae (Heteroptera) from New Zealand, with Descriptions of a New Genus and Four New Species.

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Abstract.

The Miridae of New Zealand are poorly known, only thirteen species having been recorded, of which three, or possibly four, are introduced. This paper adds six species, four of them new and two introduced. It is hoped to deal with other members of the family in later papers. The Miridae comprise one of the largest families of the Heteroptera, and it seems likely that many more species remain to be described, although, as is the case with most other families of this sub-order, the total will probably prove low in comparison with that in other regions of similar area.

The holotype and allotype of each new species and specimens of the introduced species have been deposited in the collections of the Auckland War Memorial Museum and paratypes in the Dominion Museum, Wellington.

In all proportionate measurements, 1 unit = 0.025 mm.

ACKNOWLEDGMENT.

The writer is greatly indebted to Dr. W. E. China, of the British Museum (Natural History), for the identification of the introduced species and for his other invaluable assistance, particularly in generic determinations, without which, work on this extensive and often difficult group would, in New Zealand, have been impossible or much more uncertain.

SUB-FAMILY MIRINAE.

Genus **CHINAMIRIS** gen. nov.

Body oval, dorsally with a covering of pale, deciduous pubescence. Head strongly declivous in front; eyes contiguous with and exserted beyond anterior margin of pronotum; vertex with complete transverse carina between eyes; antennae rather slender, with the first segment about as long as head and the second segment at least twice as long as first; rostrum reaching hind coxae. Pronotum shortly trapeziform, with prominent anterior collar; calli well developed; sides sinuate; base shallowly emarginate, exposing mesoscutum; disc without punctures but distinctly transversely rugose. Ostiolar peritreme large. Cuneus and membrane deflected, the latter mottled and with two cells. Posterior femora incrassated; tibiae with dark spines.

Genotype: *Chinamiris muehlenbeckiae* sp. nov.

Near *Poeciloscytus* Fieber, 1858, from which it can be distinguished by the form of the pronotum: disc not strongly convex and depressed in front, impunctate, transversely rugose, the rugae rather widely separated, not closely interconnected to approach a punctate condition; sides sinuate.

As a basis for future wider comparison, certain differences are noted between the male terminalia of *Chinamiris muehlenbeckiae* and of the type species of *Poeciloscytus, P. unifasciatus* (Fabricius, 1794), the only species of this genus at present available to me for study. The former is distinguished by the prominent, backwardly projecting lobe on the left margin of the terminal abdominal sternum. The left clasper is similar in size and general form in the two species (large, with the apical portion strongly curved forward and the extreme apex sharply pointed and down-bent), but in *C. muehlenbeckiae* does not have the middle portion twisted and flattened, nor is there a prominent subapical dilation.

Chinamiris muehlenbeckiae sp. nov., figs. 1, 2.

Length, 4.4 mm. Width across hemelytra, 2.0 mm. Rather broadly oval. Head, pronotum, scutellum, and hemelytra except for membrane clothed with a mixture of short, fine, recumbent, dark hairs and pale, deciduous, scale-like hairs; ventral surface with pale pubescence. Ostiolar peritreme large, pale.

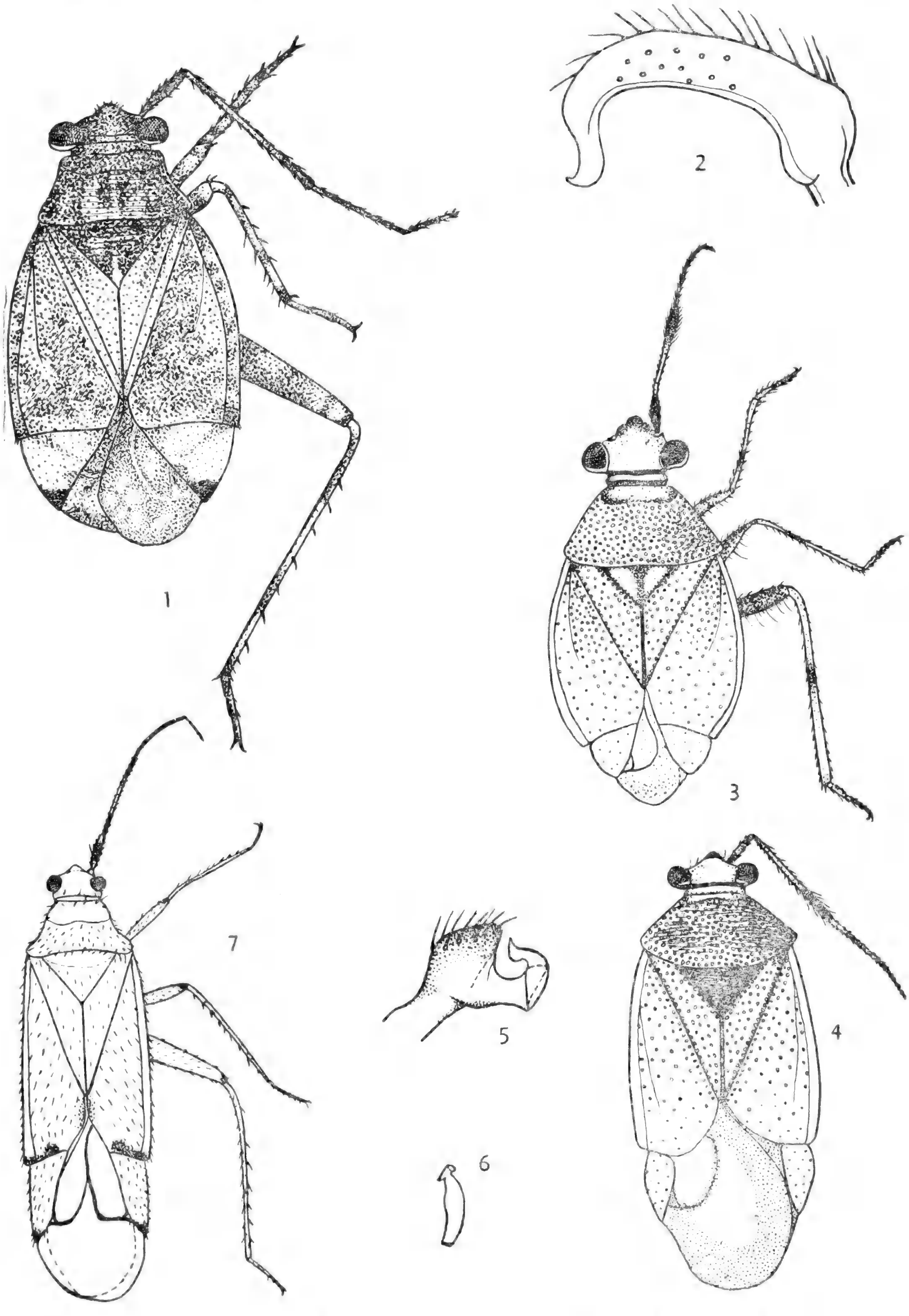
Colour: Dark brown, ground-colour testaceous heavily infuscated with black or brownish black mottlings. On vertex, pronotum, and scutellum a more or less defined narrow, median, pale testaceous line; mesial part of pronotal disc mostly testaceous, lateral regions mostly brownish black.

Head: Vertex behind nearly flat between eyes, with a prominent, rounded, posterior carina extending the whole width between the eyes. Head in front slightly convex, declivous, with the dark hairs suberect. Tylus strongly convex. Jugum pale at upper and lower margins, black in middle. Lorum with two pale spots near anterior margin. Bucculae pale except at base. Eyes large, brown or brownish black, narrowly margined with pale testaceous; touching pronotum and extending beyond its anterior angles; from above, each eye nearly $\frac{3}{4}$ as wide as interocular space (13.5: 19). Rostrum reaching hind coxae.

Antennae: Nearly as long as whole body (169: 176). First segment cylindrical, moderately thickened, fuscous, clothed with very short, fine, dark bristles, length twice width of an eye and almost equal to width of collar; other segments finely pubescent; second segment testaceous, infuscated for about apical third and usually also shortly near base, extreme base pale; third and fourth segments fuscous. Proportionate lengths of segments I-IV in male, 27: 68: 42: 32 (in female segment II is somewhat shorter (62).

Prothorax: Collar well defined, posteror margin convex; longest in middle, where it is nearly $\frac{1}{5}$ total length of pronotum (6: 31). Pronotum short; sides sinuate; calli well developed, confluent in middle;

disc behind calli only moderately convex, impunctate, transversely rugose; posterior angles rounded, dark; base very shallowly emarginate in middle, width $1\frac{1}{2}$ times width across anterior rounded angles behind collar, twice width of collar, twice total median length, and $\frac{1}{3}$ as wide



Figs. 1-2. *Chinamiris muehlenbeckiae* sp. nov. 1, ♂; 2, left clasper of ♂.

Figs. 3-6. *Deraeocoris maoricus* sp. nov. 3,♀; 4, ♂; 5, left clasper; 6, right clasper.

Fig. 7. *Engytatus nicotianae* (Koningsberger), ♀.

again as head across eyes (60 : 40 : 30 : 31 : 46). Xyphus and propleura pale-margined.

Scutellum: Convex, transversely rugose, anterior region completely or mottled with testaceous, posterior region darker except for pale median line and pale apex. Mesoscutum exposed.

Hemelytra: Mottled testaceous and fuscous Costal margin broadly convex, nearly straight in middle, incurving near base and apex. Clavus and membrane declivous. Clavus pale, almost colourless to light amber, with apical and inner angles black and basal margin more or less distinctly reddish; towards inner margin more or less invaded by darker mottlings. Outer margins of corium and cuneus in ratio 80 : 28. Membrane fuscous, large cell black, all with pale mottlings; veins pale.

Legs: Trochanters pale. Coxae and femora dark brown to black with pale mottlings. Tibiae with suberect dark spines; pale with four dark bands, the narrow, subbasal band often not clearly separated from the second in the hind tibiae; fourth band apical. Tarsi fuscous, black at apex.

Male Terminalia: From the left-hand postero-lateral margin of the terminal abdominal sternum there projects backwards above the base of the left clasper, but distinct from it, a prominent lobe, conical or nearly cylindrical in form and with the apex somewhat narrowed and bluntly rounded. The corresponding process on the right side is a very much smaller, inconspicuous, subtriangular lobe, marked off ventrally by a notch in the sternal margin. Left clasper large, wide at base; proximal $\frac{2}{3}$ stout, broadly curved, but not twisted or flattened; apical third narrowed and tapering, strongly curved forward, with extreme apex finely pointed. Right clasper small.

Localities: Holotype ♂, allotype ♀, paratypes: 2 ♂♂, 2 ♀♀, 17 other ♂♂ and 19 other ♀♀, collected at Foxton, Manawatu, North Island, 8/1/50; 2 ♂♂, 1 ♀ at Paiaka, Manawatu, 5/1/50; all by beating *Muehlenbeckia australis* Meissn., from which also a series of nymphs was obtained.

SUB-FAMILY DERAEOCORINAE

Genus DERAEOCORIS Kirschbaum.

Deraeocoris Kirschbaum, 1855, *Jahrb. Ver. naturk. Nassau*, 10. Distant, 1904, *Fauna Brit. India, Rhynch.*, 2, 466.

Capsus Fieber, 1858, *Wien. ent. Monat.*, 2, 307, not of Fabricius, 1803.

Macrocapsus Reuter, 1875, *Petites Nouv. ent.*, 1 (137), 547. 1879, *Ofvers. Finska Vetensk.-Soc. Forh.*, 21, 55.

Type: *Cimex olivaceus* Fabricius, 1776, = *Capsus medius Kirschbaum*, 1855, fixed by Distant.

Deraeocoris maoricus sp. nov., figs. 3-6.

Female: Broadly oval. Length, 3.2 mm. Width across hemelytra, 1.9 mm. Dorsal surface shining, strongly convex, almost entirely bare. Brownish black, with legs yellowish brown.

Head: Impunctate; markedly declivous in front. Width across eyes a little greater than length to apex of tylus (37: 33). Eyes brownish black. From above, each eye slightly less than $\frac{2}{3}$ as wide as interocular space (10: 17). Vertex ochreous between eyes; posterior transverse carina, tylus, juga, and lorum black. Tylus and juga with sparse, fine hairs; tylus strongly convex, juga short, convex. Bucculae not prominent. Rostrum reaching to hind coxae.

Antennae: $\frac{3}{4}$ as long as whole body (99: 130) and $\frac{2}{3}$ as long again as posterior width of pronotum (99: 60); clothed with fine, suberect hairs. First segment somewhat swollen, black; second segment ochreous in middle, black at each end, the dark apical portion notably dilated; third and fourth segments black, with base of third ochreous; proportionate lengths of segments I-IV, 16: 42: 27: 14.

Pronotum: Disc moderately and fairly evenly convex, ochreous, with brownish black infuscations and coarse black punctures; calli and anterior collar impunctate; calli prominent, confluent; collar pale ochreous, narrowly margined with black; sides nearly straight; base broadly convex, only very slightly sinuate; width at basal angles $2\frac{1}{2}$ times that across collar and rather less than twice length, including collar (60: 24: 34).

Scutellum: Only slightly convex and moderately raised, impunctate, with very fine transverse rugulae; ochreous, with apex and often more or less of median region dark, the dark area sometimes almost covering disc.

Hemelytra: Strongly convex, with cuneus and membrane strongly depressed; costal margins broadly convex; clavus with coarse, dark punctures; corium with rather finer punctures set more widely apart; cuneus very finely and sparsely punctate; clavus ochreous with margins narrowly or widely dark; corium blackish brown, often with more or less of costal and claval borders ochreous; cuneus brownish black; membrane small, infuscate towards apical border, length (from apex of clavus to apex of membrane): greatest width :: 46: 31; veins dark brown; length of costal margins of corium and cuneus, 66: 20.

Legs: Slender; yellowish brown, femora, apex of tarsi, and band near middle of tibiae darker; fore coxae ochreous, mid and hind coxae brownish black. Clothed with very short hairs; spines of tibiae inconspicuous, very fine and short; femora with a few very long and slender pale erect hairs on posterior margin.

Abdomen: Venter shining brownish black, impunctate, finely pubescent.

Male: There is a marked sexual dimorphism, the ♂ differing from the ♀ in the following respects:

Elongate oval, only moderately convex above. Length, 4 mm. Width, 1.7 mm.

Head: Width of head, interocular space, and eye in ratio 34.5: 16.5: 9.

Antennae: $\frac{2}{3}$ as long as body (105: 160) and $\frac{3}{4}$ as long again as posterior width of pronotum (105: 59). First segment ochreous in middle, black at base and apex, with ochreous region almost obscured in dark specimens. Second segment longer than in ♀ and with basal black region shorter; slightly thickened towards apex, more gradually so than in ♀. Length of segments I-IV, 16: 46: 27: 16.

Pronotum: Colour as in ♀, except that disc and calli are often largely black; convexity between basal angles and declivity behind it usually more pronounced than in ♀; posterior width, width of collar, length, in ratio 59: 22: 36.

Scutellum: Entirely brownish black or black in all specimens seen; rugulae more pronounced than in ♀.

Hemelytra: Only moderately convex, with cuneus and membrane scarcely depressed; extending well beyond apex of abdomen; clavus black; corium and cuneus more or less uniformly dark brown; incision at claval suture more obvious than in ♀; costal margins only weakly and gradually convex; corium and cuneus much longer than in ♀, their costal margins in ratio 80: 30; membrane large, length (measured as in ♀) to greatest width, 50: 80, apical infuscation altogether more pronounced than in ♀, being both darker and much broader, extending as a wide brown band around entire margin except for a narrow pale strip next to apex of cuneus, and leaving a large central area and the main cell clear; veins brown, margined by an infuscated zone of membrane.

Legs: Femora lighter than in ♀, often with a reddish brown tinge.

Genitalia: Left clasper with basal lobe black, conical; apical process rather long and slender, curving first upwards and to right and then forwards and to left, apex finely pointed. Right clasper very small.

Close to *D. biròi* Poppius, 1915 (from New Guinea), but differing in the impunctate scutellum, the colour of the antennae, the longer hemelytra of the ♂, with the large, clear central area of the membrane.

Localities: Holotype ♀, allotype ♂, Botanical Reserve, Nelson, 11/12/49. Paratypes: Auckland, 22/5/49 (♂), 13/3/49 (♀). Others: Nelson, 10-11/12/49 (9 ♂♂, 1 ♀); Auckland, 22/12/38 (4 ♀♀), 25/10/44 (1 ♀), 13/3/49 (3 ♀♀), 18/3/50 (1 ♀); Paihia, Bay of Islands, North Auckland, 10/2/49 (2 ♀♀).

SUB-FAMILY MACROLOPHINAE (DICYPHINAE).

Genus ENGYTATUS Reuter.

Engytatus Reuter, 1876, *Ofvers. Kongl. Vetensk.-Akad. Forh.*, 32 (9), 82. 1910, *Act. Soc. Sci. Fenn.*, 37 (1), 151. *Cyrtopeltis* Fieber, Reuter, 1909, *ibid.*, 36 (2), 62.

Type: *E. geniculatus* Reuter, 1876.

Engytatus nicotianae (Koningsberger), fig. 7.

Leptoterna nicotianae Koningsberger, 1903, *Mededeel's Lands Plantent.*, 64, 32, pl. 4, fig. 8. *Cyrtopeltis* (?) *nicotianae* Kirkaldy, 1908, *Proc. Linn. Soc. N.S. Wales*, 33, 377 (as new species). ?*Dicyphus tabaci* Froggatt, 1920, *Agri. Gaz. N.S. Wales*, 31, 715-716 (possible synonym; description very brief). *Dicyphus nicotianae* (Konings.) Fulmek, 1925, *Deli Proefstat., Bull.* 25, 2, not of Horvath, 1922. *Engytatus tenuis Reuter*, China, 1938 *(partim)*. *Ann. Mag. nat. Hist.* (11) 1, 604-607. *Engytatus nicotianae* (Konings.) Usinger, 1946, *B. P. Bishop Mus., Bull.* 189, 72-74, fig. 17.

This species, described from Java, has a wide distribution—the Malay Archipelago, Australia, the Pacific (Guam, New Caledonia, Fiji). Its presence in New Zealand is of interest as a potential pest of tobacco, apparently a preferred host, and perhaps of other solanaceous species. Owing to the mainly tropical distribution of this Mirid, there is the possibility that heavier infestations may be looked for on plants growing under glass.

Dr. W. E. China states *(in litt.)* that this species is probably generically distinct from the genotype *E. geniculatus* Reuter.

The following redescription was made from New Zealand specimens:—

Male: Elongate oblong. Length, 3.7-4.0 mm. Width, 1.1 mm. It appears that there may be local variations in size. Usinger (1946) writes: "The length is given as 4 mm. in the original description, whereas my series is uniformly about 3.5 mm." Clothed dorsally with short, fine, dark hairs. Head, pronotum, and scutellum yellow, often with more or less of a greenish tinge.

Head: Small, subglobular, usually with a more or less well defined median dark line; frons and tylus strongly convex, the latter black at apex; eyes small, brownish black, not reaching pronotum, each $\frac{2}{3}$ as wide as interocular space (6: 9); rostrum reaching posterior end of middle coxae.

Antennae: Finely pubescent; about $\frac{3}{4}$ as long as body (124: 160); first segment only slightly thickened, black in middle, pale at base and apex; second segment pale in middle, black at base and apex; third and fourth brown, with extreme base of third paler; proportionate lengths of segments I-IV, 15: 44: 45: 20.

Pronotum: Anterior collar sharply constricted, nearly 1-7 total median length of pronotum (3: 22); calli pronounced, convex, with disc shallowly grooved behind them; anterior margin nearly straight; sides only slightly sinuate; posterior angles broadly rounded; base deeply and widely emarginate, largely exposing mesoscutum, just over twice as wide as across collar (36: 17) and about $\frac{2}{3}$ as wide again as median length (36: 22); disc shining, remotely and very finely and shallowly punctate.

Scutellum: Disc moderately raised, smooth, with fine hairs; apex acute, black; base to length in proportion 17: 15.

Hemelytra: Extending well beyond abdomen; costal margins of corium straight, nearly parallel, almost three times length of cuneus (75: 26); corium and clavus pale, translucent, straw-yellow; apex of corium dark-margined and with a dark spot before cuneal fracture and a smaller, less well defined dark spot just beyond apex of clavus; claval suture narrowly dark; cuneus translucent, almost colourless except for dark apex; membrane finely rugulose, colourless except for the very narrowly infuscate margins and the veins, which are dark except towards base; outer cell very small, inner cell oblong.

Legs: Slender, pale stramineous; finely pubescent, tibiae with fine, dark spines and with a small dorsal dark spot at extreme base; tarsi brown, dark at apex.

Ventral surface: Coxae and ventral thorax shining yellow or yellowish green; abdomen green or yellow to grey, with fine, pale pubescence.

Terminalia: The left clasper and the terminal abdominal segment of the ♂ are peculiar and highly distinctive in form. The left clasper comprises a stout, curved ventral lobe from the inner margin of which, near the middle projects upwards a long, flattened, blade-like chitinous arm. The apex of the terminal abdominal segment forms a bilobed, upturned process, the apical arm of which is short and blunt and lies to the right of the ventral lobe of the left clasper, while the other arm is considerably longer, broad basally and apically curved to the left as a slender process behind the blade of the clasper and above the broad lobes of the clasper and abdomen. These structures are figured by Fulmek (1925) and Usinger (1946) (see above).

Female: Resembles ♂ except in the following respects: Head and interocular space slightly wider; eye: interocular space :: 6.25: 10. Antennae, especially second and third segments, considerably shorter (13: 31: 33: 19), and only about $\frac{3}{5}$ as long as body (96: 160). Pronotum slightly wider; width of base: width of collar: median length :: 39: 18: 22. Costal margins of corium and cuneus, 80: 26.

Localities: Paihia, Bay of Islands, N. Auckland, 20-25/3/49, 5 ♂♂, 2 ♀♀, (Dr. R. A. Cumber). Auckland, 3/49, 1 ♂, 1 ♀ (T.E.W.). Remuera, Auckland, in light trap, 25-28/1/50, 4 ♀♀, 2 ♂♂ (Mr. E. T. Giles). Determined by Dr. W. E. China.

SUB-FAMILY CYLLECORINAE (ORTHOTYLINAE).

Genus **CYRTORHINUS** Fieber.

Cyrtorhinus Fieber, 1858, *Wien. ent. Monatschr.*, 2, 313. *Tytthus* Fieber, 1864, *ibid.*, 8, 82. *Sphyracephalus (partim)* Douglas and Scott, 1865, *Brit. Hem.*, 1, 349. *Cyrtorhinus* Reuter, 1884, *Act. Soc. Sci. Fenn.* 13, 379 (emendation). *Periscopus* Breddin, 1896, *Deutsch. ent. Zeit.*, 1896, 106 (not of Fitzinger, 1843). *Breddiniessa* Kirkaldy, 1903, *Wien. ent. Zeit.*, 22, 13 (*n.n. pro Periscopus* Breddin).

Type: *Capsus elegantulus* Meyer-Dür, 1843 = *Capsus caricis* Fallen, 1807.

Cyrtorhinus cumberi sp. nov., figs. 8, 9.

Both brachypterous and macropterous forms occur. Four ♂♂ were collected and all were macropterous. Of eleven ♀♀, ten were brachypterous and only one was macropterous, and even in this specimen the hemelytra, and particularly the membrane, were considerably shorter than in the ♂♂. It is possible that wider collection will reveal a small proportion of brachypterous ♂♂.

Named after Dr. R. A. Cumber, of the Entomological Research Station, D.S.I.R., Nelson, to whose hospitality and assistance is due the collection of this and other interesting species of Hemiptera.

Macropterous Male: Elongate, oblong. Length, 3.7 mm. Width, 1 mm. Clothed with very short, fine, pale, recumbent hairs.

Colour: Face, tylus, juga, lorae, genae, antennal bases, and anterior $\frac{3}{5}$ of pronotum, including collar, black; eyes reddish or blackish brown; vertex yellow-brown, sometimes tinged with greenish or reddish, posteriorly with a more or less well defined brick-red band, sometimes extending on to eyes, extreme posterior border black. First segment of antennae blackish brown, extreme apex pale; other segments black. Scutellum and posterior $\frac{2}{5}$ of pronotum yellow, the former sometimes more or less tinged with green, and the latter with orange. Legs yellowish brown, femora sometimes tinged with green, apex of tarsi dark. Hemelytra green; membrane transparent, iridescent, lightly infuscated with brown or grey, especially near margins; veins yellow or light brown, narrowly margined with darker brown. Abdomen yellow or green.

Head: Shining, smooth except for microsculpture of minute punctures and reticulations; face declivous and subvertical in front of eyes; the black anterior region narrowing behind and ending in an acute apex between eyes, the brown posterior region extending forward around inner margin of each eye. Eyes nearly touching and extending beyond anterior margin of pronotum; from above, each eye $\frac{2}{5}$ as wide as interocular space (8.5: 14). Tylus strongly convex; juga short, nearly flat; bucculae black, margins pale, fringed with a row of long, fine hairs. Rostrum yellowish brown, black-tipped, reaching to middle coxae.

Antennae: Slightly longer than body (160: 150); clothed with fine pubescence. First segment rather stout, slightly curved, with two long hairs on apical half of inner margin, slightly longer than pronotum (21: 20); second more slender than first, cylindrical; third and fourth more slender than second. Proportionate lengths of segments I-IV, 21: 61: 53: 25.

Pronotum: Shining; considerably widened posteriorly; with an extremely short anterior collar; sides sinuate just behind middle; base widely emarginate, largely exposing mesoscutum; anterior angles rather broadly rounded; posterior shoulders more angularly rounded, scarcely raised; anterior black region in form of large, convex callus, with surface minutely punctate-rugulose and with five shallow depressions, two on each side of mid-line and one median and posterior; posterior pale region shallowly, remotely punctate and finely rugose; across posterior angles slightly wider than head, twice as wide as collar, and $\frac{3}{4}$ as wide again as long (35: 31: 17: 20).

Scutellum: Nearly flat; disc transversely rugulose, most strongly so near base behind mesoscutum; the latter glabrous except for a single row of sparse, short, fine hairs a short distance before posterior margin; scutellar triangle, including mesoscutum, about $\frac{4}{5}$ as long as wide at base (21: 25).

Hemelytra: Well surpassing abdomen; costal margin nearly straight, slightly and gradually convex in anterior third, scarcely incised at cuneal fracture; costa and subcosta nearly parallel throughout; corium and clavus convex, shining, shallowly punctate-rugulose; claval suture deeply depressed; length of costal margins of corium and cuneus, 65 : 25; membrane well developed, extending far beyond apex of cuneus, length (from apical margin to apex of clavus) about twice greatest width (63 : 30).

Hind Wings: Well developed, passing abdomen and nearly as long as hemelytra.

Legs: Slender, with fine brown pubescence; tibiae with sparse, fine, brown spines. Usinger (1939, *Proc. Hawaii. ent. Soc.*, 10 (2), 272) points out that the genus *Cyrtorhinus* is anomalous among Mirids in the variable nature of the pretarsal processes; while some species have fully developed arolia, in others these structures are replaced by a pair of fine, parallel setae. *C. cumberi* resembles such species as *fulvus* Knight and *lividipennis* Reuter in having the large, membranous, convergent arolia characteristic of most members of the sub-family.

Terminalia: Left clasper with ochreous ventral lobe stout, curved, convex below, concave above, the rounded and somewhat narrowed apex upturned; the brown, sclerotised dorsal process coming off from dorsal surface of ventral lobe towards base, curved upwards and to right, slender, sinuous, very long, with fine apex. Venter of terminal abdominal segment produced as a broadly rounded lobe to right of left clasper. The two closely apposed genital valves projecting backwards and upwards from end of abdomen above base of left clasper. Right clasper: outer process a large, ochreous, knob-like, backwardly projecting pyriform lobe, beset with very long hairs; inner process a shorter, broad, laterally flattened, backwardly directed plate, ochreous with apical margin brownish black.

Brachypterous Female: Elongate oval. Length, 3.4-4.1 mm. Width, 1.3 mm. (The length is affected by the state of distension of the exposed abdomen.)

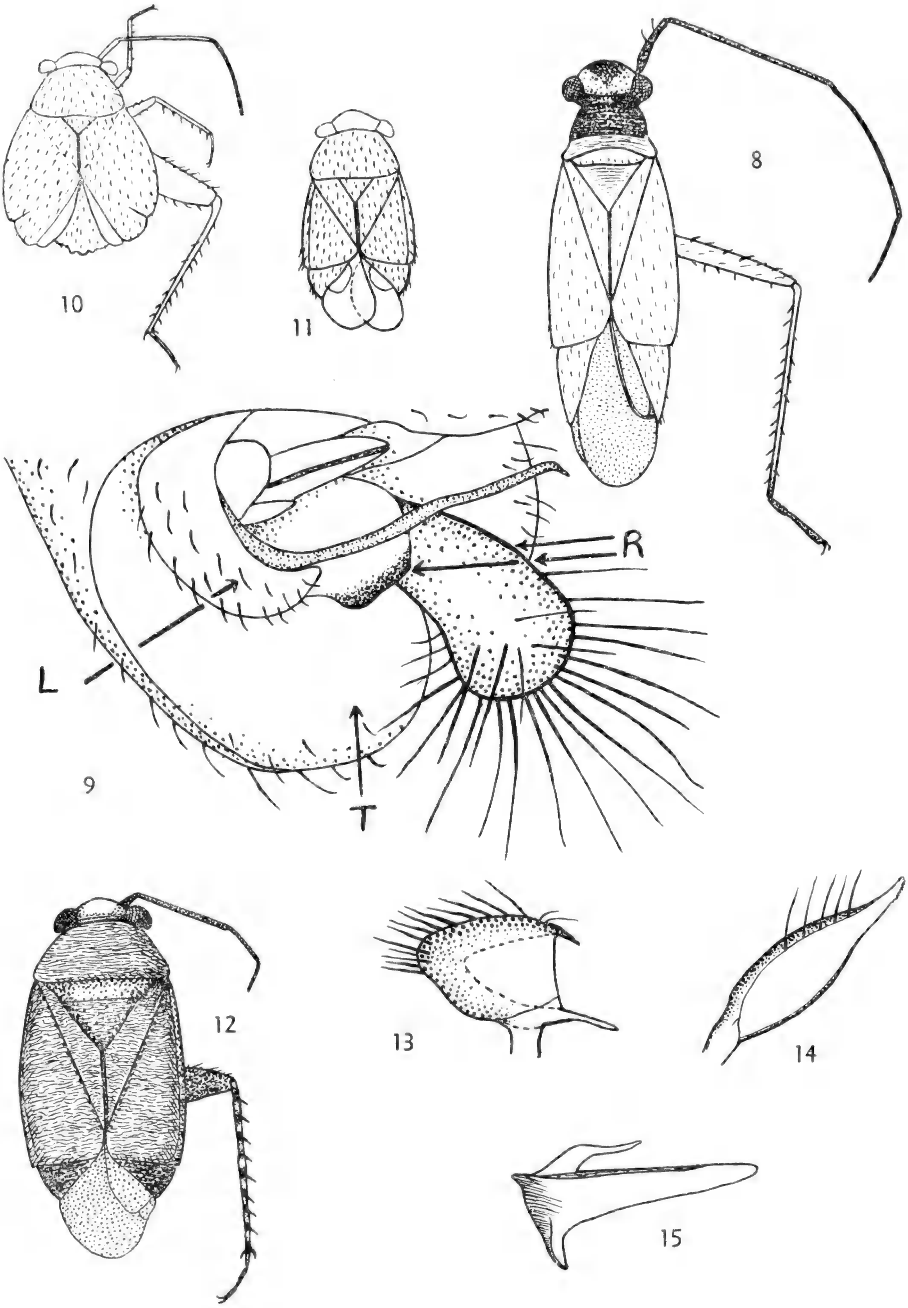
Colour: As for ♂, except that first antennal segment is reddish brown with pale apex and second segment often reddish brown in middle, with base shortly and apex longly black.

Head: Interocular space rather wider than in ♂ (eye : interocular space :: 8.5 : 16).

Antennae: $\frac{7}{8}$ as long as in ♂ (140 : 160) and usually shorter than body; segments I-IV, 20 : 55 : 43 : 22.

Hemelytra: Short, leaving the last two or three complete tergites exposed; costal margin more convex than in ♂; corium above less convex than in ♂, clavus nearly flat; cuneus very short, only $\frac{1}{5}$ as long as corium (13 : 65); membrane very small, not or occasionally barely extending beyond apex of cuneus, length (from apex of clavus to apex of cuneus) about three times greatest width (30 : 9 or 39 : 13).

Hind Wings: In form of short, rounded triangles, reaching usually less than half way along abdomen.



Figs. 8-9. *Cyrtorhinus cumberi* sp. nov. 8, macropterous ♂ ; 9, ♂ terminalia, left posterior aspect: L, left clasper; R, right clasper; T, terminal lobe of abdomen.

Figs. 10-11. *Halticus tibialis* Reuter. 10, ♀; 11, ♂.

Figs. 12-15. *Sthenarus myersi* sp. nov. 12, ♂ ; 13, left clasper; 14, right clasper, ventro-lateral aspect; 15, theca.

Macropterous Female: Length, 3.6 mm. Width, 1.3 mm. (In this form also, length will no doubt vary with state of distension of abdomen.) Head and colour of antennae as in brachypterous ♀.

Antennae: Much shorter than in ♂ and about as long as body. Segments I-IV, 20: 58: 43: 25.

Hemelytra: Reaching but not entirely covering last complete tergite. As in brachypterous ♀ except that cuneus is intermediate in length between that of macropterous ♂ and of brachypterous ♀ (corium: cuneus:: 70: 19), and membrane is larger, extending well beyond apex of cuneus (length (apical margin to apex of clavus): greatest width :: 52: 23).

Hind Wings: Longer than in brachypterous ♀, but considerably shorter than hemelytra and ending at third complete tergite from end of abdomen.

Locality: Holotype ♂, allotype ♀, 2 paratype ♂♂, 2 paratype ♀♀, 8 other ♀♀, 1 other ♂, and 9 nymphs, below and in tufts of rushes and grasses, Paiaka, Manawatu, 4/1/50.

Several species of *Cyrtorhinus* have been shown to be exclusively predacious on the eggs of leaf-hoppers, particularly Delphacids, inserted by the ♀♀ into the tissues of leaves and stems (*vide* Usinger, 1939, *op. cit.*, 271-273). *C. mundulus* (Breddin) has been used successfully to control the sugar-cane leaf-hopper *Perkinsiella saccharicida* Kirkaldy. Careful observations on the feeding habits of the New Zealand species would be of considerable interest. Delphacids occurred abundantly with it at the bases of the tufts of grass and rushes.

Genus **HALTICUS** Hahn.

Halticus Hahn, 1832, *Wanzenart. Ins.*, 1 (3), 113, pl. 18. *Astemma* Latreille, 1829, *in* Cuvier, *Règne Anim.*, ed. 2, 5, 199, not of Lepeletier et Serville, 1825. *Eurycephala Laporte*, 1832, *Mag. de Zool.*, 2, Suppl., 36. *Halticocoris* Douglas and Scott, 1865, *Brit. Hemipt.*, 1, 478.

China (1943, *The Generic Names of British Insects*, pt. 8, p. 268) points out that if the date of publication of *Eurycephala* Laporte can be proved to have been before November, 1832, this genus will replace *Halticus* Hahn.

Type: *Acanthia pallicornis* Fabricius, 1794 = *Cicada aptera* Linnaeus, 1764.

Halticus tibialis Reuter, figs. 10, 11.

Halticus tibialis Reuter, 1891, *Revue d'Entomologie*, 10, 135-136.

This small bug was described from Java and has since been widely recorded from tropical Africa and Asia (including Ceylon, the Carolines, Amboina and Macassar). Usinger (1946, *op. cit.* p. 86) quotes Esaki as recording it as injurious to beans in the Carolines.

The following redescription, based on New Zealand specimens, is given as an aid to identification.

Macropterous Male: Oval. Length, 2 mm. Width across hemelytra, 1 mm.

Colour: Shining black; eyes brown; vertex with a narrow pale yellow line along inner margin of eye; antennae pale yellowish brown, with apex of second segment and third and fourth segments except at base fuscous. Legs pale yellow-brown, with claws, apex of tarsi, and all except apical quarter of the swollen hind femora black; basal half of hind tibiae more or less infuscated. Membrane of hemelytra fuscous. A certain amount of colour variation can apparently be expected. Reuter (1891) describes the rostrum except for the last segment and the apex of the femora widely as pale yellow, and Usinger (1946) describes all the femora as black except at the apex.

Head: Highly polished, nearly glabrous, minutely rugulose-punctate; downwardly flexed, so that little of its length is visible from dorsal aspect; almost as long to apex of tylus as wide across eyes (25: 26); carinate posterior margin slightly overlapping front of pronotum; width across eyes: posterior width of pronotum :: 26: 30. Eyes prominent, with greatest length set vertically; contiguous to pronotum and extending beyond its anterior angles; from above, each eye just over $\frac{1}{3}$ as wide as interocular space (5.5: 15). Tylus convex. Rostrum stout, reddish brown, reaching or just surpassing posterior margin of hind coxae.

Antennae: Slender, three times as long as posterior width of pronotum; first segment somewhat swollen, not reaching apex of head, with two long, erect hairs in apical third; other segments slender, cylindrical, clothed with short, stiff hairs; second segment slightly longer than costal margin of corium (35: 33); proportionate lengths of segments I-III, 9: 35: 25.

Pronotum: Short, trapeziform, weakly convex, shortly and gently declivous towards base; disc minutely and shallowly punctured, obscurely transversely rugulose; sides straight; posterior angles broadly rounded; base only slightly emarginate; about $\frac{2}{3}$ as wide across anterior angles as across posterior (22: 30); posterior width twice median length.

Pronotum and hemelytra except membrane with rather sparse, golden, deciduous pubescence.

Scutellum: Small, scarcely raised, obscurely transversely rugulose, minutely and sparsely punctate; rather less than twice as wide at base as long (12: 7).

Hemelytra: Corium and clavus convex; claval suture deep; costal margin moderately convex, deeply incised at base and apex of cuneus; membrane well developed, extending well beyond abdomen, with cell complete, veins wide, narrowly dark-margined; cuneus and membrane strongly deflexed; costal margin of cuneus slightly more than $\frac{1}{3}$ that of corium (12: 33).

Legs: Clothed with fine, short hairs; hind tibiae with dark, erect spines.

The short- and long-winged forms in this genus differ strikingly. In general appearance the brachypterous forms superficially resemble the small "flea-beetles" (Halticidae).

Brachypterous Female: Shortly oval; dorsal surface broadly convex. Length, 1.75 mm. Width, 1.25 mm. Width across eyes: posterior width of pronotum :: 29: 32. From above, eye well over $\frac{1}{3}$ as wide as interocular space (6.5: 16). Antennae less than three times as long as posterior width of pronotum; second segment shorter than in ♂, barely $\frac{3}{4}$ length of costal margin of corium (29: 40). Width across anterior angles of pronotum just over $\frac{2}{3}$ that across posterior angles

(23: 32). Pronotum not declivous along base. Hemelytra broadly and evenly convex; clavus very small, claval suture inconspicuous, not depressed; costal margin of corium strongly and widely convex; cuneus and membrane not deflexed; margin of cuneus marked off anteriorly by angular incision but posteriorly by a gradual convexity; costal margin of cuneus only $\frac{1}{4}$ that of corium (10: 40); membrane very small, fuscous, without cells, projecting only shortly beyond cuneus and not passing end of abdomen.

Localities: 1 macropterous ♂, 1 brachypterous ♀, Russell, Bay of Islands, N. Auckland, 14/2/49. 1 macropterous ♂, Paihia, Bay of Islands, 13/2/49. Determined by Dr. W. E. China.

SUB-FAMILY PLAGIOGNATHINAE (PHYLINAE).

Genus **Sthenarus** Fieber.

Sthenarus Fieber, 1858, *Wien. ent. Monatschr.*, 2, 321. Kirkaldy, 1906, *Trans. Amer. ent. Soc.*, 32, 123. *Phoenicocoris* Reuter, 1875, *Bih. svenska Vetens-Akad. Forh.*, 3 (1), 55.

Type: *Capsus rottermundi* Scholtz, 1846, fixed by Kirkaldy.

Sthenarus myersi sp. nov., figs. 12-15.

Male: Oblong oval. Length, 3 mm. Width, 1.3 mm. Dorsal surface and thorax at sides clothed with fine, pale, deciduous hairs, easily rubbed off. Ventral surface finely pubescent.

Colour: Black. Eyes black or reddish black. Rostrum except at apex, clavus at extreme apex, trochanters, femora at extreme apex, ventral margin of fore and mid femora, tibiae, second segment of tarsus, and claws ochreous; tibiae with extreme apex black, and banded with conspicuous black spots.

Head: Strongly declivous; face subvertical. Vertex nearly flat, shining, with microsculpture of minute, close punctures. Juga short, flat; tylus scarcely raised above them. A complete, rounded posterior carina between eyes, with a single very fine hair on each side a short distance from eye. Eyes touching and extending beyond sides of anterior margin of pronotum; from above, each just over half as wide as interocular space (8: 15). In front view, head $\frac{2}{3}$ as long (to apex of tylus) as wide across eyes (21: 31). Rostrum reaching to hind coxae.

Antennae: Black, very short, first segment appearing extremely short from above, owing to flexion of head. Clothed with dark pubescence; two bristles set close together at $\frac{1}{3}$ from apex. Relative length of segments I and II, 9: 36.

Pronotum: Short trapeziform; sides straight; anterior margin nearly straight, very slightly convex, with an extremely short, unsculptured anterior rim, set slightly below surface of disc; posterior margin nearly straight; anterior and posterior angles rounded. Disc only moderately convex, transversely rugulose and with microsculpture of minute punctures. Length about equal to width across anterior angles and $\frac{1}{2}$ width at base (24: 49).

Scutellum: Nearly flat. Sculpture as for pronotum; the exposed mesoscutum with micropunctures only. Basal width to length: scutellum only, 23:19; with mesoscutum, 30: 23.

Hemelytra: Punctate-rugulose. Well surpassing abdomen; cuneus and membrane deflexed. Costal margin of corium slightly convex, three times as long as that of cuneus (60: 20) and equal in length to posterior tibiae. Membrane black, a small pale ochreous spot at anterior end of vein and another at its posterior margin.

Legs: Hind femora very broad, somewhat flattened and curved; tibiae with fine ochreous setae arising from the black spots.

Genitalia: The ♂ claspers in the Plagiognathinae are very small, but a preliminary study of five genera indicates that they may be used, when necessary, as good taxonomic characters, showing both generic and specific distinctions. In *S. myersi* the left clasper is short, black, and subconical, with the outer surface convex and the inner concave; its lateral spines unequal, one short, thorn-like, the other much longer, only slightly curved, with the apical half much narrowed. Right clasper glume-like; basal $\frac{2}{3}$ wide, concavo-convex, distal $\frac{1}{3}$ narrowed and prolonged as an awn-like process. Theca with a slender acessory spine, bent basally and thereafter nearly straight and parallel with main spine, reaching about $\frac{1}{2}$ way to its apex. (In this subfamily the theca (aedeagal sheath) is a prominent, dark, spine-like process with the outer margin at its base attached to the abdomen just in front of, but separate from, the right clasper, and is directed backwards and to the left. It is hollowed or grooved along its inner side to ensheath the aedeagus, and fits against the concave surface of the left clasper, the two spines of which embrace it. Both claspers with conspicuous basal peg inserted into abdomen.)

Female: Similar to ♂, except in the following particulars. Length, 3.1 mm. Rather broader across hemelytra (1.5 mm).

Colour: Rather lighter above; dark brownish black. Base and posterior angles of pronotum narrowly margined with ochreous. Antennae with basal $\frac{2}{3}$ of second segment and extreme apex of fourth ochreous. Clavus tinged with reddish brown. Membrane fuscous, usually with veins paler and with pale spot behind cuneus.

Antennae: Second segment slightly shorter than in ♂. Segments I-IV, 9: 33: 14.5: 11.75.

Localities: 2 ♂♂, 2 ♀♀, Foxton, Manawatu, 8/1/50, beating *Muehlenbeckia australis.* 1 ♂, 1 ♀, Te Paki, North Auckland, 21/1/50, *Leptospermum.* 6 ♀♀, Ngakengo Bay, North Auckland, 27/1/50, *Leptospermum.*

The specimens from the far North are consistently smaller than those from the Manawatu, described above, and the ♀♀ are lighter in colour, with a distinctly reddish brown tinge, especially on head, pronotum, scutellum, cuneus, and anterior parts of corium and clavus (the pronotum and clavus of one only are black). Length: ♂, 2.5 mm.: ♀, 2.6mm.-2.7 mm. Width: ♂, 1.3 mm.; ♀, 1.4 mm. Other dimensions in proportion, e.g., in ♂, width of eye: interocular space :: 7.5:14; head, length: width :: 19: 29; length of corium: cuneus :: 54: 18; pronotum, length: width at base, :: 21: 43 (in ♀, 21.5: 44). All structural features, including the ♂ genitalia, are similar, and it is not proposed, on the basis of the present material, to suggest subspecific categories.

This species is named after the late Mr. J. G. Myers, who added a great deal to our knowledge of the New Zealand Hemiptera.

A New Species of Cermatulus Dallas from the Three Kings Islands, New Zealand (Heteroptera: Pentatomidae).

By T. E. WOODWARD, Department of Zoology,

Auckland University College.

The specimens on which this species is based were collected by Mr. E. G. Turbott, of the Auckland Museum, from *Leptospermum ericoides* shrubland on Great Island, Three Kings (Turbott, 1948, p. 261), and put aside as differing in appearance from *Cermatulus nasalis* (Westwood).

I wish to thank Mr. Turbott for drawing my attention to this interesting material, and Dr. Archey, Director of the Auckland Museum, for the opportunity of examining and describing it.

SUB-FAMILY ASOPINAE.

Genus **CERMATULUS** Dallas.

1851.—Dallas, *List Specimens Hemipt. Ins. Coll. Brit. Mus.* 1, p. 106.
Type: *Aelia nasalis* Westwood, 1837.

Cermatulus turbotti sp. nov. Fig. 1.

Length of the 3 ♀♀ seen: 11.5 mm., 13.5 mm., about 15 mm. (wings spread in this specimen). Total length about twice basal width of pronotum, which is rather less than greatest width across abdomen (5.75 : 6; 6.5 : 7; 7 : 8). Moderately convex above and strongly punctate, punctures finer than in *C. nasalis,* particularly on pronotum; connexivum closely, very finely punctate; finely punctate below, venter of abdomen strongly convex, with punctures sparser and shallower at extreme margins, apex, and particularly in middle. Surface of body rather shining.

Colour: Dark above, with ground-colour of ochreous, punctured and infuscated with black; with more or less distinct bronzy or greenish reflections, either restricted to head or extending also over pronotum and scutellum as a conspicuous metallic sheen. Dorsal surface of abdomen black with bronze or coppery reflections. Ventral surface of abdomen light ochreous; punctures blackish brown; a black patch on either side of mid-line at anterior margin of each sternite, the patches on last complete sternite longer and more irregular than others; anterior and posterior ventral marginal angles of each sternite black.

Head: Nearly flat above, more finely punctate than pronotum. Juga with outer margins straight and parallel in the middle, posteriorly arcuately diverging to meet eyes; anterior angles widely rounded, though less broad than in *nasalis,* with more of the curve lateral and less directly anterior than in this species. Tylus with sides nearly straight and parallel, converging only slightly in front; apical margin free, distinctly convex, in all three specimens projecting slightly beyond juga. Whole snout much less blunt at end than in *nasalis.* Tylus much more sparsely punctate than in *nasalis,* punctures entirely or almost entirely restricted to margins; distinctly transversely rugulose in front and behind. Juga punctate and distinctly rugose.

Tylus black-margined, yellowish ochreous in mid-line. Juga black except for a narrow, sublateral, yellowish ochreous line. A similarly coloured, impunctate, triangular patch behind inner posterior margin of each eye, and another similar but ovoid patch on each side of base of head behind ocellus. On each side, a shining, impunctate, black or bronzy-black patch in front of ocellus, and another behind ocellus internal to the basal ochreous spot.

Greatest width across juga slightly over $\frac{1}{2}$ width across eyes (18: 35; 19: 37; 20: 39). Each eye somewhat less wide than in *nasalis* in proportion to interocular space (only $\frac{1}{3}$:-7: 21; 7.25: 22.5; 8: 23).

Ventral surface pale stramineous; rostrum ochreous, reaching posterior coxae, apical segment black, sides of first segment concave shortly before apex, sparsely and shallowly punctate and obscurely striate.

Antennae: About half as long as body. Antenniferous tubercle small, black above, with a short, pale, ventral spine. First segment very short, black, with ventral ochreous streak; second segment wholly brownish black, or with apex black; the others with base reddish brown and about apical $\frac{2}{3}$ in fifth segment and apical $\frac{1}{2}$ in third and fourth segments black; the dark and paler regions clearly contrasted. Seg. III $\frac{5}{8}$ to $\frac{3}{4}$ as long as II (22: 30; 20: 32; 18: 26); IV in these specimens about $\frac{1}{5}$ longer than III (26: 22; 24: 20; 22:18); V subequal to or rather shorter than IV.

Pronotum: More finely punctate than in *nasalis.* Anterior margin deeply and widely excavated. Anterior angles with a very short, blunt, outwardly and forwardly directed spine. Sides incurved and sinuate at middle, posterior half projecting outwards at a pronounced angle and not in line with anterior half, and posterior angles thus more prominent and acute in appearance than in *nasalis;* anterior half only obscurely crenulate, posterior half smooth. Posterior margin in front of scutellum straight; on each side, outside base of scutellum, with a triangular process overlying base of clavus; postero-lateral margin outside this sinuate. Posterior width 2.15 to 2.25 times length. Lateral margins pale ochreous except on dark posterior shoulders. A more or less pronounced median pale line, most definite anteriorly, and extending on to anterior part of scutellum. Calli black or bronzy black.

Scutellum: Raised and broadly convex in front, remainder nearly flat. Disc distinctly rugulose. Sides concave behind middle, straight before and after concavity, the margins in front of it posteriorly convergent and (with wings closed) incurved at basal angle; margins behind it only slightly convergent; apex broadly rounded, off-white or pale creamy yellow, with only sparse, fine, shallow punctures. Median line with punctures comparatively few and fine; except at base and apex shining black, the black area extending in front to form a Y, with the anterior median pale line enclosed between the arms. Inner margin of fovea at basal angles straight, yellowish ochreous.

Mesosternum: Disc black, with coppery reflections, impunctate, transversely rugulose; median carina a low, ochreous ridge.

Wings: Extending rather further beyond abdomen than in *nasalis*. Corium with an impunctate, shining black patch in centre of posterior two-thirds. Membrane of hemelytra brown, finely rugulose; veins dark. Hind wings nearly colourless, faintly cinereous; veins dark brown.

Legs: Ochreous; femora and tibiae spotted with reddish- or blackish-brown; apex of tibiae and of tarsal segments fuscous, tarsi sometimes almost entirely black. Femora unarmed; with fine, rather long and sparse hairs. A single black, apically directed spine on ventral surface of fore tibiae only; tibiae otherwise unarmed, clothed with fine pubescence; upper surface with shallow, longitudinal groove. Tarsi clothed with fine, pale hairs, longest and erect towards apex of last segment.

Abdomen: Dorsal surface very finely punctate. Sides convex; connexivum extending moderately beyond costal margins of closed wings, posterior angle in each segment projecting slightly beyond anterior margin of the next, but not spined or backwardly produced. Connexivum strongly marked with black at anterior and posterior margins of each segment; orange or orange-brown between them. Anterior abdominal spine very short, not reaching anterior margins of hind coxae.

Localities: Collected by Mr. E. G. Turbott on Great I., Three Kings Is. 1♀, Tasman Valley, 6/5/46; 2 ♀♀ near depot, 5 and 10/5/46; all on *Leptospermum ericoides* A. Rich. (kanuka).

Types: Holotype and 2 paratypes in Auckland Museum.

Close to *Cermatulus nasalis* (Westwood), but readily distinguished by the differently shaped pronotum and juga, the markedly convex apex and nearly impunctate disc of tylus, the finer punctation, particularly on pronotum, the colour of antennae and apex of scutellum, and the metallic bronzy reflections on some or all of the regions listed in the description.

The only other recorded species in the genus, *C. pulcher* Tryon, 1892, is from Fly River, British New Guinea.

For fuller comparison, a redescription of *C. nasalis* is added, giving those features in which this species differs from *C. turbotti*, since most of them are not covered in detail in the earlier descriptions. To avoid recapitulation, features common to both species are omitted from this account.

Cermatulus nasalis (Westwood). Fig. 2.

1837.—*Aelia nasalis* Westwood, *Cat. Hope* 1, p. 32.

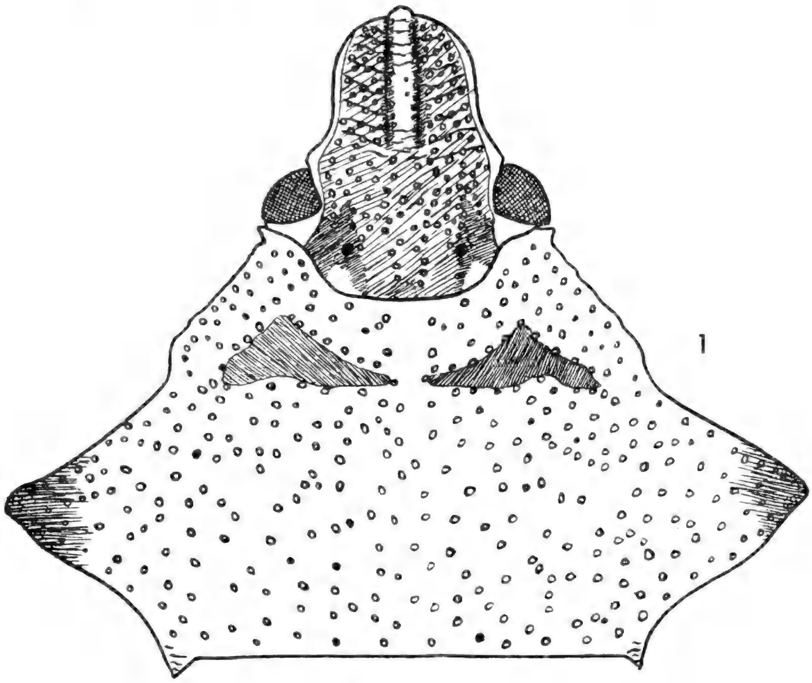
1842.—*Asopus nummularis* Erichson, *Arch. fur Naturg.* 8, p. 276.

1844.—*Asopus nummularis* Herrich-Schaeffer, *Wanzenart. Ins.* 7, p. 114, fig. 776 (as new species).

1851.—*Cermatulus nasalis* (Westwood) Dallas, *List Hem. Ins. Coll. Brit. Mus.* p. 106, pl. 2, fig. 3.

1867.—*Asopus binotatus* Walker, *Cat. Specimens. Het. Hem. Coll. Brit. Mus.* 1, p. 144 (recorded from Brazil: in error, according to Kirkaldy, 1909).

1867.—*Rhaphigaster pentatomoides* Walker, *ibid.* 2, p. 370.



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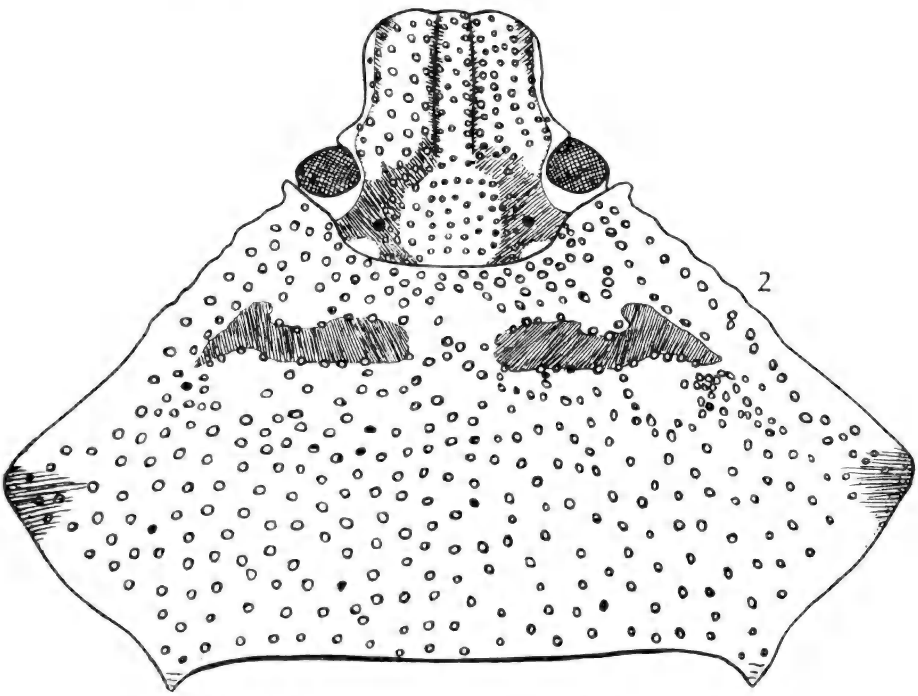

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Fig. 1. *Cermatulus turbotti* sp. nov.; head and pronotum.

Fig. 2. *Cermatulus nasalis* (Westwood); head and pronotum.

Length: ♀♀, 10.5-12.5 mm. (23 specimens); ♂♂, 9-10 mm. (5 specimens). Width across abdomen: ♀♀, 5.75-6.75 mm. ♂♂, 5-6 mm. Width across pronotal shoulders: ♀♀, 5-6 mm.; ♂♂, 4.5-5.5 mm. Proportions as in *turbotti.* More coarsely punctate above than in *turbotti,* especially on pronotum. Venter of thorax rather coarsely and deeply punctate, venter of abdomen more finely and shallowly punctate, particularly in middle, at sides and apex.

Colour: Ground-colour of testaceous or ochreous, punctured and infuscated with brownish black. Considerable variation in the general colouration of this species is given by differences in the shade of the ground-colour (yellowish-, orange-, or reddish-brown) and the relative darkness of the punctures and infuscations and the extent of the latter. Without any bronzy metallic sheen. Dorsal surface of abdomen black; ventral surface mottled ochreous and testaceous, rather variable, but darker than in *turbotti,* with similar black markings, but last pair of black patches usually extending to or near posterior end of sternite and broadly confluent behind, sometimes entirely fused.

Head: Anterior angles of juga more broadly rounded than in *turbotti,* with more of the curved margin facing anteriorly. Tylus with free apex straight or very nearly so, at the most scarcely and very broadly and bluntly convex; ending level with juga or very slightly shorter or longer. Whole snout with end more bluntly rounded than in *turbotti.* Each eye somewhat wider than in *turbotti* in proportion to interocular space ($\frac{2}{5}$). Tylus punctate in middle as well as at margins. Tylus and juga with or without rugulae. Vertex with an impunctate black patch narrowly surrounding each ocellus and extending forwards near inner posterior angle of eye. Sides of tylus with narrow black margins, continued back to base of head as broader black bands more or less confluent with the black patches described above. Impunctate, ochreous spots as in *turbotti.* Rostrum ochreous or reddish brown, apical segment brownish black or black, sides of first segment rarely distinctly concave before apex.

Antennae: First segment ochreous, sometimes more or less infuscated; other segments ochreous or reddish brown, second wholly so, third and fourth with about apical $\frac{1}{2}$ and fifth with about apical $\frac{2}{3}$ fuscous or dark reddish brown, the dark apices less heavily pigmented and less strongly contrasted with the paler bases than in *turbotti,* the two regions often scarcely differentiated. Seg. IV $\frac{1}{5}$ to $\frac{1}{2}$ as long again as III. Other proportions with range as in *turbotti.*

Pronotum: Very coarsely punctate. Sides straight or nearly straight, sometimes slightly sinuate at middle; anterior half more or less distinctly crenulate, posterior half smooth. Posterior shoulders less prominent and more bluntly rounded than in *turbotti.* Posterior width 2.3 to 2.45 times length. Lateral margins paler ochreous throughout. Calli black.

(Fig. 2 illustrates about the maximum extent of the lateral sinuation, to show that even where such occurs the condition is markedly distinct from that in *turbotti.* Many specimens of *nasalis* have the margins quite straight.)

Scutellum: Disc not distinctly rugulose. Apex yellowish- or orange-brown. Mid-line, except at base and apex, black or brownish black. Inner margin of fovea at basal angles ochreous or orange-brown.

Mesosternum: Black; median low ridge usually pale.

Wings: Shortly exceeding abdomen. Hind wings cinereous, with green reflections; veins dark brown.

C. nasalis is a rather variable species (size, colour, proportionate length of antennal segments, presence or absence of a slight sinuation in sides of pronotum). In respect of the first three features, *C. turbotti* also shows variation; the length, indeed, in the three ♀♀ examined has a greater range than in 23 ♀♀ of *nasalis* collected at different times from several widely separated localities. There seems little doubt that the distinctive specific characters of *turbotti* have evolved as the result of the continued isolation of a restricted population, initially sharing the general variability in certain features and possibly at the same time displaying small local peculiarities, later accentuated and added to.

The apparently local origin and restricted insular distribution of this species is of interest in view of the very wide distribution of *C. nasalis*, which occurs in Australia and Tasmania and, within New Zealand, has been recorded from a wide range of localities in both North and South Islands. (See, e.g., Myers, 1926, p. 494.)

Factors involved in the isolation of the Three Kings fauna include the continued separation of the islands from the mainland, now about 35 miles away, since about the early Tertiary, the effects of wind and strong currents, and the sheer, rocky shores. (See, e.g., Buddle, 1948; Oliver, 1948; Turbott and Buddle, 1948.)

The isolation of such a small population could easily have provided suitable conditions (e.g., by periodic or even a single extreme reduction in the numbers of the effective breeding population in the area) to permit action of the Sewall Wright effect, which increases rapidly with the smallness of the population, in the differentiation by "drift" of a new species in the Three Kings, while on the mainland the population has remained conspecific with the Australian form.

While there is as yet little or no direct information on the present numbers or biology of the species, it is possible to list tentatively a number of factors which might have induced such a process as outlined above: (1) The initial segregation and continued isolation of a population extremely small in comparison with that of the mainland. (2) The observed low population density of species of the predacious sub-family Asopinae, compared with that of many phytophagous insects, including other Pentatomidae. (3) The long non-breeding period of *C. nasalis* (as of most other Pentatomids) compared with the breeding period. (Univoltine, with the breeding season restricted to a few weeks in the warmer part of the year.) There is thus ample opportunity for the considerable reduction of the breeding population for any one year (especially in view of the smallness of the area inhabited, which increases the chances of factors acting more or less uniformly throughout it). Two main factors which might be involved, either singly or together, in such reduction: exceptionally adverse climatic or other ecological conditions during the long non-breeding period (particularly over winter); an extreme fluctation in (egg) parasite-host balance, involving a temporary decrease in numbers of the latter, followed by a rapid building up of the population from the survivors. (4) Judging from collections, the apparently small proportion of males to females in *C. nasalis*, materially reducing the effective size of the population. (Wright, 1940, p. 170.)

The Asopinae are predacious. Thus any possible effects, on the biology of the species, of the recent vegetational changes that have occurred on Great Island through the depredation of goats (Baylis, 1948; Turbott, 1948), would presumably have been mainly or entirely indirect, through their influence on the populations of insect prey. But since the known range of prey of other species of the sub-family, including *C. nasalis*, is very wide, such effects have probably been negligible or at least much less extensive than with many of the purely phytophagous insects, and the population has probably not suffered adversely. It is possible that the development of a *Leptospermum* shrubland, typically with the insect and other arthropod fauna prolific in numbers of individuals, has even increased the population. In any case, as is general in this predacious group, specimens, even if fairly numerous over an area, would be expected to be rather sparsely distributed within it.

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The Genus Rhopalimorpha Dallas (Hemiptera-Heteroptera) with a Description of a New Species.

By J. G. PENDERGRAST, St. Heliers.

In recent years the consensus of opinion has been that the genus *Rhopalimorpha* Dallas is represented by only two species, *R. obscura* White (New Zealand and the Chatham Islands) and *R. humeralis* Walker (Queensland). *R. similis* Mayr has long been regarded as a synonym of *R. obscura.* Buchanan White (1878) wrote: "*R. similis* Mayr is, I feel pretty sure, the same as *obscura* White." Mayr (1866) listed certain differential characters for distinguishing *R. similis* from *R. obscura.* On inspection these are found to apply equally well to the latter species. In his description of *similis* Mayr (1866) noted that the scutellum had "eine feine Endspitze." As will be seen below, the possession of an acute apex to the scutellum is an important characteristic of *R. obscura.* Similarly, *R. ignota* Hutton has proved to be synonymous with *obscura.* After examination of the type Myers (1924) stated: "The writer is of the firm opinion that *R. ignota* is admissable not even as a constant colour variety." And, further, "After examining some hundreds of specimens from widely separated localities the present writer feels sure that there is only one species, and that this is surprisingly constant in structural characters." Through the courtesy of Mr. R. R. Forster, of the Canterbury Museum, the author has been able to examine the type of *R. ignota* and agrees with Myers that this is synonymous with *R. obscura.*

While working on the anatomy and life history of *R. obscura* it became apparent to the writer that two species were present in his collections. Dr. W. E. China, of the British Museum, was kind enough to examine the collection of that institution and agreed that there were two species involved. Writing to Dr. T. E. Woodward of the Auckland University College, he said: ". . . there are two species involved. These can be distinguished in both sexes most easily by the apex of the scutellum which is pointed in one and rounded in the other. The ♀ type of *R. obscura* White has the pointed apex of the scutellum and this is the species which is most abundantly represented in our collection."

Because of the lack of a generic description (Dallas, 1851, provides only an almost worthless key) and the inadequacy of the descriptions of *R. obscura* and *R. humeralis,* it is felt that the genus and these species should be redescribed and it is hoped to make this the subject of a future paper.

FAMILY PENTATOMIDAE.

SUB-FAMILY ACANTHOSOMATINAE.

Genus RHOPALIMORPHA Dallas, 1851.

1. **Rhopalimorpha obscura** A. White, 1851.

Rhopalimorpha similis Mayr, 1864.
Rhopalomorpha similis Mayr, 1866.
Rhombocoris similis (Mayr) Hutton, 1874.
Rhopalimorpha ignota Hutton, 1898.

2. **Rhopalimorpha humeralis** Walker, 1867.

3. **Rhopalimorpha lineolaris** sp. nov. (**Figs.** 2, 3, 4).

Rhopalimorpha obscura White. Myers, 1926 (*partim*).

Length: Female, 8.0-8.5mm. Male, 6.5-7.5mm.

General Colour: Dorsally usually mahogany-brown, frequently green-brown, sometimes brick-red; ventrally lighter except as detailed.

Head: Dorsally, coarsely punctured with black except for smooth band in mid-line marked with white posteriorly; tylus bordered with deep black clefts, anterior extremity prominent and rounded; lateral jugal margins raised and white. Ventrally smooth and glossy except for gula and few punctures on gena; gula roughened and slightly pubescent; maxillary plate with conspicuous tooth-like projection with flat dorsal surface; rostrum reaching intermediate coxae; antennae slender, reddish-amber, fifth and distal half fourth segment dark brown, joint between second and third segments inconspicuous, second scarcely longer than third (1.05: 1.00); eyes dark purple; ocelli bright red.

Thorax: Pronotum and scutellum coarsely punctured except on callus areas and on smooth median band marked with light stripe; pronotal margins white or buff; scutellum apex light coloured, broad, non-acute; hemi-elytron fairly broad, corium green-brown, membrane buff, nervures light brown; scent gland orifice bordered above by conspicuous dark brown plate marked with white dorsally; mesothoracic carina small but more prominent than in *obscura;* femur dark brown with black punctures, remainder of leg dark amber.

Abdomen: Somewhat swollen; connexivum inconspicuous, marked with black in each segment; venter dark brown mesially, lighter towards edges; ventral spine broad, extending almost to intermediate coxae.

Female: Sixth sternum marked with pair of conspicuous dark circular setose patches; valves covering genital opening making up flat circular area; seventh sternum with broad low median keel.

Male: Ninth segment or pygophor with slightly concave ventral posterior margin bearing single median patch of long bristles.

Types: All collected Orakei, Auckland, 8/7/50. Host plant: *Carex longifolia.* Holotype ♀ and allotype ♂ deposited in Auckland War Memorial Museum. One pair (♀ and ♂) of paratypes deposited in Dominion Museum, Wellington, Canterbury Museum, Christchurch, and Otago Museum, Dunedin.

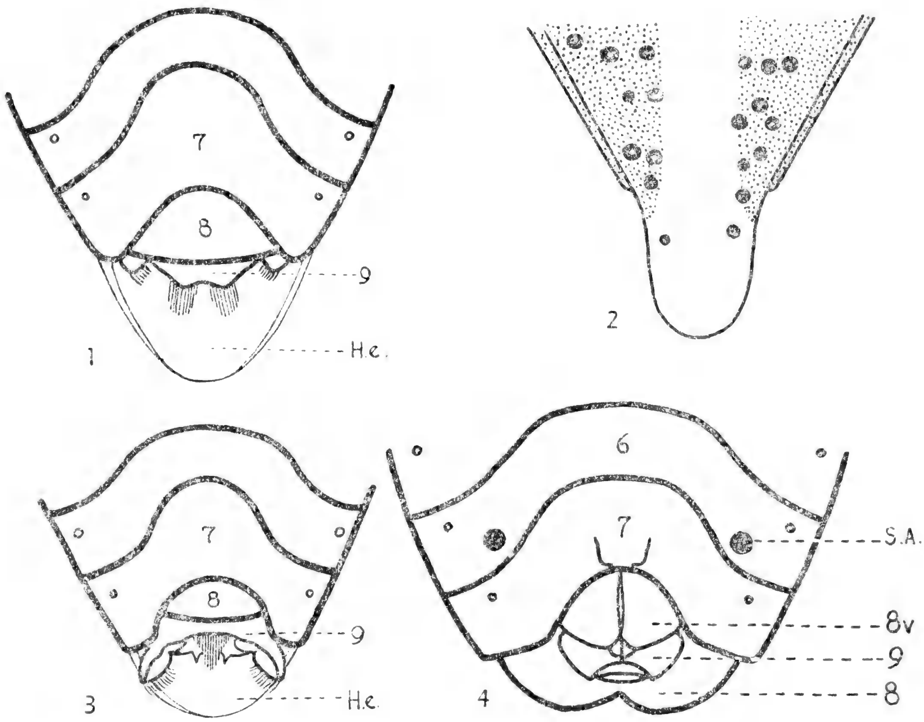

Fig. 1. *Rhopalimorpha obscura* White. Male. Ventral view posterior abdominal segments.

Fig. 2. *Rhopalimorpha lineolaris* sp. nov. Male. Ventral view posterior abdominal segments.

Fig. 3. *Rhopalimorpha lineolaris* sp. nov. Female. Ventral view posterior abdominal segments.

Fig. 4. *Rhopalimorpha lineolaris* sp. nov. Apex of scutellum.

REFERENCE LETTERING.

H.e.—Hemi-elytron.
S.A.—Setose area.
6-9.—Abdominal sterna.
8v.—Valves enclosing vulva.

This species can be distinguished from *R. obscura* White chiefly by the non-acute apex of the scutellum, the genitalia and the somewhat swollen abdomen lacking a definite connexivum. There are other less obvious distinguishing characters, such as the punctured femora, the large plate marking the orifice of the scent gland, the more conspicuous tooth-like projections from the maxillary plate and the more definite mid-dorsal stripe on head and thorax. In addition, certain differences in the internal structure have been noted, chief of which is the number of ovarioles in each ovary. In *R. lineolaris* the number is four, while in *R. obscura* it is seven, as is usual in the Pentatomidae.

Preliminary investigations have shown that *R. lineolaris* probably has a very similar distribution to that of *R. obscura* in New Zealand, i.e., over the greater part of both main islands. Around Auckland, individuals of both species are frequently found living together on the same plant. In the Auckland area the main food plants are *Carex longifolia; C. divulsa; Juncus effusus; Mariscus ustulatus;* and the Cocksfoot grass, *Dactylis glomerata.*

The life history of both species is at present being investigated and differences in the nymphs of the two species have been discovered. It is intended to describe these in a later paper.

ACKNOWLEDGMENTS.

Mention has already been made of the writer's indebtedness to Dr. China, of the British Museum and to Mr. Forster, of the Canterbury Museum. In conclusion the writer would gratefully acknowledge the valuable advice and helpful criticism of Dr. T. E. Woodward, of the Zoology Department, Auckland University College, under whose supervision the work has been carried out.

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The Geology of Rangiawhia Peninsula, Doubtless Bay, North Auckland.

By M. H. BATTEY, Geologist, Auckland Museum.

Abstract.

Basic pillow lavas, submarine keratophyres and associated sediments (late Palaeozoic or early Mesozoic) are overlain unconformably by breccia, conglomerate and sandstone (perhaps upper Cretaceous). Folding about east-west axes has bent these sediments vertical. After the folding, tear faults striking north-west have displaced the country north-east of the fractures north-westwards at least 2¼ miles. With this movement, a dyke-like mass of basic and intermediate plutonic rocks was intruded along the plane of weakness for over 70 miles, from North Cape to south of Whangaroa Harbour.

There is a marine terrace just over 100ft. above sea level and one at 50ft.

INTRODUCTION.

The northernmost part of New Zealand is comprised of a group of high, rocky tracts linked together and joined to the "mainland" by belts of sand hills, of which the chief is that joining the North Cape-Cape Reinga highland (itself consisting of several smaller blocks linked by sand dunes), Te Waka o te Haua ("The Bluff"), and Mt. Camel to the high ground near Kaitaia. This region Bell and Clarke (1910) designated the Aupouri Peninsula, from the name of the Maori tribe that formerly flourished upon it (text-fig. 1). It is a region of distinctive geographical and geological character, comprising massifs that, though strictly part of the mainland, present themselves irresistibly to the mind in the character of islands—an effect to which the topography and their isolation are contributory.

Rangiawhia Peninsula* is a land-tied island forming the promontory that separates Doubtless Bay on the east from Rangaunu Bay on the west, at the southern end of the great tombolo leading to North Cape. The rocky part of the Peninsula (plate 5) rises to a height of 600 feet above the sea and has rather the shape of a hand with one extended finger pointing to the north. It is 7 miles long from north to south and 5 miles from east to west, with an area of 15 square miles and is joined to the mainland by a belt of sand dunes and swampy ground some 3 miles wide and 8 miles long, in which some of the dunes rise to heights of more than 100 feet. This tombolo serves also to link together the conical rocky hill Puheke and the low-lying rocks around Rangiputa, both to the west of the Rangiawhia block.

The geology of this area has received but cursory treatment from earlier geologists, probably because of its relative inaccessibility. Hector (1891, p. lxxxi) visited a copper deposit on the south face of Knuckle

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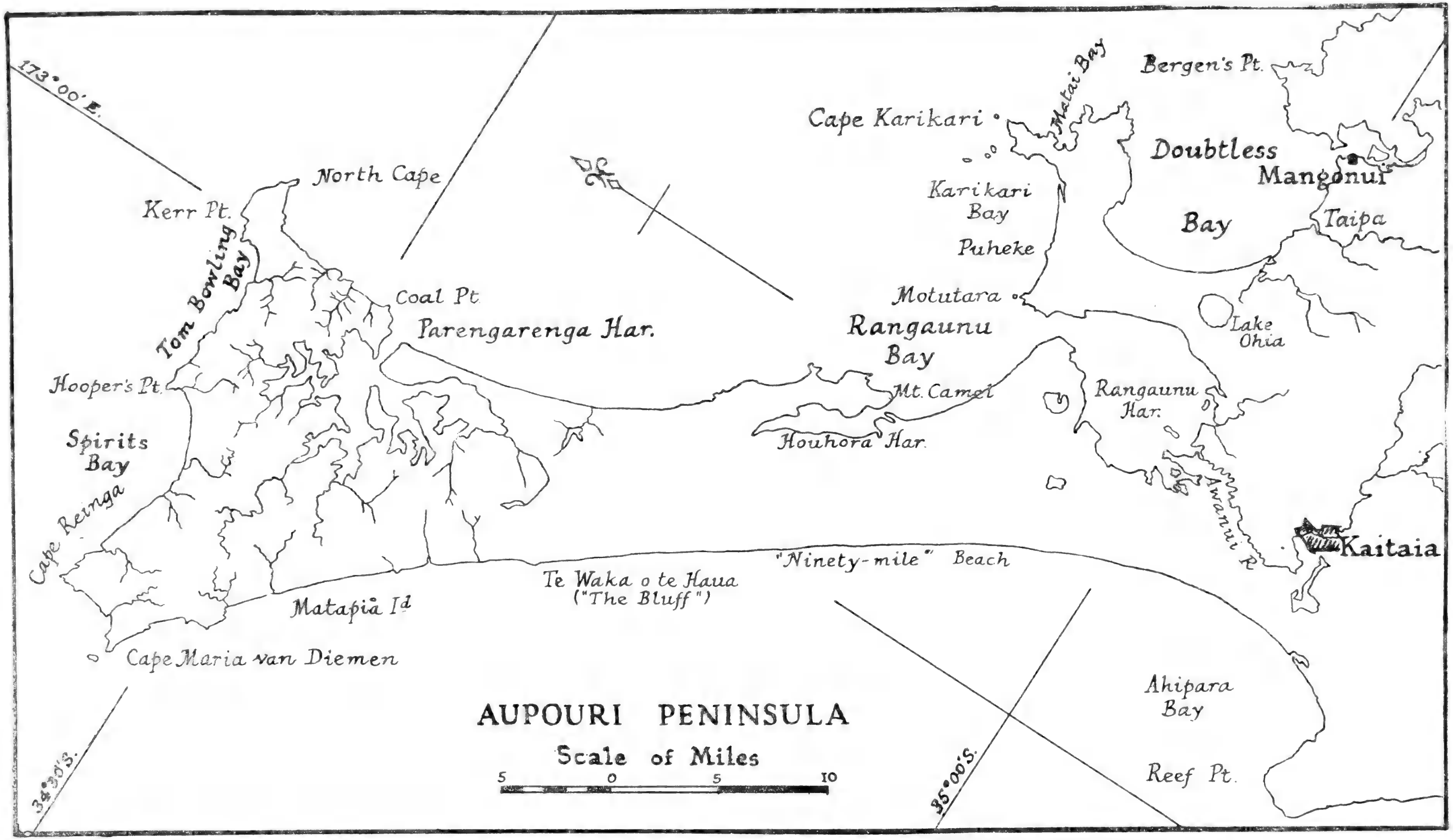
* Sometimes called Cape Karikari Peninsula, from the name of its northernmost promontory.



Text-fig. 1. Locality map of northern North Auckland.

Point that had been prospected in 1847*, and published an interesting sketch of the cliff-face there. On McKay's map of 1894 the area is marked as composed of Palaeozoic sediments and igneous rocks, the boundary between solid and drift being delineated. Bell and Clarke (1910), following McKay (1894, pp. 72, 89, 90) and Marshall (1908, p. 81), map the rocks as falling in their Older Igneous Group. Apparently neither they, nor Marshall, actually visited Rangiawhia Peninsula.

The rocks of the Peninsula may be grouped as follows (see also plate 5):

5. Drifts
   - (c) Recent alluvium
   - (b) Sand dunes
   - (a) Elevated marine sands

4. Basic and Intermediate intrusives. Dykes, mainly of intermediate nature, invade the older rocks throughout the Peninsula; but they become more numerous and more massive to the east, giving place, about Whangatupere Bay and in Cape Karikari to the north-west, to a continuous mass of coarse-grained igneous rock of a banded nature which includes thoroughly basic and even ultrabasic types.

3. Breccias, conglomerates, grits and sandstones, appearing as a narrow strip along the south-east coast of the Peninsula, between Whatuwhiwhi and Knuckle Point.

2. Hard black shales of uncertain stratigraphic position. They have so far been found only in the same places as rocks of Group 3. They lie to seaward of the breccias, conglomerates and sandstones and are faulted against them, generally below high tide mark.

1. Acid and basic soda-rich submarine lavas, including pillow lavas, with some associated sediments, underlying most of the south-western part of the Rangiawhia Block.

GROUP 1.—THE LAVAS AND THEIR ASSOCIATED SEDIMENTS.

Distribution.

Rocks of this Group underlie all that part of the Peninsula extending eastwards and north-eastwards from the northern end of Tokerau Beach to beyond Brodie's Creek, and inland to the northern side of the belt of high ground called the Te Ari Ridge that runs east and west between Whatuwhiwhi and the village of Merita, except for a narrow coastal strip north-east of Whatuwhiwhi where beds of Groups 2 and 3 occur. Excellent outcrops occur along the coast, but the rocks along the ridge are in general much weathered and the slopes of the ridge south of Merita are mantled with sands to a height of about 200 feet. Rocks of this group also occur along the crests of the ridges leading to Knuckle Point and Pihakoa Point, where they form remnants of the roof of

* Hector writes that the prospecting was done in 1857, but the Rev. Wm. Puckey, who was a missionary at Kaitaia, records in his journal having visited the Brodies at Knuckle Point, whence they had gone to open a copper mine, on 22nd March, 1847.

the intrusion of basic and intermediate rocks. Maitai Pa, in the centre of Matai Bay*, is also composed largely of them, and they also outcrop, surrounded by intrusive rocks, inside the north head of Matai Bay.

The rocks of the Group exhibit some variety, and the work so far carried out permits the recognition of three subdivisions, namely:

(c) Light-coloured acid lavas, including keratophyres and quartz-keratophyres;

(b) Dark-coloured basic lavas often variolitic and sometimes showing pillow structure;

(a) Indurated sandstones and argillites.

(a) *Argillites and greywackes.* At the northern end of Tokerau Beach, interstratified argillites and greywackes in beds one inch to eight inches in thickness outcrop at the base of the cliffs and extend around the headland to the beach Perehipe†. The dip wavers in both direction and amount, but in general it is east-north-east at about 30°. The beds are disturbed by a number of small faults and broken by closely-spaced joints running north-west by west and north-north-east. They are overlain with apparent conformity by dark lavas of subdivision (b). A thin sill-like mass of lava was seen near the top of the stratified rocks.

In a bluff near the middle of the beach Perehipe thin-bedded argillite and greywacke is followed upward by lava with quartz amygdales up to 2cm. across and dense greenish variolite 3 feet thick. Hard, splintery greywacke and argillite follow in relatively thick beds much broken by small dislocations; the strata are thinner (about 6 inches thick) higher up in the succession. A small reversed fault dipping 43° to the north-east displaces the beds about 12 feet.

At the eastern end of the beach there is a small outcrop of the thin-bedded sediments, with wavy but generally horizontal stratification. These beds meet white-weathering keratophyre on their northern side in a vertical contact running east by north. The keratophyre sends small apophyses amongst brecciated wisps of the sediment and has perhaps slightly hardened it. On the southern side of the exposure the sediments pass beneath a breccia of keratophyre, some greenish, streaky crushed lava and argillite fragments. The way in which argillite is mingled with keratophyre in the headland east of Perehipe will be described below.

The greywackes and argillites make their next appearance at Knuckle Point, the easternmost point of the Peninsula. They occur low in the cliffs on the northern side of the promontory, dipping south-west at a moderate angle. Greywacke is here more prominent than argillite, and though the rocks are in part thin-bedded, as at Tokerau Beach, more massive strata also occur. The sediments are closely associated with fine-grained dark-coloured lavas, but the relationship of the two rock types is not well shown. By analogy with the sequence near Tokerau Beach, it may be presumed that they are interstratified.

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* This is commonly spoken of as Merita Bay. The rocky knoll in the centre of the bay is known to the Maori people as Maitai, and this name, corrupted to Matai Bay, is applied to the whole bay on all the available maps and charts.

† For convenience of description a number of Maori place-names, kindly furnished by local residents, will be used. The localities so named are marked on the maps.

Along the crest of the Knuckle Point ridge and high on its southern slope, thin-bedded greywackes and argillites are weathered to pink and white banded clays and dip south-west and west at angles of about 25°. These must be the "pink tuffstones" shown in Hector's sketch (1891, p. lxxxi), for they are conspicuous above and to the east of the green coloration on the cliff face, which presumably marks the site of the copper prospect. I did not see the sharp synclinal fold shown in the sketch, but this may well be visible from seaward.

The attitude of the beds at Knuckle Point seems to be due to movements associated with the intrusion of closely-spaced dykes, trending north-westward and connected with the Whangatupere Bay intrusion.

At Pihakoa Point, and south of it, there are small areas of indurated fine and very fine sandstone with splintery or conchoidal fracture showing small scale lamination on fresh surfaces. They are in more massive beds than the rocks at Tokerau Beach but resemble some of those at Knuckle Point. As at Knuckle Point, their relations to associated lavas are not clear. A poorly-defined lamination strikes north-west and dips at about 50° to the north-east. The influence of the numerous dykes sent off from the Whangatupere Bay intrusive is again manifested in the attitude and distribution of the strata. The roof rocks of the intrusive have a strong north-west grain.

(b) *Basic lavas.* At the northern end of Tokerau Beach, and in the bluff near the middle of Perehipe Beach, basic lavas, exposed for only 18 feet above their base, succeed the argillites and greywackes with apparent conformity. In two places the lavas and sediments are interstratified over a small part of the sequence at their junction. The lavas are dark-green and variolitic with quartz-filled amygdales up to 2cm. across in parts and patches of cavernous rusty calcite near the base. Glassy material is not conspicuous, but pillow structure can be recognized, on close examination, in the cliff face at the western end of Perehipe Beach: the individual pillows are flattened and dip north-east at about 20° in approximate conformity with the underlying sediments.

Some 3½ miles to the north-east, greenish to dark-grey variolitic lavas with associated black perlitic glass outcrop on both sides of the entrance to Brodie's Creek. They show pillow form on the eastern side of the inlet and along the coast between 300 and 600 yards west-south-west of its entrance. The pillows are well preserved at the westernmost part of this exposure, where their elongation indicates that the mass has been tilted 66° to south by west: the mutually accommodating curves of the pillows suggest no overturning (plate 1, fig. 1).

The lower part of the succession is best studied on the eastern side of Brodie's Creek. Dark, fine-grained lava appears just within the mouth of the inlet and is followed to the south by 18 feet of fine-grained dove-grey sandstone with current bedding, 12 inches of dark lava and further laminated sandstones. The contacts between lava and sediment dip 76° north-west by north. The sandstone, which is crossed by microscopic veins of albitic plagioclase, passes south into a grey-white flinty rock with an orange-brown to reddish weathering crust, crossed by narrow quartz veins and cracks filled with epidote. The lamination of the sediment gradually disappears as it assumes its new character.

The resulting rock, which extends to the opposite (western) head of the inlet, has lost almost all signs of clastic origin and is composed of a mosaic of feldspathic material with scattered quartz grains and little flakes of biotite. It appears to be a kind of adinole.

The section at Brodie's Creek is then interrupted for 50 yards by a little beach, south-south-west of which sediment gives place to lava along a plane dipping 52° north-north-west. The lava, which shows good pillow form, continues for about 75 yards and is succeeded south-south-eastwards, along a plane dipping 70° north-north-east, by a body of white-weathering lava which extends for at least 100 yards farther. Beyond this the coast has not yet been examined.

I think that this section, with its steep northward dips, may be overturned. No definite evidence on the point was obtained, though the current bedding in the sandstone may be expected to yield it to more minute study. Nevertheless, the succession west-south-west of Brodie's Creek, which will be described below, where the beds dip south or south-east, suggests that the beds south of the pillow lavas are the younger, and at Tokerau Beach interstratification of lavas and sediments characterizes the base of the succession.

About 450 or 500 feet of lava and sediment is exposed in the section on the eastern side of Brodie's Creek, which is terminated northward by a mass of later intrusive rock. A little over 400 feet of lava appears where the coast cuts across the strike 600 yards west-south-west of the mouth of the creek, but this second section probably does not extend so far down in the succession as the first, for the thick bands of sediment do not appear in it north of the pillow lavas.

There are some points of difference between the succession incorporating the basic lavas at Brodie's Creek and that at Tokerau Beach. The thin-bedded argillites and greywackes exposed at Tokerau are not to be seen at Brodie's, where intrusive rock limits the section on the north. As has been mentioned, however, such sediments reappear at Knuckle Point. The sandstones interstratified with the lavas at Brodie's Creek are unlike any exposed at Tokerau Beach. At Brodie's Creek the lavas themselves seem much fresher and the pillow form is much better preserved than at Tokerau Beach. In spite of these differences, however, it seems justifiable to correlate the basic lavas of these two localities, not only on lithological grounds but also on structural evidence to be given below in connection with the rocks of Group 3.

(c) *Keratophyres.* The keratophyres and quartz-keratophyres are green to light-grey, weathering white, often with amygdales of chalcedony and quartz and commonly porphyritic, though the phenocrysts are sparse. The silica of the amygdales is sometimes stained red, while the plagioclase phenocrysts may be pink, and these, set in the green base of a fresh lava, make a handsome rock. The amygdales often stand out prominently on weathered surfaces, but otherwise the weathered rock is buff or dirty-white, perhaps with flecks of green, and often earthy in appearance. Carious erosion of surfaces of quite fresh rock is common along the coast.

Throughout the keratophyres are discontinuous, often ill-defined bands of light-coloured porphyritic rock streaked with bright-green chlorite in flattened wisps and ragged ribbons, arranged with their broad surfaces parallel so as to impart a foliation to the rock, along which it shows a rude fissility. The largest mass of this green streaky rock seen is in the cliffs below the schoolmaster's house at Whatuwhiwhi, where it outcrops for over 200 yards in the cliffs. The flowing wisps of chlorite give a lively impression of movement, and I believe that the bands of green streaky rock represent crush zones along which adjustment has taken place during the strong folding movements that have affected the relatively rigid lavas. So far, no order has been discovered in their distribution and disposition.

As has been mentioned (p. 38), quartz-keratophyre meets thin-bedded argillite and greywacke in a partly intrusive contact trending east by north at the eastern end of Perehipe Beach. Thence the keratophyres in their different varieties outcrop eastwards along the coast to Waiari; beyond this, they appear discontinuously in the cliffs north-eastwards for about a mile, their exposure being interrupted by the development of breccia, conglomerate and sandstone beds of Group 3.

There is a good deal of argillite interstratified with keratophyre and greenish crush rock between tide marks at the tip of the headland east of Perehipe Beach, its amount decreasing towards high-water mark. The planes of junction between sediment and lava dip north-north-east at 70°. Farther east, argillite is enclosed in the lava in such a way as to give the appearance of a breccia. In places the argillite fragments are only an inch or so across, but some large masses occur. The planes of junction between the larger argillite masses and the lava strike, generally, east and west, with varying dips, sometimes southerly and sometimes northerly. Not very much reliance can be placed on the attitudes of the argillite masses, for it is quite likely that they were displaced during the extrusion and possibly partly intrusive emplacement of the keratophyre. The relationships here are reminiscent of those described by Cox (1915, p. 308) from Pembrokeshire, where, he believed, the rocks "represent what were practically lavas which burrowed among the mud of the sea-flood" and that "at times, the escaping vapours completely fractured the almost solidified rock, converting it into a breccia." He found intermingling of sediment and lava at both bottoms and tops of flows. At Rangiawhia the presence of the argillite probably indicates either the top or the bottom of a flow, but the exposure is too limited to show which it is.

At Waiari a hard breccia of dark, angular keratophyre fragments, up to 1½ inches across, set in a grey-white matrix of micro-crystalline quartz and muddy material, forms a low bluff to the west of the stream that discharges there. This is regarded as an agglomerate formed by explosions connected with the effusion of the keratophyre. It is succeeded southward by a sheeted zone with fractures striking N.60°W., in which greenish crush rock penetrates the breccia in so intimate a fashion as to suggest that it represents the alteration product of keratophyre, here intrusive into the breccia before its cementation. Chloritic keratophyre showing conspicuous carious weathering succeeds the sheeted zone to seaward. This belt of fracture is probably connected with the zone of green crush rock below the schoolmaster's house at Whatuwhiwhi, which lies on the line of strike of the fractures and is itself broken by master joints trending N.60°W. and dipping south-westward at 85°.

The dark-coloured pillow lavas 600 yards west-south-west of Brodie's Creek give place southwards along the coast to light-coloured porphyritic amygdaloidal keratophyres, which have a prominent wide-spaced parting, taken as bedding, that dips south-eastwards at about 40°. Though quite distinct from the usual type of pillow-forming lava, these rocks have shreds and streaks of glass associated with them and are definitely pillowy in places. They outcrop continuously, save for interruption by dykes, for about 700 yards along the coast, to their contact with breccia and conglomerate beds in a headland 1,100 yards south-west of the entrance to Brodie's Creek.

The apparent thickness of the keratophyres in this section is a little more than 1,000 feet, but this value is possibly greater than the true thickness, for, as will be shown later, tear faults striking north-west have allowed north-westward movement of the country on the north-eastern sides of the fractures at short intervals along this coast. These faults are difficult to detect in the lavas and have only been demonstrated where the stratified rocks of Group 3 are exposed, but they undoubtedly transect the lavas just as frequently, and may have caused repetition of part of the keratophyre sequence.

Inland, keratophyres outcrop in the Te Ari Ridge running east and west between Whatuwhiwhi and Merita; in general the rocks are much weathered, but fresh amygdaloidal keratophyre outcrops in the knoll east of the Whatuwhiwhi-Merita Track where it crosses the ridge.

The lavas that form remnants of the roof of the intrusive mass of Whangatupere Bay, along the ridge between Koware trig. station and Pihakoa Point, prove under the microscope to be thermally metamorphosed representatives of the keratophyre group. In hand specimen they are quite different from the rocks of the southern coast of the Rangiawhia Block, being dense, dark-grey and splintery, and to be distinguished only with difficulty, under the lens, from the indurated greywackes with which they are associated. The same is true of the lavas surrounded by intrusive rocks in the north-western corner of Matai Bay.

Structure, correlation and age.

On the whole, little direct evidence on the structure has been gleaned from the outcrops of the rocks of Group 1. Observations on their contact with argillite and greywacke and on planes taken to represent bedding in the lavas suggest that, between Perehipe and Waiari, they strike roughly east and west. The dip is variable, either northward or southward, steep or moderate. Around Brodie's Creek, too, the strike varies about the east-and-west direction, though in the keratophyres south-west of the inlet it swings to north-east. The beds dip steeply northward east of the inlet and southward or south-eastward at steep to moderate angles south-west of it.

From the study of the breccias, conglomerates and sandstones of Group 3, it is clear that the country has been subjected to vigorous folding about east-and-west axes and, in so far as they were capable of yielding by flexure, the lavas must have partaken of this deformation.

Since these rocks are rather rigid, probably some of the adjustment took place by fracture and crushing. It is not possible to attempt to reconstruct the attitude of the lavas before this folding.

Since the folding, the area has been broken by tear faults striking north-west, the results of which will be more conveniently considered below in connection with the structure of the beds of Group 3. Here it may be mentioned that there is some evidence that the pillow lavas near Tokerau Beach and those near Brodie's Creek are at the same horizon and once formed a belt striking about east-and-west that has been disrupted and displaced by the tear faults (text-fig. 3, p. 49).

So far, no fossils have been found in Rangiawhia Peninsula to fix the age of any of the rocks there. The nature and sequence of the lavas invite direct comparison with those discovered on Great Island, in the Three Kings Group, by Bartrum (1936 a & b). He found spilitic pillow lavas 40 feet thick at the base of the cliffs in North West Bay, associated with greywackes showing fine lamination in places and hard black shales, while albite porphyry*, estimated as 60 feet thick, outcrops high above in the cliffs, and quartz-keratophyre lava (perhaps partly tuffaceous) is recorded from surface blocks above the porphyry.

We have here a section strictly comparable, even in detail, with that at Rangiawhia Peninsula. Lamination of the greywackes is characteristic of both areas, while Bartrum's description of the pillow lavas is applicable in all points to those near Tokerau Beach. I have not been able to visit these pillow lavas near sea level at the north-west landing on Great Island, but the overlying keratophyres, whether they be intrusive or extrusive, are comparable, both in appearance in the field and under the microscope, with types from Rangiawhia Peninsula. It may be remarked that the albite porphyry of Great Island is richly amygdaloidal in places, while little, if any, sedimentary rock intervenes between its outcrop and that of the rocks described by Bartrum as lavas higher up the cliffs, though unfortunately talus obscures the accessible ground. Its character as a sill can therefore not be regarded as above question; it may well be part of a group of lava flows. It is remarkable that even the tuffaceous rock (Bartrum, 1936a, p. 416) finds its counterpart in the brecciated keratophyre at Waiari.

There can be little doubt that the rocks of these two areas, 85 miles apart, belong to the same formation.

Bartrum believed that the rocks of Great Island belong "to the Hokonui System . . . approximately mid-Mesozoic in age . . ." (1936a, p. 415) and correlated them with lavas interbedded in the Waipapa Series of Bell and Clarke (1909) around Whangaroa. The recent discovery by the Geological Survey† of fusilines and corals in a marble associated with pillow lavas, in the Waipapa Series near Whangaroa, proves that this part of the Series is of Permian age, so that possibly both the Great Island rocks and those of Group 1 in Rangiawhia Peninsula are also as old as this.

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* Intrusive keratophyre in the terminology of Wells (1922).

† Personal communication from Dr. J. Marwick.

Bartrum specifically observed that the Great Island igneous rocks are not to be regarded as the magmatic associates of the Upper Cretaceous pillow lavas near Cape Maria van Diemen, but are older; "their period of eruption is separated from that of the lavas of the mainland by one of the greatest unconformities yet established in New Zealand" (1936a, p. 422). Specimens of lava collected from South West Island and Hole-in-the-Wall Rock (one of the Princes Islets) by Buddle and Johnston in 1947 were classified by Bartrum as quartz andesites resembling members of the Upper Cretaceous (Rahia) Series of the area around Cape Maria van Diemen, to which formation he assigned them (Bartrum, 1948, p. 206). Since the rocks of the North Cape-Cape Reinga area known as the Older Volcanic (or Whangakea) Series (Bell and Clarke, 1910; Bartrum and Turner, 1928) have been transferred to the Upper Cretaceous (or Rahia) Series (Bartrum, 1934), Great Island has been the sole remaining bastion of supposedly pre-Cretaceous rocks in the Far North.

To return to Doubtless Bay, there is a belt of basic submarine lavas with pillow structure which forms the headlands along the southern shore of the Bay, 8 miles south of the Rangiawhia Block, from Mangonui Township at least to the promontory west of Taipa Beach. Inland of these, in Taipa Estuary, are Cretaceous sediments striking east-and-west and dipping northwards at moderate to steep angles, which closely approach the lavas on the east side of the Estuary, but are not to be seen actually in contact with them. Green cherts occupy the interstices between the pillows, and discontinuous bands of red and green chert are caught up in the lavas. The largest mass of sediments seen in the lava is at the western end of Taipa Beach, where the included and partly invaded sedimentary beds strike south-west by west. Because of the close association of the sedimentary beds with the lavas and their general conformity of strike, it seems very likely that these lavas are part of the Upper Cretaceous succession here. Besides, pillow lavas are well known to be associated with Cretaceous and Eocene beds in many other parts of North Auckland.

There are no keratophyres between Mangonui and Taipa, however, and the sediments associated with the pillow lavas are quite different from those in Rangiawhia Peninsula. Moreover, while the lavas between Mangonui and Taipa are freely invaded by a medium to coarse-grained albite diorite, which is probably as abundant as the pillow lavas in the coastal outcrops, no such intrusive appears in Rangiawhia Peninsula.

For these reasons, admittedly not highly satisfactory, I am inclined to think that the lavas of Group 1 at Rangiawhia are not properly to be correlated with those of the southern shore of Doubtless Bay, but are more probably pre-Cretaceous.

The question whether they are coeval with the Palaeozoic members of the Waipapa Series at Whangaroa, mentioned above, must be left in abeyance until fossils are found, or until more is known of the successions and rock types in areas where there is fossil evidence of age.

GROUPS 2 & 3.—SHALE GROUP AND BRECCIA, CONGLOMERATE AND SANDSTONE GROUP.

These two groups of rocks are exposed in close association along the same stretch of coast and it is convenient to consider them together, with the aid of a large scale map (plate 4).

Distribution.

Breccias, conglomerates and sandstones of Group 3 outcrop as a narrow, interrupted strip along the coast between Waiari and Brodie's Creek and again, apparently, at the old copper workings on the southern side of Knuckle Point. I have not yet visited this last locality, but Hector (1891, p. lxxxi) describes the deposit, which he regarded as a volcanic agglomerate, as being the country of the copper-ore and his sketch of the cliff shows that an excellent exposure of the junction between the breccia and the older lavas is there available. This contact has been examined on the coast at a point 1,100 yards south-west of the mouth of Brodie's Creek as well as in the area described in detail below.

The accompanying map (plate 4) represents the relationships of the formation for a distance of about a mile east-north-eastward from Waiari. The strip of rocks of Group 3 is nowhere exposed for a width of more than 150 yards and its greatest inferred breadth is only 300 yards. Marine erosion has to proceed but little farther to remove the members of the Group altogether. The waves have, in many places, worn away the land until the resistant lavas have been reached, so that the rocks of Group 3 are exposed chiefly in the low tide platform, though also in the cliffs in some places (plate 2, figs. 1, 2). They strike steadily east and west (save for a slight systematic curving due to faulting), everywhere stand very steeply and are often overturned to the south (plate 2, fig. 2).

Close to their contact with the lavas the breccias are very coarse and contain masses, several feet across, of greenish crushed lava, normal keratophyre and dark grey, indurated, fine sandstone. On the eastern side of the point at Waiari they contain large boulders of graphic granodiorite (plate 2, fig. 3) of which no parent mass is now exposed*. The majority of the smaller blocks and pebbles are of keratophyre. Other constituents are spotted greywacke that has undergone mild thermal metamorphism, coarse sandstone and pieces of an older conglomerate. Much of the coarser material is angular, but a fair proportion of well-rounded boulders and pebbles is present. Generally speaking, the material of the breccias and conglomerates becomes finer upwards in the sequence and gives place to fine conglomerates, grits and sandstones.

These characteristics of the beds and their distribution suggest that the group represents the basal part of a normal marine sequence

* It may be recalled that smaller pebbles of granitic rocks occur in basal conglomerates of the Kaeo formation in the Whangaroa district (Bell and Clarke, 1909, p. 50).

deposited unconformably upon the lavas of Group 1, rather than a volcanic agglomerate as Hector supposed. The great size and angular form of many of the boulders make it clear that the land from which the fragments were derived was very close to the area where the deposits lie—some of the breccias, in fact, look like cliff-foot talus accumulations.

The basal contact of the breccias with the lavas is well exposed in a few places, but, since the beds stand at high angles and are overturned in many places at the contact with the relatively unyielding lavas, the junction may be expected to have been a plane of movement and, as such, is not capable of affording much information about the original nature of the surface on which deposition took place. Later faulting has also occurred along lines crossing the contact. The possibility of the generation of independent zones of breccia by both kinds of movement cannot be disregarded, although the actual lines of such brecciation would be difficult to detect in the field. The magma of the injected series (Group 4) has taken advantage of the contact as an easy route of uprise in a number of places.

Between half a mile and a mile north-east of Waiari the beds of Group 3 are limited to seaward by a fault striking parallel to the coast, generally between tide marks, which brings the breccias, conglomerates and sandstones into contact with hard, coal-black slaty shales, the parting in which strikes slightly oblique to the fault-line and generally dips south-east at about 60°. These shales reappear at the extreme edge of the low-tide platform south-south-east of the cliffs at Waiari. Small pebbles of shale along the beach just east of the schoolmaster's house at Whatuwhiwhi suggest that the shale is not far off shore farther to the south-west.

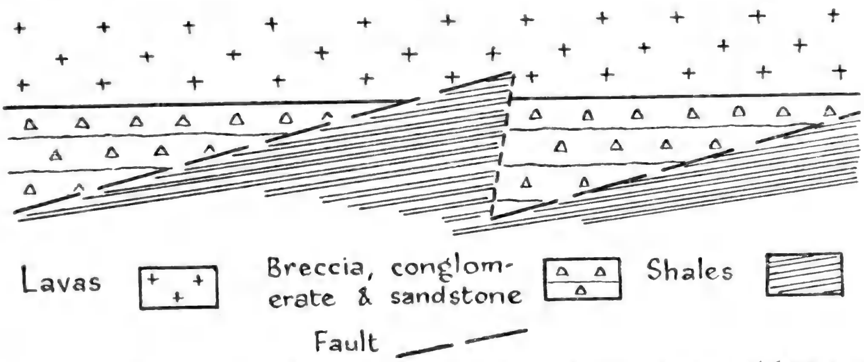
Several sills intrude the shales and they are crossed also by dykes, both kinds of intrusion being representatives of Group 4 (plate 3, figs. 2, 3).

Only for a distance of 40 yards about 200 yards north-east of Homarere, have the shales been seen in contact with the lavas of Group 1. Here, though the contact is poorly exposed, the shale seems to be faulted against the lavas along a plane striking roughly parallel to the fault separating the shales from Group 3 beds elsewhere, and dipping north-west at 63°.

Structure.

As the beds are followed north-eastwards from Waiari, the east-and-west trending contact of the breccias with the lavas is found to be progressively displaced to the north by a series of tear faults striking north-north-west. The movement of the country to the north-north-west or north-west on the north-eastern sides of these faults is well displayed by the displacements of the fault plane separating the black shales from the breccias, conglomerates and sandstones, and as can be seen from the mapping, the effects of drag along the faults is clearly exhibited in the curving of the strike of the beds of the breccia-sandstone group as well as in that of the black shales at Homarere.

In only two cases is the apparent relative displacement along the faults in the opposite sense and in only one case is this appearance truthful—that is, in the case of a reverse shift of 20 yards near Anaputa. The second apparent case, where the shales meet the lavas 200 yards north-east of Homarere, is due to a different cause. It will be seen that the fault that separates the shales (Group 2) from the breccias, etc., of Group 3 strikes obliquely to the east-and-west contact between beds of Group 3 and lavas of Group 1. If we restore the beds to their original position, before the north-north-west shifting took place, we find that the trend of the fault must have caused it to approach ever nearer to the breccia-lava contact as this contact was followed eastward, until it crossed the boundary at a point that now lies 200 yards north-east of Homarere (Grid position 92219838). Movement along the fault promptly died out as the plane passed into the infrangible lavas and the displacement was taken up by another plane of the same trend in the more readily broken beds of Group 3 (text fig. 2). The trend of the



Text-fig. 2. Diagram showing relations of shales to breccia group and lava group north-east of Waiari.

new fault plane, however, still brings it continually nearer the breccia-lava contact eastwards, and it must encounter the lavas again at a point that now lies immediately north-east of the area mapped in detail. I hope that its behaviour on doing so will be observable here when the mapping is extended farther north-eastwards, though igneous intrusion, the trend of the coast and the rugged cliffs together seem to militate against it.

Before the wider implications of this tectonic pattern are discussed, another point in connection with the map (plate 4) may be mentioned. Faults are difficult to detect in the lavas and in the jumbled mass of the lower part of the breccia. Four faults not observed seem necessary to explain the distribution of the beds. Three of these have been drawn in accordance with the north-west or north-north-west grain of the country so clearly seen in the disposition of dykes and joints, other faults, and in the coastal morphology. The fourth, at Homarere, has been drawn with a north-north-eastward trend, on the basis of the positions of lava outcrops protruding through the beach gravels, and of a mass of shale exposed a few dozen yards off-shore at low water, supported by the presence of a prominent cleft in the lavas in the cliffs and the position of a small outcrop of breccia. Although this trend is tectonically inharmonious, I have preferred not to multiply assumptions in order to dispense with it, for the observed fault plane at Waiari shows that divergences from the general trend do occur. Obvious difficulties arise, however, in the area indicated by the question-mark. Further observation will probably show some deficiency in the mapping here.

When the style of tectonics found north-east of Waiari is applied in explanation of the distribution of all the outcrops of Group 3 beds so far known, including that described by Hector at the copper mine, we find that, across a belt of country of a width of nearly $3\frac{1}{4}$ miles at right angles to the planes of movement (taken as trending about N.40°W.), the base of the breccias has been shifted north-westwards a total distance of over $2\frac{1}{4}$ miles. In the outcrops that I have myself examined, of which the most north-easterly is that 1,100 yards south-west of Brodie's Creek, there has been a north-westward shift of 1,650 yards distributed over a distance of 2,270 yards normal to the direction of movement*.

This displacement is probably connected with the intrusion of the Whangatupere Bay basic igneous mass, or rather, the intrusion, which appears to connect with similar rocks at North Cape and perhaps around Whangaroa, is probably connected with the displacement. If this is so, it seems fair to assume that the amount of disturbance and relative north-westward shift will decrease south-westwards, away from the intrusive mass and the supposed main plane of weakness. In other words, the curve of shift against distance from the intrusive will flatten out. We have not enough data to find out just how rapid this flattening out may be, but some estimate of it may be attempted. The average gradient of the curve over the whole distance between Waiari and the copper mine† is 77%. Between Waiari and the base of the breccia south-west of Brodie's Creek it is 72.5%, while between this last point and the copper mine it is 80%.

This flattening of the curve of shift against distance from the intrusion becomes of interest when the distribution of the rocks of Group 1 is examined in the light of the tear fault movements. Let us assume that, over a further 2,400 yards south-westwards of Waiari, the average gradient of the curve falls to 70%. This means that the breccia base at Waiari must be shifted 1,680 yards to S.40°E., relative to the outcrop of the pillow lavas near the northern end of Tokerau Beach. Then, restoring the breccia base north-east of Waiari to its original east-and-west disposition, and plotting the position of the pillow lavas 700 yards north of the breccia base south-west of Brodie's Creek, we find that a line joining the pillow lavas at Tokerau Beach and the new

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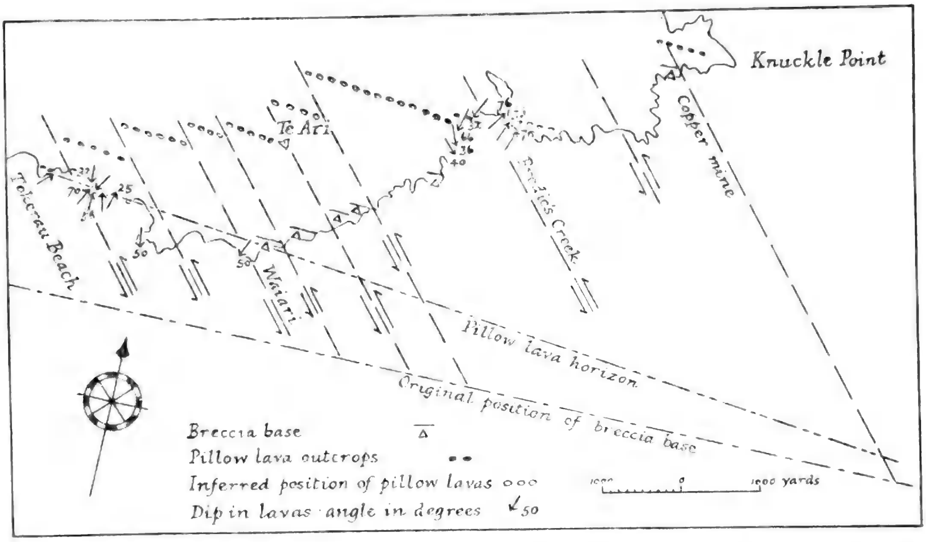
* In calculating the amounts of these displacements the strike of the base of the breccia has been taken as being east-and-west. There is a suggestion, in the trend of the relatively long section of the basal contact exposed south-west of Homarere, that it may have been originally more nearly east by south, the effect of drag on the tear faults having affected, to some extent, the whole of the short sections of the beds between them. If this is so the gradient of shift must be greater.

† It must be realized that the position of the contact at the copper mine is only approximately known at present.

position of those of Brodie's Creek trends east by south (text-fig. 3). It will be recalled that the few data gained from the outcrops of the Group 1 lavas suggested a more or less east-and-west strike, with which the results of the present reconstruction harmonize quite well. Further comment on the significance of this zone of tear faulting is given in discussion of the associated intrusive rock (p. 55).



Text-fig. 3. Diagram showing the effects of tear faulting along south-east coast of Rangiawhia Peninsula.

Correlation of the pillow lavas at Tokerau Beach and Brodie's Creek implies the persistence of basic submarine lava-flows at roughly the same horizon for 7,000 yards along the strike. This demand will be the more readily granted for the fact that, as has already been mentioned, between Taipa Beach and Mangonui Township, on the opposite shore of Doubtless Bay, basic variolitic lavas, showing pillow structure and similar in many respects to those around Whatuwhiwhi, form a continuous east-and-west belt for at least 8,250 yards along the coast.

The strong folding about east-and-west axes recorded by the rocks of Group 3 supports the view that this fold-direction represents a trend of fundamental importance in the Far North.

Structural data on the region north of the Raetea and Maungataniwha Ranges, which extend west-south-west from south of Whangaroa Harbour to south of Kaitaia, are not numerous. Concerning the northern flank of the Maungataniwha Range, McKay (1894, p. 72) remarks that "the Cretaceo-tertiary rocks sweep round the older rocks in all directions and, except where contact is made along lines of fracture by faulting, are usually inclined at moderate angles." He records dips to the west and north-west at Peria (1894, p. 85).

Marshall, who made only a rapid traverse of the country, states (1908, p. 81) that a north or north-north-east strike "appears to be represented in the hills between Mangonui and Oruru Valley and in the shales that are occasionally displayed in the range extending from Reef Point to Raetea."

In the Whangaroa district, Bell and Clarke (1909, p. 42) found that their Waipapa Series, which they regarded as Palaeozoic or early Mesozoic in age, is folded into an anticlinorium that trends west-north-west and east-south-east on the eastern seaboard and east-north-east and west-south-west in the inland area. Dips range from 30° to vertical. The rocks of their Kaeo Series, of Cretaceous and Tertiary age, they found to have a very variable strike, but they concluded that in the southern area around Lake Omapere the strike is east-north-east and west-south-west, while in the area around Whangaroa it is meridional (p. 47).

Ongley (in Morgan, 1919, pp. 39-40) has supplied data on the attitudes of limestones in the Victoria Valley and near Kaitaia. His observations suggest a dominant south-eastward strike and moderate south-westward dips. One almost east-and-west strike with a steep southward dip and one north-east strike and north-westward dip are recorded.

To these observations must be added the fact that Cretaceous rocks strike east-and-west and dip northwards at angles from 30° to 70° for a mile across the strike in Taipa Estuary.

In the North Cape-Cape Reinga area more detailed information is available in the work of Hector (1872), McKay (1894), Bell and Clarke (1910), and Bartrum and Turner (1928). From this work it is clear that the lavas and sediments of the Rahia (Upper Cretaceous) Series, with which the Whangakea Series is now united (Bartrum, 1934), strike east-and-west or west-north-west and east-south-east with moderate to steep dips. In the lowest division of the Coal Point (Mid and Upper Tertiary) Beds Bartrum and Turner record prevailing southward dips, with which McKay's statement (1894, p. 72) agrees, but in the middle and upper divisions the dominant direction of dip is south-westward at angles of from 15° to 35°.

These observations seem to justify the conclusion that there exists an important development of post-Cretaceous folding about east-and-west axes in the region north of the latitude of Reef Point and the Bay of Islands which has not so far received much attention save from Bell and Clarke (1909) in their statements on the Waipapa Series and the southern area of the Kaeo Series.

To move into a more speculative field, it seems possible that there is some connection between this east-and-west folding and the trends of the Raetea and Maungataniwha Ranges; the high ground on Rangi-awhia Peninsula, including Puheke; the North Cape-Cape Reinga block and the line of summits represented by the Three Kings Islands. Generally speaking, these areas have cores of hard rocks with Cretaceous and later sediments lying off them with, in many cases, northward and southward dips. When McKay (1894, p. 72) writes that "the Cretaceo-tertiary rocks sweep round the older rocks in all directions" it is possible that he is describing the effects on the attitude of the strata of axial culminations and depressions in a system of east-west folds.

It should be noted that Bartrum and Turner (1928, pp. 136-7) concluded that the evidence from North Cape supports the view that "fold-axes open out to the north and north-west of the main structural axis of New Zealand and pass through North Auckland as an integral part of [Suess's] 'Third Australian Arc.'" In reaching this conclusion they were influenced by the north-westward trend of the foliation in the gabbro of North Cape. The present study proves, however, that this gabbro, which must certainly be part of the same mass as that exposed in Rangiawhia Peninsula, was intruded under the influence of powerful north-westwardly directed shearing forces, to which its foliation may be ascribed, and that the intrusion and shearing were both later than the folding movements.

The mechanics of tear faulting have been dealt with by E. M. Anderson (1942, pp. 13-14 and Ch. V; see also Kennedy, 1946, pp. 67-70). Tear faults (transcurrent faults) theoretically should occur in two sets inclined at somewhat less than 45° to the direction of greatest pressure, the movements on one set being sinistral and on the other dextral. One or other of the two sets may in some cases be suppressed.

The trend (N.40°W.) of the tear faults in our area and the fact that the displacement on them is sinistral means that, to accord with Anderson's theory, the direction of greatest pressure must have been west by north and east by south. We are not dealing, therefore, with a system of folds and faults related to one direction of compressive force, like that so beautifully shown in South Wales (Anderson, 1942, p. 56). On the contrary, we must infer a change from north-south compression to east-west compression between the period of folding and the period of tear faulting. That such a change should take place within a relatively short span of time is surprising, but on the evidence available it seems that the idea must be entertained provisionally. The meridional strike found by Bell and Clarke (1909) in the northern area of their Kaeo Series may perhaps support the idea that such a change did take place.

There have been two main ideas about the structure of North Auckland. (1) The trend of the North Auckland Peninsula is not connected with the direction of fold axes, but is the result of a later system of fractures. This was the early view of Suess (II, p. 146) and was adhered to by Marshall (1908), Bell and Clarke (1909), Park (1921) and Benson (1924, pp. 128-132), though these geologists were not at one about the directions of fold axes. (2) The trend of the North Auckland Peninsula is the expression of a system of north-west trending folds. This was Suess's later view (IV, p. 318) and was held tentatively by Ferrar (1925, pp. 18, 33), more definitely by Bartrum and Turner (1928, pp. 136-7), and with considerable confidence by Macpherson (1946).

The study of Rangiawhia Peninsula supports the first of these conceptions and, more specifically, shows that the early folding there was about east-and-west axes and was presumably due to north-south compression, while it suggests that the later north-west fractures were due to east-west compression.

Enough is not known of the kind of displacement on the fault that brings black shales of Group 2 against beds of Group 3 for it to be definitely related to either of these two inferred systems of forces. The faulting took place before the north-westward tear faulting and probably after the east-west folding, for if the Group 3 beds are first unfolded an improbable flat-lying thrust must be invoked to explain the relations of the shales to the breccia group. The relative ages of the two sets of beds are not known with certainty, but from the appearance and degree of induration of the shale as compared with the breccias, conglomerates and sandstones, there can be little hesitation in pronouncing the shales the older. Where it meets the lavas of Group 1 near Homarere the fault hades 27° to the north-north-west. Evidence has already been given for the belief that the movement in the area mapped took place on two faults *en echelon.* If these are normal faults, a third system of forces is required to explain them. It seems more likely that they are related to one of the other sets of movements, in which case they are probably tear faults, and their behaviour where one of the planes meets the Group 1 lavas would suggest sinistral displacement, which would relate them to the epoch of north-south compression.

Age.

Nothing is known of the age of the shales of Group 2. From their indurated nature they are considered, without much doubt, to be older than the Group 3 beds.

In the absence of fossils and of descriptions of comparable beds elsewhere the age of the beds of Group 3 must also remain uncertain. Reasons have been given for the belief that the underlying rocks may be pre-Cretaceous, and it was there mentioned that the breccias, sandstones and conglomerates do not have a Tertiary aspect.

Conglomerates at the base of the Kaeo Series (Cretaceous and Tertiary) in the Whangaroa district contain pebbles up to 2 inches across of graphic granitic rocks (Bell and Clarke, 1909, p. 50), and pebbles of graphic granodiorite occur in Upper Cretaceous conglomerates on the southern shore of Hokianga Harbour (Mason, 1948). The large size of the masses of graphic granodiorite at Waiari, five or six feet across (plate 2, fig. 3), indicate that the terrain from which they came was close at hand. The presence of these boulders, together with the degree of consolidation and general field appearance of the grits and sandstones accompanying the conglomerates are virtually all the justification that exists for assigning to them an Upper Cretaceous age and regarding them as basal beds of the post-Hokonuian transgression. As there will be occasion to notice later, Bartrum (1934) correlates the intrusive of North Cape with the supposedly early Tertiary intrusives of Silverdale, near Auckland, and since the intrusives of Rangiawhia represent another portion of the North Cape mass, and cut the beds of Group 3, we have a tentative upper limit to the stratigraphical position of the latter and to the date of their folding.

GROUP 4.—INTRUSIVE IGNEOUS ROCKS.

Distribution.

As has already been mentioned, dykes of medium- to course-grained intermediate and basic igneous rock intrude the other solid formations in all parts of Rangiawhia Peninsula, but become more numerous and more massive eastwards, until they give place, around Whangatupere Bay, and in Cape Karikari, to a continuous mass of coarse-grained igneous rock.

The average trend of dykes is north-west by north, though those of a group in the headland east of Perehipe run more nearly north. With the exception of two dykes running east-and-west at the northern end of Tokerau Beach, the only other trend represented is between north-east by north and north-east by east near the contact of breccias and conglomerates of Group 3 with the lavas of Group 1 between Waiari and Brodie's Creek, and in the black shales, in which the intrusions are parallel with the parting.

The dykes are easily weathered and the sea has usually eroded them away to form north-west trending clefts and inlets along the coast. It may clearly be seen, as one proceeds eastward, how this grain gradually overmasters the general north-eastward trend of the south-eastern coast of the Peninsula and eventually becomes completely dominant and dictates the course of the coast-line at Whangatupere Bay and in Cape Karikari. Its influence, in reaction with the stubborn relics of the invaded country, produces the bipartite form of Matai Bay, an effect seen to even better advantage in the coastal morphology on both sides of Bergen's Point, at the south head of Doubtless Bay (Provisional One Mile Sheet N.7), and particularly in Taimaru Bay and the charming little trefoil indentation of Waimahana Bay.

In the deep, narrow bay 1,000 yards south-west of Brodie's Creek the pinnacles of rock arranged along north-west lines, which break the surface of the water, are masses of country rock resisting the sea after the intrusive rock that formerly enclosed them has been driven back a furlong to the north-west.

The south-western shore of Whangatupere Bay is composed almost wholly of intrusive rock with only small amounts of included hornfelsic country rock. In the ridges leading to the headlands of Knuckle Point and Pihakoa remnants of the roof of the intrusive are preserved in the form of metamorphosed lavas and sediments of Group 1, invaded by a swarm of dykes springing from the intrusive mass below. Quite large masses of country rock continue down to sea level at the north-western and south-eastern ends of Whangatupere Bay.

The western margin of the intrusion cannot be investigated along much of its length for lack of outcrops, but it probably does not possess a mappable boundary, passing rather, by increase in the amount of included rock, into a swarm of dykes, as for example in Maitai Pa* (plate 3, fig. 1) and the north-western corner of Matai Bay.

The rock composing the intrusion is petrographically very variable. It ranges from leucocratic types well seen in the two bluffs on the southern shore of Matai Bay to melanocratic rocks near the north-western end of Whangatupere Bay and in Cape Karikari. The various types have not yet been petrographically examined, but in the hand-specimen they are seen to include light- and dark-coloured diorites.

* The cusp in the centre of Matai Bay.

gabbros, pyroxenites and greenish, porphyritic, uralitized or chloritized andesites which appear to invade the other rocks in irregular dyke-like masses. Narrow veins of a fine-grained rock with a very small proportion of dark constituents traverse the complex. The contacts between the different rock types are sometimes sharp, sometimes gradational; they run straight for only short distances in most cases, but their general trend is between north and north-west.

The dykes west of the main intrusive mass are mostly andesites and porphyritic micro-diorites.

In the main mass at Whangatupere Bay there is a well developed joint pattern with one set of vertical joints, along which there has been intense shearing, running N.30°W. to N.40°W., and another set roughly at right angles to this, while a more or less horizontal sheeting characterizes the rocks exposed along the coast. The joints cross all types of rock in the complex indifferently.

The Rangiawhia intrusion strikes directly towards the massif of ultrabasic and basic rocks that forms North Cape and Kerr Point, in which there is a foliation trending steadily north-west and south-east in conformity with the strike of the south-western margin of the mass (Bartrum and Turner, 1928, p. 123 and map, p. 99). The gabbro at Whangatupere Bay and Cape Karikari is very similar in hand specimen and field occurrence to that exposed on the shore of the bay on the southern side of North Cape, and due west of the lighthouse, where leucocratic veins and hornfelsic inclusions like those at Whangatupere Bay are to be found. No peridotites, however, have been recognized in Rangiawhia Peninsula. Since Bartrum and Turner (1928, p. 121) remark that gabbroic rocks intrude the ultrabasics at North Cape particularly on the western margin of the massif, it is possible that peridotites lie off shore north-east of the coast at Rangiawhia Peninsula. On the other hand, it seems that there is a greater proportion of leucocratic rock-types exposed in Rangiawhia Peninsula, while biotite, which is not recorded in the descriptions of North Cape rocks, is conspicuous in the diorites and some of the gabbros at Rangiawhia. This, together with the preservation of part of the roof of the intrusion there, suggests that in the south-east we have exposed the upper part of the plutonic mass, which rose to a higher level in the crust at North Cape, where its deeper parts are now visible. The fact that much coarser-grained rocks (with crystals up to four inches across) are described from North Cape than any yet found at Rangiawhia may support this idea. Petrographic study of the rocks should throw more light on the question.

South-eastward, the Rangiawhia mass strikes towards Bergen's Point and thence to the intrusive mass of gabbro, diabase, diorite and andesite of post-Waipapa (Palaeozoic-early Mesozoic) and probably post-Kaeo (Upper Cretaceous-Tertiary) age mapped by Bell and Clarke (1909, pp. 76-7) around Haunga trig. station south-south-west of Kaeo. Little is recorded of the grain of the intrusive body here, but the rock types are the same as those to the north-west, and the copper mineralization associated with them provides a link with the Rangiawhia rocks.

It seems very likely that they should be regarded as part of the same great dyke-like mass*.

The correlation of the intrusions along the line between North Cape and Haunga implies that the tectonic environment and style of faulting so intimately linked with it at Rangiawhia probably prevails over the same distance. Bartrum and Turner (1928, p. 104) infer that the south-west side of the North Cape mass is faulted, and Bell and Clarke (1909, p. 80, etc.) emphasize that the country of the Pupuke copper mines around Haunga is much faulted.

This belt of intrusion and inferred faulting, from North Cape to Haunga, is probably part of a very much larger tectonic element, for, when its line is continued south-east of Haunga beneath the Kerikeri basalt flows, it emerges to run accurately along the south-western margin of the basement rock (here mapped as greywacke and argillite) from near Puketona to the western side of the Waiomio depression†. Recent discoveries by the Geological Survey have invested the line along the south-western margin of the greywacke from Waiomio to Whangarei (where it joins the Harbour Fault of Ferrar, 1925, p. 18) with very great tectonic importance‡. The details of this work are eagerly awaited, for it now seems that a line from North Cape to Whangarei Harbour mouth may be expected to prove of great significance in North Auckland structural interpretation.

Age of the intrusion and associated faulting.

Bartrum (1934), after incorporating the Whangakea Series of the older maps of the North Cape area in the Upper Cretaceous Rahia Series, pointed out that the North Cape gabbro and ultrabasic rocks must consequently be regarded as having been intruded during the orogeny that closed upper Cretaceous sedimentation in that area. He correlated them with the supposedly early Tertiary serpentine intrusions in the Silverdale district near Auckland.

It does not now seem necessary to suppose that the intrusion was connected with the folding movements that closed the Cretaceous and and early Tertiary sedimentation; rather seems it to have been connected with a quite different and later scheme of movements. When more is known of the age of the rocks of the Kaeo Series invaded by gabbros and diorites near Whangaroa Harbour it will be possible to give a more satisfactory maximum age for the intrusion and faulting. As for its minimum age, there are intrusions in the lowest division of the Tertiary beds near North Cape that might not unreasonably be supposed to be a product of the North Cape intrusive episode, though Bartrum and Turner who described them (1928, p. 127) did not regard them as such. If they are connected with the North Cape mass the period of intrusion and faulting is at least as late as lower Miocene.

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* There are similar rocks between Tupo Bay and Taupo Bay north-west of the entrance to Whangaroa Harbour and five miles north-east of the strike line through North Cape, Cape Karikari and Haunga, which may be genetically connected with the same intrusive system.

† A narrow tongue of basement rock crosses this line on the northern side of Ngapipito Valley owing to the upthrow on the northern side of the Kawakawa Fault.

‡ Personal communication from Mr. R. Hay.

All this remains speculative at present. All that can be said with certainty is that the whole episode of intrusion and faulting was post-Cretaceous.

5.—DRIFTS.

(a) *Elevated marine sands.*

A flat bench some 250 yards broad, a trifle under 100 feet above sea level and sloping inland slightly, fronts the coast between Waiari and Brodie's Creek. Subaerial erosion by a swampy streamlet that runs south-westward along its inland margin and collects the run-off from the high ground to the north has caused it to decline towards Waiari. The same surface may be seen around the Hall at Whatuwhiwhi and again north of the school-house, where it is 120 feet above sea level. Farther west it is represented in the flat tops of the spurs between Patia Beach and Perehipe (135 feet) and between Perehipe and Tokerau Beach (150 feet). Thence it skirts the western end of the Te Ari Ridge above the Tokerau Beach-Merita Road. In all these places it is underlain by sands which, to judge from the cuttings along the road, are about 70 feet thick on the spur between Tokerau Beach and Perehipe, though they are much thinner to the east, for only about 10 feet of them can be seen from the shore in the edge of the bench north-east of Waiari.

The schoolmaster's house at Whatuwhiwhi stands on a remnant of a subordinate flat bench 50 feet above sea level.

Sands cover the surface around the eastern end of the Te Ari Ridge, between Brodie's Creek and Merita, to a height of 195 feet, and they sweep up the northern flank of the ridge to about the same height along its whole length. The tops of the spurs are fairly flat for 1,500 yards south of Merita village—that is, to just below the 200-foot contour—where the ascent of the main east-and-west ridge begins and the sandy soil gives place to clay, but the break of slope is not very sharp and the upper limit of the sands can be fixed only roughly.

East and north-east of Merita the sands probably extend to about the 200-foot contour also (plate 3, fig. 1). The neck of land between Matai Bay and Karikari Bay is composed of them and they lap on to the slopes of the high ground along the eastern side of Cape Karikari.

Behind the little bay on the western side of the Cape, two terraces are well developed; the more prominent one is a little more than 100 feet above sea level, backed by low rolling downs to 200 feet, and the other is at about half this height. These two surfaces accord with those developed around Whatuwhiwhi. The 100-foot level is also represented above the cliffs of consolidated sand at the eastern end of Karikari Beach.

The sands vary in thickness. At the eastern end of Karikari Beach they extend to sea level, or below, while between the road and Matai Bay they are exposed almost to sea level and enclose well-preserved logs of wood and stumps of small trees. Northward, however, the sand capping the bluffs at the back of the northern half of Matai Bay can be seen feathering out against the slopes of the hill at the northern head of the bay.

It seems from the gradual decrease in the height of the coastal bench east of Tokerau Beach that a slight tilting downwards to the east accompanied, or followed, the change of sea-level. To explain the facts that the sands extend higher on the northern face of the Te Ari Ridge than on the south and that there is no definite break of slope at their upper limit, it may be suggested that more sand was supplied to the north-western coast and that wind-borne sand was swept up the shore above tide-mark there, whereas the well-marked bench on the southern and south-eastern coast shows the true level of the strand, as does the sand surface deposited just off the old shore around the eastern end of Karikari Beach and on the western side of Cape Karikari. The rolling surface, rising to 200 feet between the upper bench in this last area and the higher ground to the east, may represent old sand dunes behind the 100-foot shore.

The "100-foot" level* has not previously been recorded in the Far north (Henderson, 1924, pp. 582-3) but is well known along other parts of the New Zealand coast from the Auckland district southward and belongs to a period of erosion called by Henderson the Awakino Cycle (1924, p. 589). The 50-foot level represents a later, less prolonged period of steady sea level and may, perhaps, be linked with an erosion level of about this height near Whangarei (*ibid.*, p. 582).

(b) *Sand dunes* and (c) *Alluvium.*

The shifting and partly fixed sand dunes that form belts along the shores of the tombolo joining Rangiawhia Block to the mainland, the fixed dunes of its central part and the swamps impounded by the active dunes against the fixed ones will not be considered here.

On Rangiawhia Block itself small foredunes lie behind the beaches at Perehipe, Patia, Whakarara and the little bay west of Cape Karikari. A small alluvial bay-head filling lies behind the dunes of Patia and Whakarara, joining the headland at Patia Pa to the land on the north, and a small area of alluvium occupies the valley behind the dunes at Cape Karikari. These flats form an insignificant proportion of the land surface but are important in the farming economy of the Maori population.

SUMMARY.

The following conclusions can be drawn from the geological mapping of Rangiawhia Peninsula to date:

Igneous rocks of the spilitic suite, including basic pillow lavas and keratophyres, were poured out on the sea floor, and partly intruded into the muds and muddy sandstones accumulating there, probably in late Palaeozoic or early Mesozoic times. Such eruptions, it seems, took place over a wide area, the sequence of events at the Three Kings Islands being closely comparable with that at Rangiawhia.

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* Probably a little more than 100 feet on the average.

Little is known of the structure of these rocks, or of the earth-movements that followed their formation, but an east-and-west strike appears to prevail in them now. If the basic pillow lavas be accepted as of one horizon, their distribution offers some hope for the future elucidation of this phase. Perhaps granodiorites were intruded then. Whether they are of this age or older, they were exposed by erosion of the land that existed after the movements.

Succeeding submergence of a steep coastline crossing the area led to the formation of a great boulder beach over which grits and sandstones and probably a pile of other sediments were laid down as the waters deepened. This submergence possibly took place in Cretaceous times.

Violent folding about east-and-west axes followed this sedimentation and bent the strata to a vertical attitude. After the folding—perhaps as a later phase of the same movement, or long after—the crust broke along a fracture system running east-north-east along the south-eastern margin of the present Peninsula and the area to the south was displaced relatively to that on the north, so that shales of some lower formation were brought against the boulder beds and sandstones. The failure to find fossils to establish the age of the formations involved in this phase restricts severely the interpretation of the geological history.

Later still, in post-Cretaceous times, that part of the crust lying north-east of the area was wrenched north-westward for a distance of some miles, part of the displacement being accounted for by movements along a system of closely-spaced tear faults that runs north-westward across the present Peninsula and probably extends a long way to the north-west, through North Cape and to the south-east past Whangaroa, beyond which it may link with an important line of displacement that continues to Whangarei Harbour.

At the same time a long belt of intrusive basic and intermediate igneous rocks with numerous small offshoots was injected along the plane of movement over a distance of some 70 miles.

Subsequent small movements of sea level in comparatively recent times are recorded by elevated marine terraces and sands.

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Fig. 1. Pillow lavas 600 yards SSW. of Brodie's Creek. The formation dips 66° to the left (S. by W.).

Fig. 2. Closer view of pillow lavas SSW. of Brodie's Creek. There is hardly any sedimentary material between the pillows here: the interstitial rock is glassy lava.

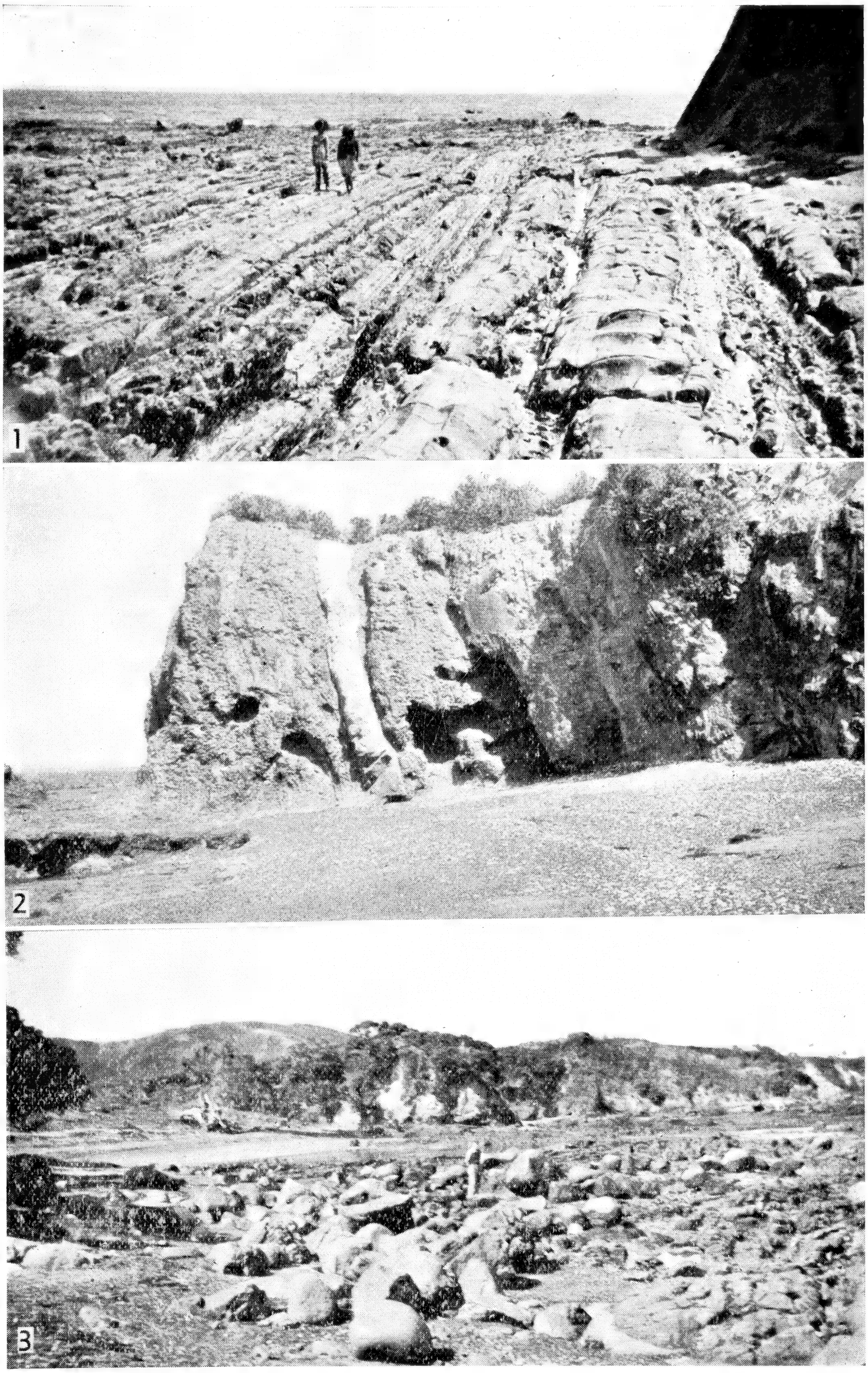


Fig. 1. Fine conglomerates, grits and sandstones at Waiari. Shales outcrop at extreme low tide mark at the upper left corner of the photograph.

Fig. 2. Breccia-conglomerates overturned and cut by a slightly transgressive sill 250 yards NE. of Homarere. Shales are faulted against them 18 yards to left of bluff.

Fig. 3. Boulders of graphic granodiorite weathered from conglomerate 100 yards N. of headland at Waiari. Beds containing them are 150 feet below those of Fig. 1.

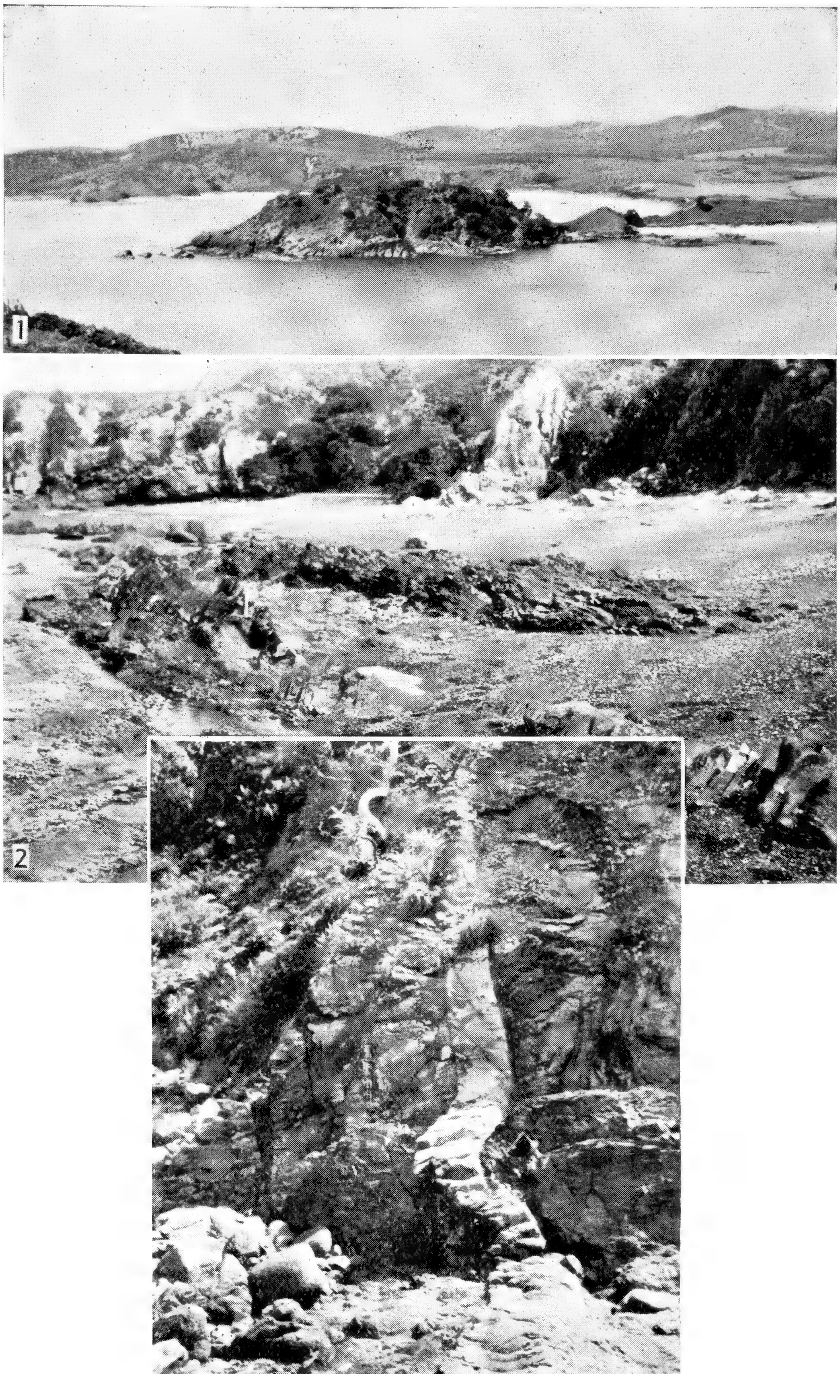
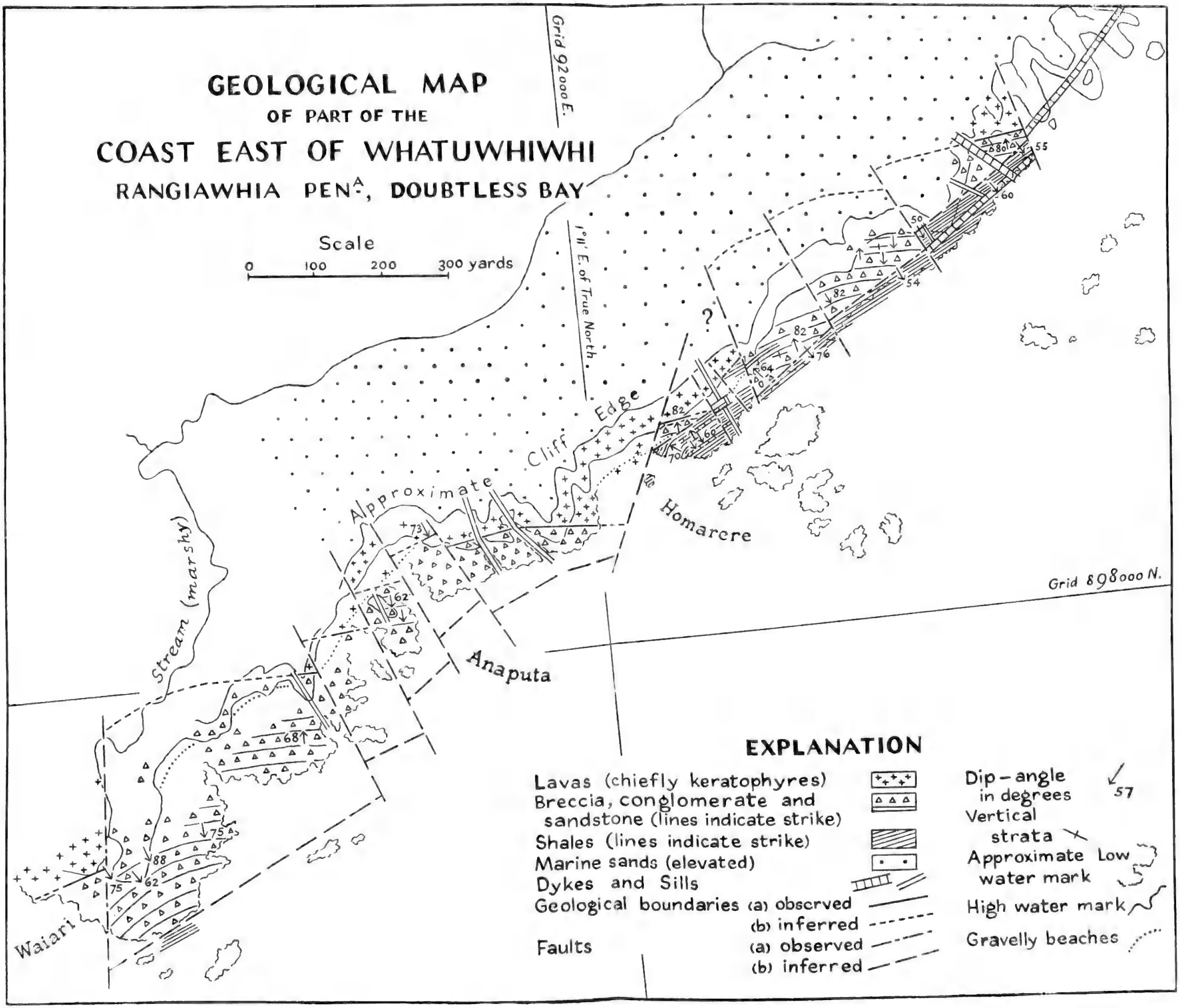


Fig. 1. Matai Bay looking S. NW. grain in Maitai Pa (centre) due to dyke intrusion and shearing. 200 feet sand surface behind right end of Pa.

Fig. 2. Black shales at Homarere. Hammer rests on sill. Keratophyres in cliffs. Between the two is a patch of breccia beyond right edge of photo. Flat top of cliffs is 100 feet marine terrace.

Fig. 3. Dyke cutting black shales 550 yards NE. of Homarere.


GEOLOGICAL MAP
OF PART OF THE
COAST EAST OF WHATUWHIWHI
RANGIAWHIA PEN^A, DOUBTLESS BAY
Scale
0 100 200 300 yards
Grid 92000 E.
1°11' E. of True North
Grid 898000 N.
Approximate Cliff Edge
Stream (marshy)
Homarere
Anaputa
Waiari
EXPLANATION
Lavas (chiefly keratophyres)
Breccia, conglomerate and sandstone (lines indicate strike)
Shales (lines indicate strike)
Marine sands (elevated)
Dykes and Sills
Geological boundaries (a) observed
(b) inferred
Faults (a) observed
(b) inferred
Dip-angle in degrees 57
Vertical strata
Approximate Low water mark
High water mark
Gravelly beaches

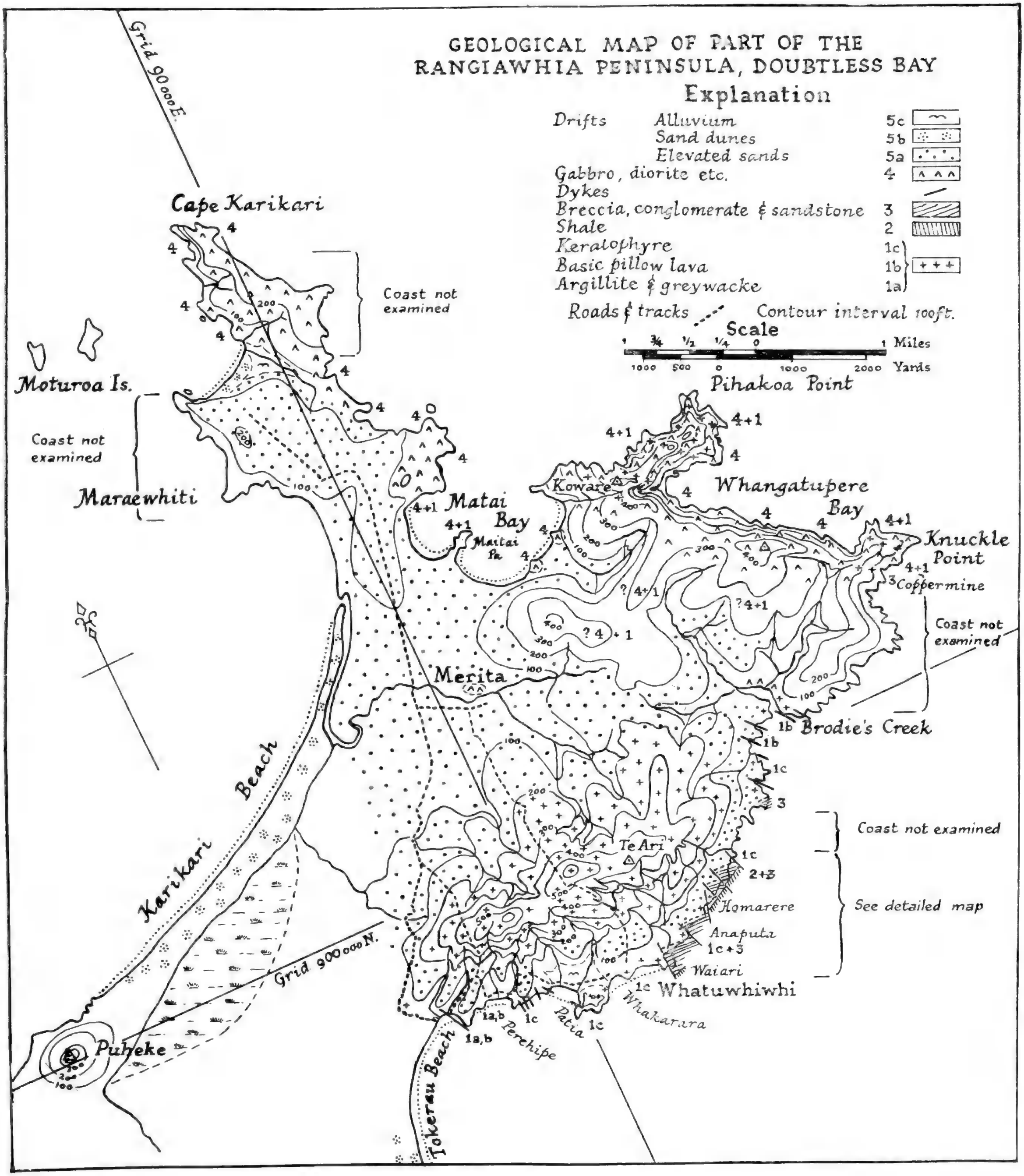

GEOLOGICAL MAP OF PART OF THE
RANGIAWHIA PENINSULA, DOUBTLESS BAY
Explanation
Drifts Alluvium 5c
Sand dunes 5b
Elevated sands 5a
Gabbro, diorite etc. 4
Dykes
Breccia, conglomerate & sandstone 3
Shale 2
Keratophyre 1c
Basic pillow lava 1b
Argillite & greywacke 1a
Roads & tracks
Contour interval 100ft.
Scale
Miles
Yards
Grid 90000E.
Grid 900000N.
Cape Karikari
Coast not examined
Moturoa Is.
Maraewhiti
Matai Bay
Maitai Pa
Pihakoa Point
Kowaro
Whangatupere Bay
Knuckle Point
Coppermine
Merita
Brodie's Creek
Te Ari
Homarere
Anaputa
Waiari
See detailed map
Whatuwhiwhi
Whakarara
Patia
Perehipe
Tokerau Beach
Karikari Beach
Puheke

PLATE 5.

Life History of Austrosuccinea archeyi, an Annual Snail, and its Value as a Post-Glacial Climatic Indicator.

By A. W. B. POWELL, Auckland Museum.

Abstract.

A native snail, *Austrosuccinea archeyi*, first discovered in consolidated sand of post-Pleistocene age at Doubtless Bay, Northland, is now shown to be a still living species on coastal dunes, with a range from Spirits Bay to Mount Maunganui and as a fossil to as far south as Cape Kidnappers. This snail is found to have an annual cycle which correlates with rainfall. The extremely specialised habitat and narrow tolerance of these snails makes the fossil occurrences useful indicators of past xerophytic phases in respect to post-Pleistocene climate.

In 1933 I described a new species of land snail (*Succinea archeyi*) obtained from post-Pleistocene consolidated sands associated with "moa" remains (*Euryapteryx geranoides* and *curtus*) at Tokerau Beach, Doubtless Bay. The New Zealand snail is closely allied to the Recent South Australian *Succinea australis* Ferussac, 1821, which species Iredale (1937, p. 307) made the type of his genus *Austrosuccinea*.

In June, 1947, Mr. C. W. Devonshire, then of Lake Ohia Native School, reported that living *Austrosuccinea* were abundant during winter and spring just behind the fore-dune at the "planks," road access to Tokerau Beach, but that living examples entirely disappeared during the summer months. A personal visit to the locality in June, 1947 confirmed the presence of living *Austrosuccinea*.

ACKNOWLEDGMENTS.

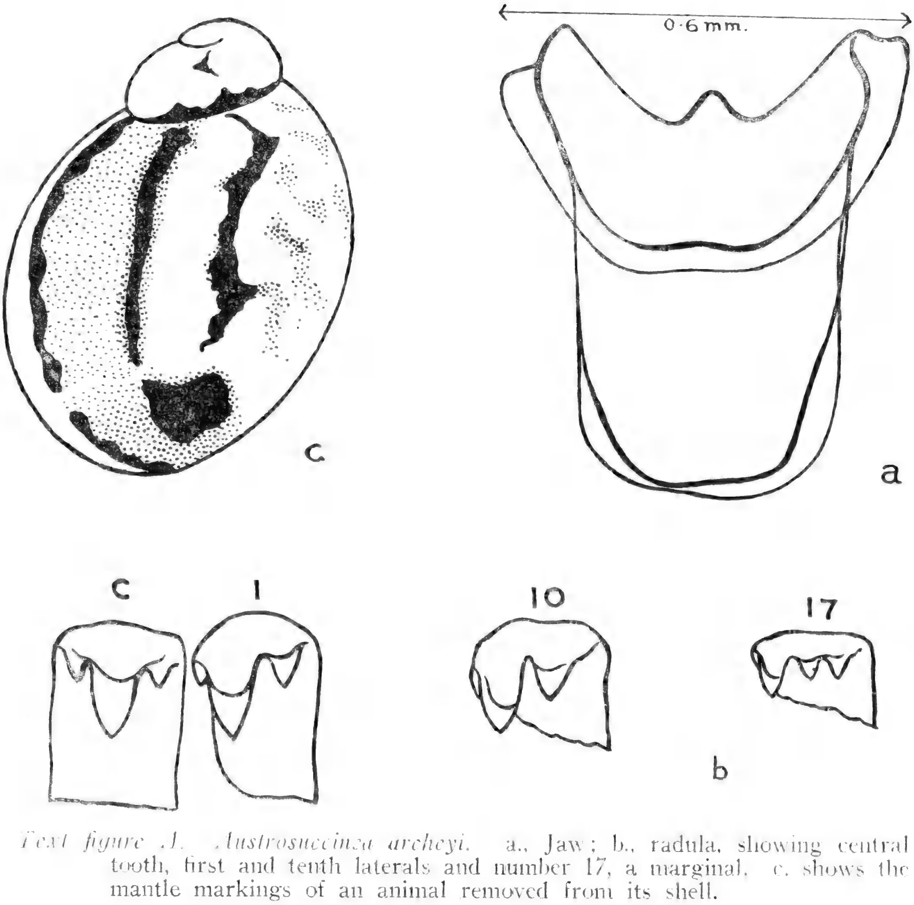
I am greatly indebted to Mr. C. W. Devonshire for his original report and subsequent observations, to Mr. A. Hancox for monthly records and growth series taken over a period of from two to three years, and to Mr. D. G. Forsyth for similar observations whilst he was stationed near the locality. For useful data relating to other occurrences I am indebted to Messrs. J. D. H. Buchanan, of Havelock North, R. K. Dell, Dominion Museum, Wellington, and G. Williams, Mt. Maunganui.

The rainfall records were generously made available by Dr. M. A. F. Barnett, director of Meteorological Services, Air Department, Wellington, and the botanical determinations by Mrs. Allen (nee Miss B. E. G. Molesworth), Miss U. V. Dellow and Mr. Robert C. Cooper.

The Generic Position of archeyi

Iredale's proposition of *Austrosuccinea* (1937, p. 307) is based primarily upon Quick's (1933, p. 312) statement that Victorian specimens (*australis*) resemble *arenaria* in jaw, radula and genitalia. Since then Boettger, 1939, proposed *Quickella* for the English-European *arenaria*, and Quick (1936, p. 42) has claimed considerable resemblance between the South African *striata* and *australis*, special reference being made to the characters in common of less than twice as many marginal as lateral teeth and the large median projection on the jaw. In this later paper Quick disassociated *australis* and *arenaria* on the grounds that a penis sheath is present in the former but absent in the latter.

Pilsbry (1948, pp. 771-847) recognised the genera *Oxyloma*, *Succinea* and *Quickella*, but reduced *Austrosuccinea* to a synonym of *Succinea* on the grounds that the few diagnostic remarks made by Iredale were misleading. Nevertheless, there seems to be a good case for the recognition of *Austrosuccinea* in the light of Quick's (1936) remarks.



Text figure J. Austrosuccinea archeyi. a., Jaw; b., radula, showing central tooth, first and tenth laterals and number 17, a marginal. c. shows the mantle markings of an animal removed from its shell.

Summarised, the differentiating criteria for the several Succinid genera would appear to be as follows:

Penis provided with a sheath
    Penis with a narrow appendix
        Jaw with weak median projection only
            Marginal teeth with long tapered bases
            Four to five times as many marginals as laterals .. *Oxyloma*

Penis without an appendix
Jaw with strong median projection and (usually) lateral folds
Marginal teeth with long bases
Twice as many marginals as laterals .... *Succinea*

Jaw with strong median projection only
Marginal teeth with broad shallow bases
One and a half as many marginals as laterals *Austrosuccinea*

Penis without a sheath
Jaw with strong median projection only
Marginal teeth with broad shallow bases
Marginals and laterals few and of equal number .. *Quickella*

I have no preserved material of *australis*, but from Quick's excellent account of that species (1936, pp. 36-39) the New Zealand *archeyi* appears to be very similar.

The radula of *archeyi* shows a slight difference from that of *australis* in that the cones are shorter. The radula formula $15 + 10 + 1 + 10 + 15 \times 90$ is almost identical with that of *australis*, which according to Quick is $16 + 10 + 1 + 10 + 16 \times 90$. It appears also that *australis* is not restricted to a sand-dune habitat, but occurs inland also.

Quick (1936, p. 37) described very different mantle markings for *australis* from those found in *archeyi*. He described the mantle in *australis* as dark and opaque with a faint indication of mottling at the periphery and with a few yellowish-white chalky spots. In *archeyi* there is a sparse pattern of several dark intermittent narrow axial streaks with a large dark rectangular patch near the lower front margin of the mantle (Text fig. Ac.).

It is of interest also that Quick (1933, p. 310) records the English *arenaria* as living on damp circular depressions in sand dunes and that Pilsbry (1948, p. 843) describes the habitat for the eastern North American members of this genus *(Quickella)* as living in small thickets in the sandy shore zone.

That an annual cycle is not peculiar to the New Zealand species is shown by a note under *Oxyloma decampi gouldi* Pilsbry (1948, p. 782), a New England *Succinea* that frequents the aquatic vegetation of muddy ponds, river margins and ditches. "Probably most of the large individuals die by the end of summer, as I have often found only half-grown shells in autumn where large ones were found earlier in the season."

Habitat

The habitat of *Austrosuccinea archeyi* is extremely specialised, for the species occurs on a substratum of fine textured loose sand (fine quartz-sand at most places) only on or in the vicinity of the first and second dunes, parallel to the beach, usually in a narrow belt not more than 100-200 yards wide, and only where the original rather sparse native plant cover remains intact. That is the "Sand-grass Dune Community" to the "Scrub Dune Community" of Cockayne (1928, pp. 92-93).

The natural shade or shelter plants of the *Austrosuccinea* habitat are *Cassinia retorta* A. Cunn., *Spinifex hirsutus* Labill, and more uncommonly *Coprosma acerosa* A. Cunn. and *Muehlenbeckia complexa* Meissn. Two introduced plants add to the cover in certain areas (Taipa Beach): lupin, *Lupinus arboreus* Linn. and a Mediterranean grass, hare's tail, *Lagurus ovatus* Linn.

The food plants essential to the snails are a blue-green alga *Anabaena variabilis* Kutz *(Cyanophyceae)*, which is available only during the wet months, and the outer tissue and finer roots of the *Spinifex* during the dry months, when the *Anabaena* dries and disappears.

Observations by Mr. Hancox show that *Anabaena* is in a lush state from May to August, is more or less dessicated during September to early October, dries up and is dispersed by winds from October to March and new growth appears again with the rains during March or April.

LIFE HISTORY

Food, or its availability, which is governed by moisture, controls the growth and life span of *Austrosuccinea archeyi*. These snails hatch from between June and August and reach maturity, just under 13 mm. in height, within twelve months, all adults dying between August and October of the year following their birth.

Young snails tide over the dry months of late spring and summer by partial aestivation, during which they keep alive with difficulty—but add little to their growth. They lie dormant in the sand around the roots of *Spinifex* and sealed by an epiphragm during dry periods, but will emerge and feed during rains. The alga has by this time disappeared, and until the new growth appears in March or April the young snails have only the food afforded by the *Spinifex*. Since hatchings occur over a period of two months in the spring and heavy mortality results from abnormal dry periods the size ranges vary from year to year for this reason. Fully grown living adults, however, can only be obtained from July to the end of September.

A prolonged dry summer results in a very late commencement of adult growth, but under such conditions growth seems to be accelerated when the rains commence and full adult size obtains before the end of August, the regular time for the dying off of the adult population. It was noticed that even during an abnormally wet spring the adult mortality took place in spite of the fact that the algal food was still in good supply. The life cycle of the snail is thus shown to be geared to the average conditions.

I have not yet managed to visit any of the colonies of the snails during the breeding months, but Mr. A. Hancox noted copulation and eggs on 28th April, 1949, and Mr. C. W. Devonshire recorded the deposition of eggs in clusters of up to fifteen on 16th July, 1947. He described the individual eggs as spherical and approximately 1 mm. in diameter and that they were attached to the thallus of the alga.

An egg associated with snails preserved in alcohol and collected by Mr. Hancox on 28th April, 1949, had a diameter of 1.75 mm. It was spherical with a large yolk which was slightly yellowish with a fine irregular network of faint lines, not reticulated. The yolk was surrounded evenly by a covering of clear jelly.

Monthly size log for Austrosuccinea

	Smallest	Average	Largest	Locality	Remarks
Jan. 2, 1949	2.50	5.00	6.75	To.	
20, 1948	4.00	6.00	8.50	To.	
Feb. 12, 1949	2.75	5.00	7.50	To.	
Mch. 21, 1949	6.50	7.25	8.30	S.	+
April 25, 1950	6.50	8.00	9.00	Ta.	
28, 1949	6.00	9.50	10.50	To.	
May 25, 1950	5.50	8.50	9.25	Ta.	
27, 1949	7.00	10.50	11.75	Ta.	
27, 1949	7.25	9.00	10.75	To.	
June 6, 1948	7.50	10.00	11.50	To.	
10, 1949	7.75	9.50	10.30	To.	(40% dead)
19, 1947	7.50	9.00	10.50	To.	
25, 1950	7.20	8.75	9.00	To.	
July 14, 1949	7.10	8.50	11.75	To.	(80% dead)
Aug. 2, 1947	8.25	11.00	12.25	To.	(maximum)*
3, 1948	7.50	10.00	10.75	To.	
25, 1948	6.75	10.00	11.50	To.	
Sept. 19, 1948	8.50	9.00	10.50	To.	(mostly dead)
Oct. —	—	—	—		(all adults dead)
Nov. 3, 1948	2.00	5.50	7.75	To.	(new generation)
Dec. 9, 1949	2.50	4.50	7.60	Ta.	
12, 1948	3.50	5.50	7.00	To.	

(To. = Tokerau Beach, Ta. = Taipa Beach, S. = Spirits Bay,
+ = abnormally wet season.)

Maximum sized dead example 13.00 mm. (To. 3/8/1948).

*Maximum sized living example, 12.25 mm.

Although the above records are rather intermittent the rapid winter growth curve, which corresponds with the availability of *Anabaena*, the adult mortality period from August to the end of September and the appearance of the new generation in November, are all very clearly shown.

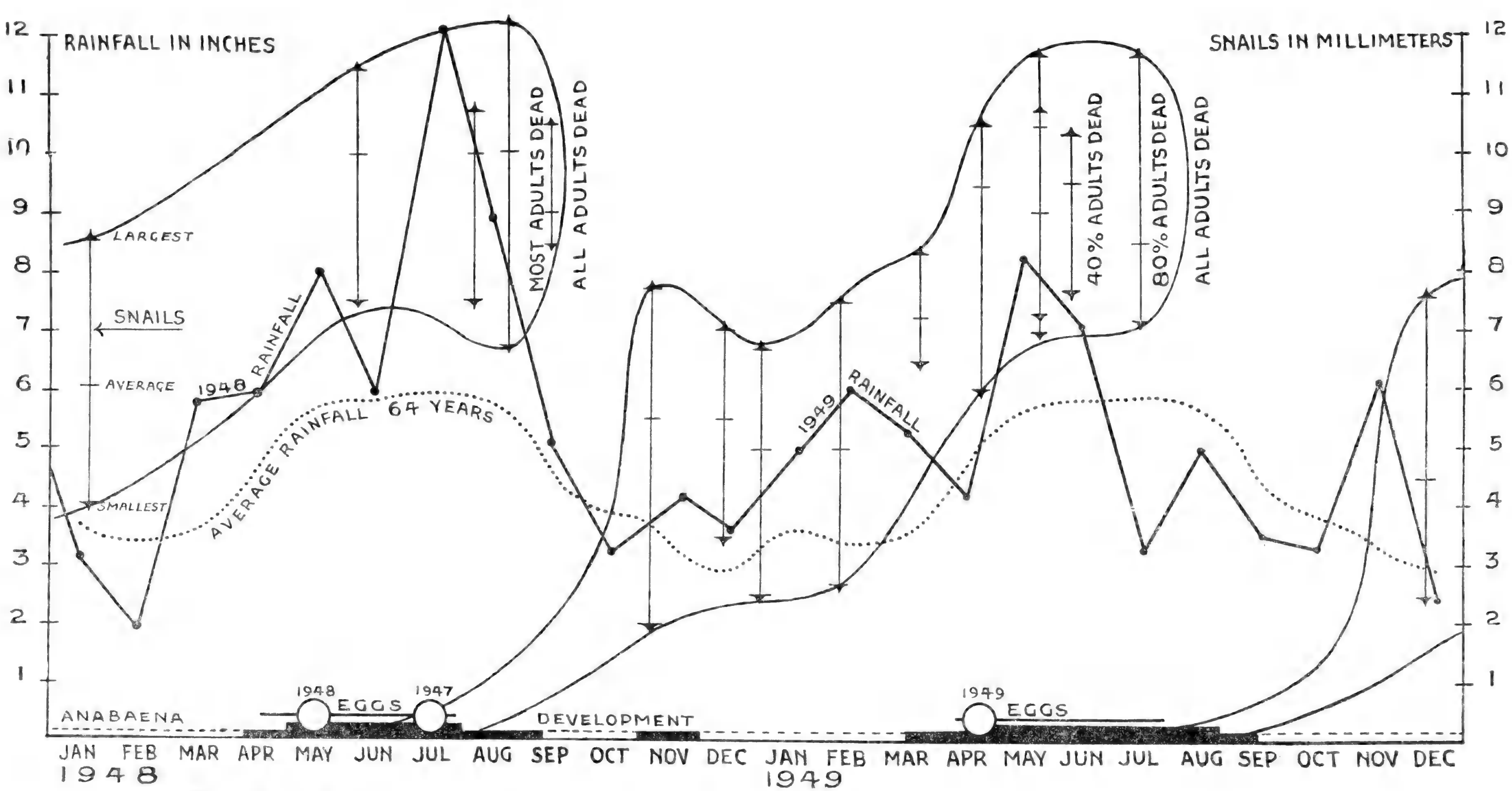
The monthly size ranges show variation from year to year, but this is resultant from a variable rainfall, year to year, as shown by the following table and in text figure B.

Rainfall in inches at Mangonui

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1947	.94	.65	2.78	7.89	5 27	7.61	10.46	5.21	6.12	3.91	6.09	6.20	63.13
1948	3.10	1.87	5.70	5.87	8.00	5 88	12.08	8.86	5.05	3.21	4.21	3.63	67.46
1949	4 99	6.03	5.32	4.13	8.28	7.10	3.25	5.01	3.60	3.31	6.21	2.49	59.72
Average 64 years	3.72	3.39	3.57	4.64	5.66	5 79	5.92	5.76	4.57	3.96	3.28	2.98	53.24

These records were kindly supplied by Dr. M. A. F. Barnett, Director of Meteorological Services, Air Department, Meteorological Branch, Wellington.

It was remarked that over the period of 64 years at Mangonui, a rainfall of 12.08 inches (July, 1948) has only been exceeded once in July, and that was in July, 1946.



Text figure B. Graph representing the growth of *Austrosuccinea* generations over two years plotted against rainfall for the relevant years shown in relation to the average rainfall curve for 64 years. The period of egg laying is shown below and the relative abundance or absence of the alga *Anabaena*. The vertical lines with arrow points represent the minimum and maximum sizes respectively and the cross bar the average size for each dated sample examined.

Living Colonies of Austrosuccinea

Spirits Bay, 1-3½ miles S.W. from Kapowairua, A. Hancox, R.A. and H. S. Prouse and A.W.B.P., 21/3/1949. The alga *(Anabaena)* was abundant and fully developed as in mid-winter, owing to an unusually wet summer season. The maximum size was 8.30 mm., which is large for this time of the year but resultant from a phenominally early growth of *Anabaena*. The colonies of snails, which were quite prolific, were under the shelter of *Coprosma acerosa* A. Cunn. and *Muehlenbeckia complexa* Meissn.

Tokerau Beach, Doubtless Bay, C. W. Devonshire, D. G. Forsyth, A. Hancox, A. C. O'Connor and A.W.B.P., 1947-1950. Distributed intermittently between the first and second coastal dunes over the entire length of the beach. The most accessible colony is at the "planks" or road access to the beach. Very extensive fires during the summer of 1950 have taken heavy toll of the colonies. The shelter plants are *Cassinia retorta* A. Cunn., *Spinifex hirsutus* Labill, and more uncommonly *Coprosma acerosa* A. Cunn. and *Muehlenbeckia complexa* Meissn. This paper deals largely with the material collected and observations made at this locality over the period from June, 1947, to July, 1950.

Taipa Beach, Doubtless Bay, A. Hancox and A.W.B.P., 1949-1950. A flourishing colony occupies the fore-dune over the western half of the beach. There is rather more shelter than in other more natural locations owing to the addition of two vigorous introductions, the hare's tail grass, *Lagurus ovatus* Linn. and the lupin, *Lupinus arboreus* Linn.

One mile north of Tauranga Kawau Point, between Whananaki and Mimiwhangata, A.W.B.P., 27/10/1947. The remains of what had been a living colony of snails a few months earlier occupied only a few square yards of the foredune. The shelter plants were very sparse, only *Cassinia retorta* and *Spinifex hirsutus*, the latter being quite dead. The *Anabaena* was still moist and fleshy where it was under cover. Grazing sheep had so reduced the plant cover that it is doubtful if this colony still exists.

Mount Maunganui, Bay of Plenty, in coastal dunes several miles eastward along the beach. Living examples were taken by Mr. G. Williams in 1947, but a recent search (Aug., 1950) failed to locate the species either alive or dead.

Extinct or subfossil colonies of Austrosuccinea

1. On rounded, almost detached headland one mile south of Cape Maria van Diemen (mainland). R. Michie and A.W.B.P., 17/11/1948. This headland has a thick cover of 15 to 20 feet of consolidated wind-blown sand on a base of hard rock. At present most of the top of the headland is in rough grass fringed with flax *(Phormium)* and a stunted area of coastal scrub down the almost perpendicular seaward face. On the landward side there is only drifting sand and bare rock with no vestige of plant cover. Erosion of the consolidated sand in several places reveals fossil *Austrosuccinea* in a

band one to ten inches below the surface, and scattered for some feet deeper are fossils of *Rhytida duplicata* and a *Placostylus* ancestral to a living new subspecies which occupies the scrub area of the seaward cliff.

The sequence revealed by these occurrences suggests an early cover of coastal scrub with *Placostylus* and *Rhytida* followed by a dry period when the scrub disappeared from all but the seaward cliff, and the headland was overwhelmed by blown sand. Then the process of consolidation under more moist conditions, the development of the Sand-grass Community allowing advent of *Austrosuccinea* and now the development of the Shrub-dune Community modified by grazing stock. The now complete cover of the sand on the headland excludes *Austrosuccinea*, which apparently only exists under xerophytic conditions.

2. On a small island directly south of the most northern headland block at Cape Maria van Diemen mainland, A. Hancox and A.W.B.P., 18/11/1948. This island has been completely burned off and is now covered by a rank growth of "spiny clover."

   Remains of *Austrosuccinea* and *Placostylus ambagiosus worthyi* Powell are abundant in the surface layer of ash and humus. The sequence here has been from coastal scrub to a Sand-grass dune Community, but the cover of blown sand is slight compared with the first locality. Succession from the xerophytic phase has been obscured by recent fires, but the charred remains of stunted *Metrosideros* and *Coprosma* indicate a normal development to the Sand-scrub Community.

3. The "*Placostylus ambagiosus priscus* block" occupying the high dune and "bad-lands" area lying about 1 mile to the south of the N.W. Cape Maria van Diemen mainland headland and the Werahi Stream and including the high dune of Herangi, 700 feet. The south-west corner of this block is of consolidated light brownish sand and produces fossil remains of *Paryphanta watti*, *Rhytida duplicata*, *Serpho kivi* an arboreal snail, and *Liarea* n. sp. as well as vast numbers of *Placostylus ambagiosus priscus*. The presence of the former indicates a contemporary condition of dense coastal rain forest. The mode of occurrence of the snails at this locality (Bartrum & Turner, 1928, pl. 21, fig. 7) is exactly as those found living at Unuwhao, 700-900 feet, between Spirits Bay and Tom Bowling Bay. Meandering lines of *Placostylus* as they occurred nestled in along roots and under *Astelia*, *Liarea* in circular patches suggestive of their association with *Carex* clumps, and the sporadic occurrence of *Paryphanta watti* are all indicative of a natural forest community suddenly overwhelmed by advancing sand dunes. That the underlying consolidated sand was capable of supporting a coastal rain forest is thus indisputable, as also is the inference that the climate must have been much more moist than now. Now the vegetation in the block is restricted to a sparse covering of scrub with flax (*Phormium*) and toetoe (*Arundo kakaho*) only on the top of Herangi. Here again the deterioration to xerophytic conditions is

shown by marginal occurrences of fossil *Austrosuccinea.* Burning of the area by the former Maori occupants and subsequently by settlers has undoubtedly hastened the destruction of the vegetation and allowed mass movements of sand.

It is interesting to note that a map of the area prepared by T. K. Thompson in 1895 and now in the Lands and Survey Office, Auckland, shows a covering of "fern, manuka and scrub" between Herangi and the West Coast (i.e., No. 1 locality). This traverses the middle of the *priscus* colony where the heavy rain forest formerly stood. Further, a photograph taken by W. H. Winkelmann in 1902 from Cape Maria van Diemen Island shows the whole of this area to the upper slope of Herangi to be devoid of vegetation as it is today.

4. North-western end of Tokerau Beach, Doubtless Bay, G. Archey and A.W.B.P., February, 1932. Type locality for the species, which was found abundantly as a fossil with "moa" remains. Other fossil land snails in the consolidated dunes, notably *Rhytida dunniae* and *Phenacharopa novoseelandica*, indicate a former coastal forest cover. Living *Phenocharopa* elsewhere in the north is found only in the very damp innermost recesses of tall nikau *(Rhopalostylis)* stands.

5. Sand dunes $1\frac{1}{2}$ miles south of Ngunguru, A.W.B.P., 1934. Bleached shells are encountered in loose sand drifts. A Shrub-dune area exists nearer to the Ngunguru river and the alga *Anabaena* is abundant, but no living *Austrosuccinea* were located.

6. Ocean Beach, Whangarei Heads, R. K. Dell, Jan., 1938, bleached shells in coastal dunes.

7. In consolidated sand at the back of the dunes, Oneroa, Waiheke Island, Auckland. K. Hipkins, 1946. The outcrop has since been destroyed by building activities.

8. Ocean Beach, five to six miles south of Cape Kidnappers in fixed dunes, about 100 yards from the beach, together with fossil *Rhytida spelaea* Powell; J. D. H. Buchanan.

Age significance of the subfossil occurrences

It will be noted from the above list and chronological table (following) that the same climatic sequence is shown in each locality. That is, a former moist climate allowing of a coastal rain forest on beach flats, followed by a presumed dry period when the coastal forests died and allowed the formation of drifting dunes and the development of a Sand-grass Community with *Austrosuccinea* and ultimately the elimination of that species under natural conditions with the succession to the fully developed Shrub-dune Community. In most cases, however, the advent of grazing animals, fires and other human interference has intervened between the development of these two communities.

The dating or correlation of the New Zealand periods of climatic change with those of the more fully known European sequence is conjectural.

Raeside (1948, pp. 153-171) dated the Canterbury warm forest period from between the seventh and the fourteenth centuries A.D. He also drew attention to the Report of the Committee on Glaciers for 1945 (Trans. Amer. Geophys. Union, 27, p. 219), in which it was postulated that the causative climatic variations affected both hemispheres simultaneously and not in alternation and therefore it is reasonable to suppose that the same pronounced Post-Pleistocene variations and the major Pleistocene variations were also synchronous in the two hemispheres.

One other line of evidence has a direct bearing upon the Northland climatic sequence, and that is the occurrence in raised beaches of the bivalve mollusc *Anadara trapezia*.

This is a gregarious species living partially buried on inter-tidal mudflats. It occurs living in the subtropical waters of Queensland, New South Wales and the Great Australian Bight, and as a fossil in South Australia, Victoria, Tasmania and Northern New Zealand. Its present restricted distribution is considered to have been due to refrigeration, the habit of living partially exposed to the atmosphere making it an easy victim to a sudden drop in temperature.

It is worthy of note that odd worn valves of this species occur in slightly raised beds of coarse shelly shingle underlying the foredunes both at Spirits Bay and at Tokerau Beach. These shingle beds must have been deposited during the first post-glacial period, when they received their covering of wind-blown sand that later consolidated during the warm, humid, second period, allowing of the growth of coastal rain-forest. Crocker and Cotton (1946, pp. 64-82) discuss Australian *Anadara* occurrences at some length and conclude, quoting Professor David, that the last Australian cold phase was from three to ten thousand years past and that the period of maximum aridity in South Australia may have been as late as three thousand years ago.

I have just received a paper by W. F. Harris, "Climatic Relations of Fossil and Recent Floras" (1950), pp. 53-65), in which the following chronology is suggested:

Recent or Holocene

Period 1. First post-glacial period to about 5000 B.C. (= Northern Boreal). Increasing warmth and comparative aridity.

Period 2. Period of maximum warmth, 4500-500 B.C. Greater portion of this period humid (= Atlantic), latter part dry (= Sub-Boreal).

Period 3. Cooler and moister climates lasting to the present day. Rainfall higher than now until a few centuries ago. (= Sub-Atlantic.)

Apparent sequence for four Northland Austrosuccinea sites

1	2	3	4	
Headland 1 m. S. of Cape M. v. Diemen	Pl. a priscus block, 1 m. S. Cape M. v. Diemen.	N.W. headland Cape M. v. D. (mainland)	Spirits Bay dunes 1-4½ m. S.W. from Kapowairua.	
Sh-dune with Pl. 1.	Drifting sand overwhelming Sh.-dune at Herangi.	Sh.-dune	Sg.-dune with A.	Present.
Sg.-dune with A. Sh.-dune with Pl. 1.	Sg.-dune with A. Sh.-dune with Pl. p.	Sg.-dune with A. Sh.-dune with Pl. c.	Sg.-dune with A.	Period III: as now. A.D. to Present: more moist.
Coastal f. with Pl. 2.	Rain f. with Pl. p., Pa., R.S. & L.	Coastal f. with Pl. W.	Sh.-dune - Sg.-dune with Pl. 3 (dwarf) coastal f. with Pl. S.	Period II: dry. 4500-500 B.C.: warm humid.
Formation of older consolidated dunes on ROCK FOUNDATION (Older volcanic Whangakea Series? Trias Jura)			* * *Anadara* in raised shelly beach underlying dunes.	Period I: comparative aridity. -5000 B.C.: increasing warmth.
				Pleistocene.

(Abbreviations: Sg.-dune = Sand-Grass Dune Community; sh.-dune = Shrub-Dune Community; f. = forest; A = *Austrosuccinea*; L = *Liarea* n. sp.; Pl. 1 = a living new subspecies of *Placostylus ambagiosus;* Pl. 2 = a fossil ancestral form of Pl. 1; Pl. 3 = a new fossil subspecies or form of the *ambagiosus spiritus* group. It is dwarfed and obviously lived under xerophytic conditions; Pa. = *Paryphanta watti;* Pl. c. = *Placostylus a. consobrinus;* Pl. p. = *a. priscus;* Pl. s. = *a. spiritus;* Pl. w. = *a. worthyi;* R. = *Rhytida duplicata* and S. = *Serpho kivi.*)

Note.—The asterisks in the column for locality 4 denote the absence of consolidated sands at this site. It is presumed that the *spiritus* colonies were originally associated with consolidated sands, but these have since broken down and become loose and drifting with the fossil snails lying on or near the surface.

Study of the above table reveals an alternative possibility, and that is the assumption that the Northland formerly rain-forested coastal dunes were contemporary with the Canterbury warm forest period, referred by Raeside to Period III between the seventh and fourtheenth centuries A.D.

However, it is much more likely that these consolidated dunes had their origin in the comparatively arid Period I and received their rain forest cover during the succeeding warm humid period of 4500-1000 B.C., for the Northland sequence seems to indicate that the moist early centuries of Period III had a rainfall only sufficient to support a Shrub-dune Community.

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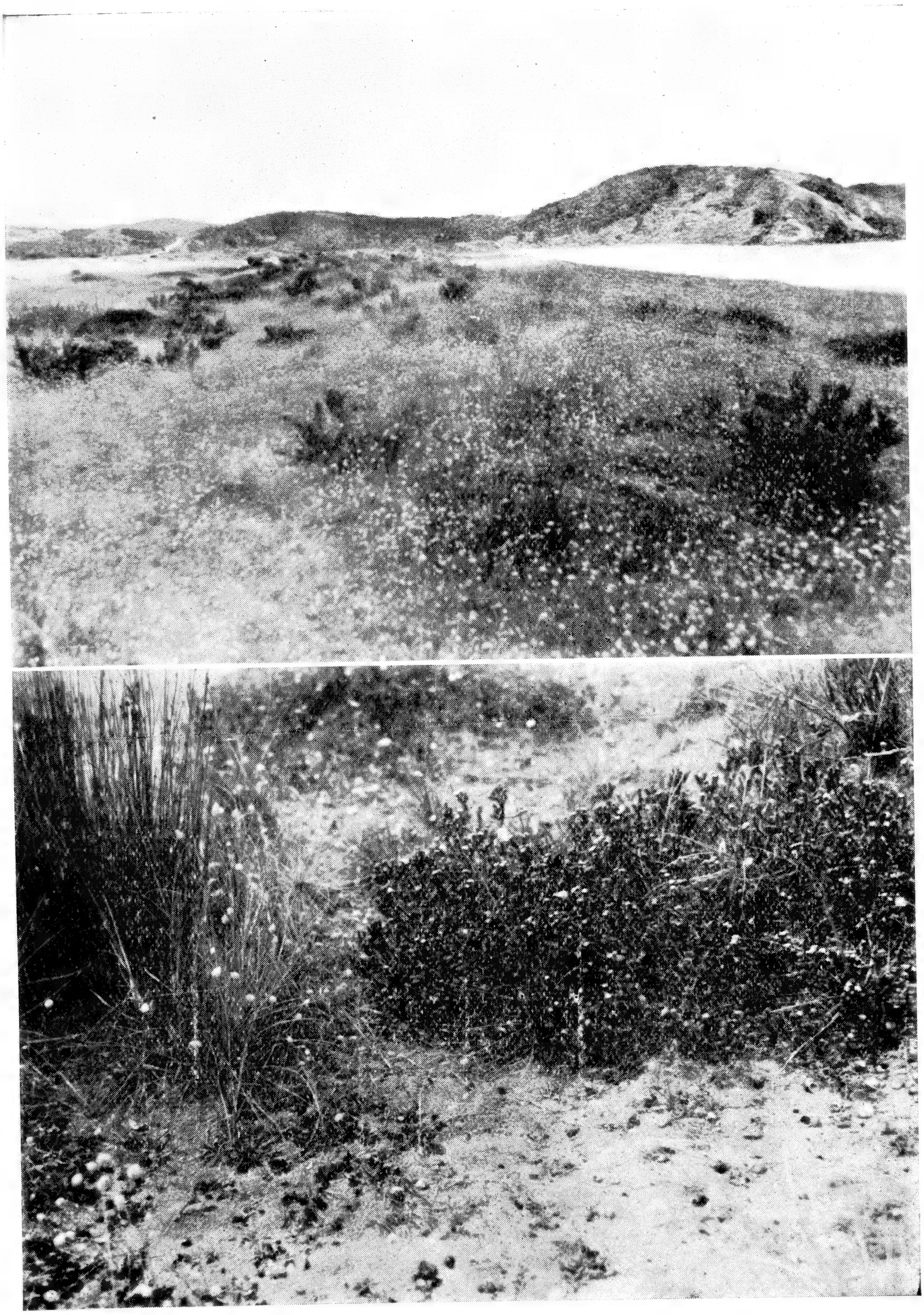

Composite photograph of Taipa Beach, looking north-west. *Austrosuccinea* lives under *Spinifex* (left foreground), *Pimelia* (right foreground) and *Cassinia* (middle right margin), but only on and in the vicinity of the foredune. The scattered dark patches on the sand are the dried-up remains of the alga *Anabaena* and the pale spots the flower heads of the introduced hare's tail grass, *Lagurus ovatus*.
20th January, 1950.

Mollusca from the Continental Shelf, Eastern Otago.

By A. W. B. POWELL, Auckland Museum.

Abstract.

A hard-bottom fauna from off the Continental shelf of Eastern Otago is named the *Chlamys delicatula-Fusitriton* community. It is compared with a similar North West American hard bottom community. The following new species of mollusca are described: *Venustas blacki, Pachymelon (Palomelon) smithi,* and *Panopea smithae;* also a new Pliocene ancestor to the latter, *Panopea wanganuica.*

The material was obtained by Captain A. Black, of the trawler "Tairoa," in from fifty to seventy fathoms along the continental shelf of Eastern Otago, from the Nuggets north to the mouth of the Waitaki River.

I am much indebted to Captain Black for his excellent work in collecting the material and to the late Mrs. J. G. Smith and Mr. Smith for the care they have taken with the preparation of the specimens, the accompanying notes and the generous gift of type specimens and representative series for the Museum collections.

An interesting outcome of study of this collection is the revealed presence of an extensive hard bottom community occupying the outer edge of the eastern Otago shelf. The dominants of this community, *Chlamys delicatula* and *Fusitriton laudandum,* were previously considered to rank amongst our very rare molluscs.

This community immediately recalls a northern hemisphere analagous one in the *Strongylocentrotus-Argobuccinum* formation from the vicinity of Puget Sound, Washington (Shelford and Towler, 1925). The dominants there are the green sea-urchin *Strongylocentrotus drobachiensis* and the mollusc *Fusitriton oregonensis* (i.e., *Argobuccinum* of Shelford and Towler). Other dominants are a starfish, crab, several barnacles, two scallops, *Chlamys hindsii* and *C. hericius,* and a gasteropod, *Calliostoma costatum.* Among the sub-dominants are the mussel *Modiolus modiolus* and the brachiopod *Terebratalia transversa.*

The Washington community is stated by Shelford and Towler to be best developed on rock bottom, but the same association of animals occurs on shelly and even hard-sand bottom. It ranges to a depth of at least 150 metres, but the upper limit is not clearly stated. Algae is of little significance and occurs only in places.

Except that sea-urchins are minor inclusions in the Otago community there is an almost exact parallel between the faunal composition of the New Zealand and Washington communities.

The Otago community, which I here designate the *Chlamys delicatula-Fusitriton* community, develops in from 50 to 70 fathoms on a hard-sand, shelly or gravel bottom under the influence of strong tidal currents and is stenothermally confined to between 46° S. and 54°42′ S. with its optimum development in the vicinity of 46° S. It would seem that *Fusitriton* loses dominance quickly to the south, but does occur sporadically far to the north of the northern Recent limit for *delicatula*, which is Otago. *Fusitriton laudandum* has been trawled in 40-50 fathoms off Cape Campbell, Marlborough, and I have a specimen from the Ninety Mile Beach, Northland. The furthest south record for *laudandum* is Auckland Islands (Cape Expedition).

At the southern extremity of the *delicatula* range the dominance is shared with the venerid bivalve *Tawera mawsoni*, and this may be termed the *Chlamys delicatula-Tawera* community.

A more precise evaluation would be formation and association respectively for these communities, but the term formation conflicts with the geological usage of that term and causes confusion, especially in paleoecological work, so the non-committal term community is preferred for the present.

The Chlamys delicatula-Fusitriton Community

a. Dominants

Chlamys (Zygochlamys) delicatula (Hutton), *Fusitriton laudandum* Finlay, *Astraea heliotropium* (Martyn), *Alcithoe swainsoni* Marwick, *Venericardia purpurata* Deshayes, *Atrina zelandica* (Gray), *Modiolus areolatus* (Gould), *Arca novaezelandiae* Smith (Moll.), and *Neothyris lenticularis* Desh.) (Brach.).

b. Subdominants

Longimactra elongata Q. & G., *Lima zealandica* Sowerby, *Ostrea charlottae* Finlay, *Glycymeris laticostata* Q. & G., *Argobuccinum tumidum* (Dunker), *Verconella fairfieldae* Powell, *Alcithoe calva* Powell, *Panopea smithae* n. sp., *Chlamys radiatus* Hutton, *C. celator* Finlay (Moll.), and *Terebratella sanguinea* Leach (Brach.).

c. Secondary species

Iredalina mirabilis Finlay, *Charonia capax euclioides* Finlay, *Venustas tigris* (Martyn), *V. pellucida forsteriana* Dell, *V. punctulata ampla* Powell, *V. foveauxana* Dell, *V. blacki* n. sp., *V. cunninghami pagoda* Oliver*, *Cardita aoteana* Finlay, *Monia zelandica* (Gray), *Pachymelon (Palomelon) smithi* n. sp., *Austrofusus glans agrestior* Finlay, *Maoricolpus roseus* Q. & G., *Maoricrypta (Zeacrypta) monoxyla* (Lesson), *Cominella (Eucominia) otakauica* Powell, and *Xenophalium (Xenogalea) finlayi* Iredale* (Moll.).

Mr. J. G. Smith mentioned the occasional presence of sea-urchins in the trawls, but I have not seen material. From other dredgings in the vicinity I have *Pseudechinus huttoni* Benham and *Goniocidaris umbraculum* Hutton.

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* These two species are uncommon in the collection and probably belong to a more shallow fine textured sandy bottom. Finlay recorded both from 20 to 30 fathoms off Otago Heads and off Waikouaiti.

Owing to the large mesh of the commercial trawls there is an almost complete absence of the smaller and micro species in the collection. However, several bottom samples in from 50-70 fathoms off Otago Heads, obtained by a naturalists' dredge, reveal a rich microfauna and the following quite abundant small molluscs: *Microlenchus sanguineus caelatus* (Hutton), *Thoristella chathamensis benthicola* Finlay, and *Myadora novaezelandiae* Smith.

Chlamys radiata (Hutton)

Five examples in the collection are large and three of them match Stewart Island topotypes in every respect. That is, they are finely and evenly scaly-ribbed and are of either uniform reddish-purple or uniformly orange colour. These are the only colours encountered at Stewart Island. The remaining two Otago specimens have slightly coarser and more sparse ribs and a diffused pattern of reddish-brown on a buff to pinkish-white ground.

I have not seen typical *radiata* from north of Otago. Cook Strait examples are mostly the smaller vari-coloured more spiny and sparsely ribbed *gemmulata*. A small vari-coloured *radiata* is found at Cook Strait, but it never reaches the size of adult topotypes. Hybridization between *radiata* and *gemmulata* seems to occur. However, a form of equal size to fully adult topotypes of *radiata* occurs ca. 70 fathoms off Kapiti Island. These were dredged in great numbers by the R.R.S. Discovery II, but only odd valves were taken and it may be that these shells are from a fossil deposit marking a cool phase in the post-Pleistocene, contemporary with the Cape Campbell, 70 fathoms deposits that yielded *Chlamys delicatula* and *Eucominia marlboroughensis* (Powell, 1946, Rec. Auck. Inst. Mus. 3 (2), p. 144).

The Kapiti shells, however, are much more finely ribbed than any other *radiata* form and merit subspecific designation. The following table is based upon a radial rib count per centimeter at a point 30 mm. from the umbo in each case.

	Left valve.	*Right valve.*
radiata (Topotypes. Steward Island)	20-24	18-22
,, Otago Heads (typical)	20-23	15-20
Otago Heads (*gemmulata* pattern)	19-20	16-16
Kai Iwi (Up Pliocene)	21-25	20-23
radiata N. subsp.? (Kapiti Island)	26-35	22-28
gemmulata (Topotypes? Cook Strait)	14-23	14-20
consociata Hauraki Gulf, 20 fath.	18-24	16-20

Huaraki Gulf examples are vari-coloured and small. They are covered by Smith's name *consociata* and may be regarded as a northern subspecies of *radiata* rather than a form of the coarser sculptured *gemmulata*.

My suggested arrangement of these shells is as follows:

radiata: Forsterian, with its normal limit North Otago; Upper Pliocene but never reaching the maximum adult size of Recent shells.

radiata consociata: Hauraki Gulf and Northland.

gemmulata: Cook Strait and as an influence to the south.

Chlamys (Zygochlamys) delicatula (Hutton)

1873.—*Pecten delicatulus* Hutton Cat. Tert. Moll. p. 30.

1873.—*Pecten diffluxa* Hutton Cat. Tert. Moll. p. 31.

1916.—*Chlamys subantarctica* Hedley Aust. Ant. Exped. Ser. C.4 (1), Moll. p. 23.

1924.—*Chlamys cambellicus* Odhner, N.Z. Moll. Pap. Mort. Pacific Exped. p. 61.

There seems little doubt that the names covered in the above synonomy refer to one species with a time range from Nukumaruan (Middle Pliocene) to the present and a Recent geographic range from Macquarie Island 54°42′ S. to Eastern Otago, 46° S.

Genus PANOPEA Ménard de la Groye, 1807.

The bringing together of material from a wide range of localities has revealed the presence of a second Recent *Panopea* in New Zealand waters and a new species ancestral to it from the Pliocene.

The two Recent members are easily separable by the depth of the pallial sinus, which feature is coupled with a distinctive shell outline for each species. In concise terms, *zelandica* has a shallow sinus which extends only half the distance from the posterior end to the umbo and the shell outline is rectangular, broadly rounded anteriorly but square-ended posteriorly. The new Recent species has an extremely deep sinus which extends to beneath the umbo and the shell outline is more or less rhomboidal, cut away at the lower anterior margin and obliquely protractively arcuate at the posterior end. The Pliocene new species has a very deep sinus also, but coupled with a further distinctive shell shape. The posterior gape is considerably greater for the Recent new species which, on this evidence, coupled with that of the very deep sinus, is indicative of a much deeper burrowing habit than for *zelandica*.

The distribution of the two Recent species presents a confused picture:

(1) Neither species is stenothermic—*zelandica* is more commonly found in northern shallow waters, and the new species in deeper southern waters, 20-70 fathoms, Eastern Otago, Stewart Island and Chatham Islands. However, there are *zelandica records* (shallow water) from The Spit, Otago Heads, and Stewart Island as well as n. sp. records from the Hauraki Gulf in 20-30 fathoms.

(2) Both *zelandica* and a species ancestral to the Recent deep-sinused one occur in the Wanganui series, i.e., *zelandica* typical from Landguard Bluff and Castlecliff and a deep sinused species from Landguard Bluff, Castlecliff, Kai Iwi, Nukumaru sands, Waipipi and Waihi Beach, Hawera. I am not certain about the nature of the sinus in the latter two occurrences, since the material is too fragile to allow excavation, but externally they conform with the Castlecliffian deep sinused species. Specimens of *Panopea orbita* from Mount Harris (Otaian-Hutchinsonian) mid-upper Oligocene, are deep sinused.

Finlay (1926, T.N.Z.I. 57, p. 473) was incorrect in adopting the vernacular rendering, i.e., "*Panope*," as the genus name. The original proposition (April, 1807) was *Panopea*.

(3) The habitat of *zelandica* is coastal in shallow-water in a substratum of fine textured, often micaceous sand. The 60 fathoms Hick's Bay record is based upon an odd valve that may have washed down from shallow water.

The true habitat of the new species is problematic. Dead shells, often with conjoined valves, are commonly dredged from shelly beds in Foveaux Strait and off the Eastern Otago continental shelf. Also the two Hauraki Gulf records are based upon odd valves dredged from coarse shelly deposits. This would seem to confirm that the new species lives buried deeply in shelly deposits, but on the other hand it may be either a mud dweller from an adjacent soft bottom area or it may occupy a gritty transitional zone between the hard and soft bottoms. However, the fact that many of the Otago shells were conjoined pairs indicates that they had not been transported far if at all from the shelly deposits from which the shells had been dredged.

(4) The Pliocene records only serve to confuse the issue still further. Admittedly the Pliocene deep-sinused species is not specifically identical with the Recent new species, so it is not essential that it should have lived under the same ecological conditions.

Pliocene records of *zelandica* confirm the habitat preference shown by the Recent occurrences of that species. It is found in the shallow-water loose yellow quartz mica sands at Landguard Bluff, that is "LG. 1" of Fleming (1947 Trans. Roy. Soc. N.Z., 76, p. 324), and also at Castlecliff in Fleming's *Zethalia-Amphidesma* Sands, "CU. 5," which is a shallow water deposit also, of loose, coarse, current-bedded micaceous sand.

The Pliocene records of the deep-sinused species, however, are conflicting, especially as all the following records are of conjoined specimens that must have lived in or near to the substratum in which they were buried. The occurrences are (a) Landguard Bluff, "LG. 1," in loose yellow quartz mica sands, (b) Castlecliff, probably "CU. 2," muddy medium micaceous sandstone, (c) Kai Iwi, "CL. 10d," muddy sandstone, (d) Nukumaru Brown Sands, "NU. 2," loose fine to coarse sands of shallow water occurrence, (e) Waipipi, mudstone, and (f) Waihi Beach, Hawera, mudstone.

(5) From the above it will be noted that *zelandica* is always associated with a fine textured sandy bottom in shallow water on an open coast, that the deep-sinused Recent species favours deep water, coarse shelly deposits, and that the Pliocene deep-sinused species apparently ranged through sandy and muddy substrata and occurred from shallow to deep water.

(6) Notwithstanding the confused ecological data, the fact remains that two easily recognised species of Recent *Panopea* occur in New Zealand waters and that a Pliocene one requires nomination as a third species ancestral to the deep-sinused Recent one. The fact is established that all specimens examined have either a shallow or a deep pallial sinus, and that the latter occurs quite irrespective of depth or bottom materials. An intermediate development of the sinus is nowhere evident.

(7) Evidently the shallow sinus is a late development, since the earliest appearance of this feature is in *zelandica* from Castlecliff. That species may represent a divergence from the main line to fit a definite ecological niche, i.e., a fine textured sandy substratum in shallow water off an ocean beach.

Panopea zelandica Quoy & Gaimard

1835.—*Panopaea zelandica* Q. & G. Voy. Astrol. 3, p. 547, pl. 83, f. 7-9.

1843.—*Panopea solandri* Gray, Dieff. N.Z., p. 255.

1913.—*Panopea zelandica*: Suter, Man. N.Z. Moll. p. 1013, pl. 61, figs. 10, a.

1926.—*Panope zelandica*: Finlay, Trans. N.Z. Inst. 57, p. 473.

1946.—*Panope zelandica*: Powell, Shellfish of N.Z. 2nd ed., pl. 11, f. 22.

Types: New Zealand; Mus. Hist. Nat., Paris *(zelandica)*; Tauranga, British Mus. *(solandri)*.

The exact locality of Quoy and Gaimard's *zelandica* was not stated but it was most likely Tasman Bay, Nelson. Their figures do not show the sinus, but the outline of the valves coincides with *zelandica* of equivalent small size, i.e., 73 x 52 mm. Only individuals of larger size than this show the medial flattening of the posterior end. The dorsal view shows a degree of inflation more in accord with *zelandica* than with the deep-sinused species. Gray's *solandri* from Tauranga is undoubtedly a synonym of *zelandica*.

Length.	*Height.*	*Inflation.*	*Anterior gape.*	*Sinus depth.*	*Locality.*
128.0 mm.	79.0 mm.	—	—	41.0 mm.	C
121.0 mm.	68.5 mm.	52.0 mm.	38.0 mm.	36.0 mm.	R
92.5 mm.	57.0 mm.	37.0 mm.	26.0 mm.	36.0 mm.	O
65.0 mm.	37.5 mm.	23.5 mm.	17.0 mm.	26.0 mm.	M

(C = Collingwood Beach, West Nelson; R = Rona Bay, Wellington; O = Opotiki; and M = Mt. Maunganui, Bay of Plenty.)

Localities: Tokerau Beach, Doubtless Bay (A.W.B.P., Jan., 1950); Cheltenham Beach (W. H. Webster) and Takapuna Beach, Auckland (C. R. Laws); Mt. Maunganui and Opotiki, Bay of Plenty; off Hick's Bay, 60 fath. (S. Voss); Rona Bay and Lowry Bay, Wellington Harbour; Collingwood Beach, West Nelson (A.W.B.P.); New Brighton, Canterbury; Warrington, Otago (Finlay coll. Auck. Mus.); The Spit, Otago Heads (C. R. Laws coll. Auck. Mus.); Stewart Island (Auck. Mus.).

Note.—The 60 fathoms Hick's Bay record is a single valve that may have washed down from shallow water. I know of no other deep water records for *zelandica*.

Panopea smithae n. sp. Pl. 7, fig. 5 and text figs. 4-6.

Shell large, solid, inaequilateral, gaping at both ends, but much more posteriorly. Outline distinctly rhomboidal, anterior end the shorter, narrowly rounded above and obliquely cut away towards the ventral margin; posterior end broadly rounded to flattened and inclined posteriorly.

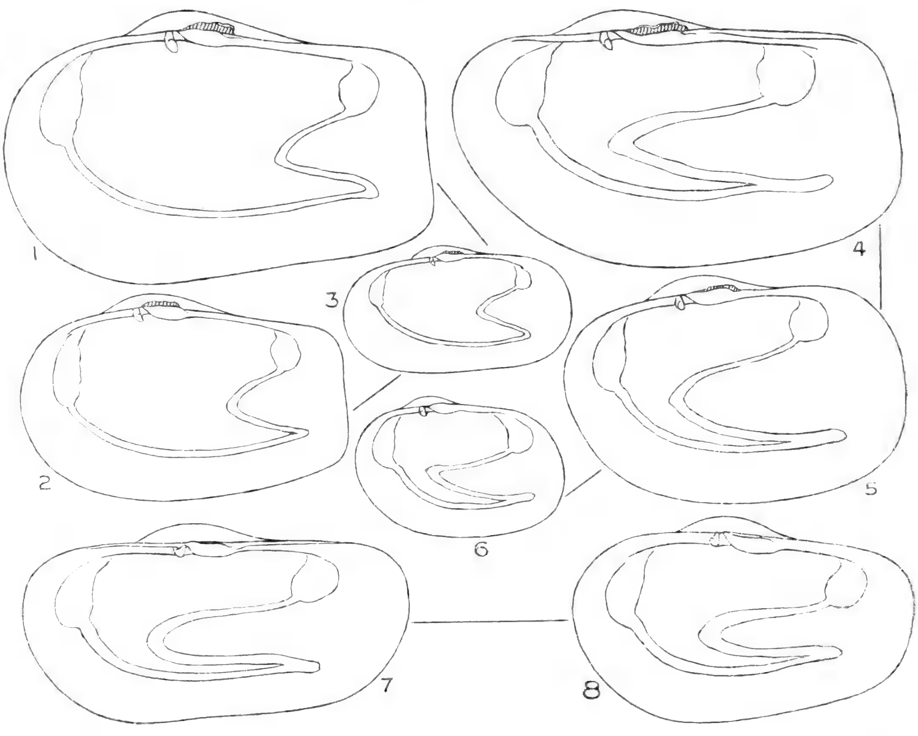
Compared with *zelandica* the new species is more solid, is of rhomboidal rather than rectangular outline, has a much deeper pallial sinus which terminates level with the umbo and a greater posterior gape of the valves. Hinge and ligament are similar in both species, but the posterior adductor scar is relatively larger and more circular in *smithae*.

Length.	*Height.*	*Inflation.*	*Posterior gape.*	*Sinus depth.*	*Locality.*
130.0 mm.	76.0 mm.	—	—	79.0 mm.	S
112.0 mm.	74.5 mm.	49.0 mm.	42.0 mm.	63.0 mm.	O
105.0 mm.	67.0 mm.	50.0 mm.	43.0 mm.	65.0 mm.	O(H)
94.0 mm.	63.0 mm.	42.0 mm.	37.0 mm.	57.0 mm.	O
60.5 mm.	41.0 mm.	—	—	35.0 mm.	O

(S = Stewart Island; O = off Eastern Otago ca. 70 fathoms; H = holotype.)

Localities: Off Eastern Otago ca. 70 fathoms (type); Stewart Island (Mrs. R. H. Harrison); Foveaux Strait, 17 fathoms (Finlay coll. Auck. Mus.); Owenga, Chatham Islands (A.W.B.P. Auck. Mus.); Wellington Harbour dredgings; Lowry Bay and Lyall Bay, Wellington (Dominion Mus.); (Since the above was written Mr. R. K. Dell has forwarded to me the *Panopea* material in the Dominion Museum collection. Both *zelandica* and *smithae* occur in two of the dredgings, but there is no indication of the bottom materials. Following is a note of the localities and the species represented: Wellington Harbour (suction dredgings), 3 *smithae* and 2 *zelandica;* Falcon Shoal, 6 fathoms, Wellington Harbour, 8 *smithae* and 2 *zelandica;* Lyall Bay (cast ashore), 2 *smithae.*); 1 mile off Cape Rodney, Hauraki Gulf, 26 fathoms (one valve, Govt. Trawler "Ikatere" Stn. 30); ¾ mile off Wellington Head, Great Barrier Island, 30 fathoms (one valve "Ikatere" Stn. 35).

All the above records are from a coarse shelly bottom.



Panopea zelandica Q. & G. Fig 1, Collingwood; Fig. 2, Opotiki; Fig. 3, Mount Maunganui. *Panopea smithae* n. sp. Fig. 4, Stewart Island; Fig. 5, 70 fathoms, Eastern Otago; Fig. 6, 72 fathoms, Otago Heads. *Panopea wanganuica* n. sp. Fig. 7, Holotype, Kai Iwi, Upper Pliocene; Fig. 8, Nukumaru, Middle Pliocene.

(All figures to uniform scale of 2-5th natural size.)

Panopea wanganuica n. sp. Pl. 7, fig. 6 and text figs. 7, 8.

Shell large, relatively thin, inaequilateral, gaping at both ends but very much more posteriorly. Outline ovate-cylindrical, relatively straight dorsally and ventrally and with shell height slightly greater towards the anterior end. Both ends narrowly rounded above middle height and arcuately cut away in broadly rounded sweeps to the flattened to slightly concave ventral margin. Pallial sinus very deep, extending to directly under, or even a little anterior to, the umbo.

Compared with *smithae*, the Pliocene species differs at sight in having both ends converging to the ventral margin. The posterior adductor scar is intermediate in size between that of *smithae* and that of *zelandica*. A feature common to both *smithae* and *wanganuica* is the very straight hinge line.

Length.	*Height.*	*Inflation.*	*Posterior gape.*	*Sinus depth.*	*Locality.*
110.0 mm.	57.5 mm.	42.0 mm.	41.0 mm.	72.0 mm	K(H)
98.5 mm.	60.5 mm.	42.0 mm.	38.0 mm.	62.0 mm.	N
78.0 mm.	41.0 mm.	30.5 mm.	26.0 mm.	53.0 mm.	L

(K = Kai Iwi; N = Nukumaru; L = Landguard Bluff; H = holotype.)

Holotype: Auckland Museum.

Localities: Landguard Bluff, LG1 (A.W.B.P. coll.); Kai Iwi, CL10d (holotype); Wanganui Castlecliffian (Upper Pliocene) and tentatively Nukumaru Brown Sands, NU2 (N.Z. Geol. Surv.); Nukumaruan (middle Pliocene): Waipipi and Waihi Beach, Hawera, Waitotaran (lower Pliocene).

The Nukumaru specimen is relatively shorter and much higher towards the anterior end, resulting in proportions nearer to those of *zelandica*, but the sinus is very deep and the hinge line straight as in *wanganuica*.

The pallial sinus is not visible in either the Waipipi or Waihi, Hawera, specimens (N.Z. Geol. Surv. coll.), so their status is undetermined. Both are nearer to *wanganuica* in shape, but are relatively shorter.

Venustas blacki n. sp. Pl. 7, figs 3 and 4.

Shell conical, moderately solid, imperforate, of flesh to bright pink colour, sculptured with numerous regularly granulated spiral ribs and an interstitial pattern of from two to five crisp spiral threads. On the base the primary spirals are narrower, weaker and wider-spaced and the interstitial threads rather more prominent, but margining the umbilical callus pad there are two closely spaced granulated spirals equal in strength to those of the spire-whorls. The spirals on the upper surface are dark pink with the granules pale pink to almost white. The smooth basal spirals have an alternation of pale and dark pink which resolves into an irregular radial pattern. The two granulated spirals bordering the umbilical callus have the granules pale on a dark pink ground as on the spire. The primary spirals are three on the second and third post-nuclear whorls, five on the ante-penultimate and eight on the penultimate. There are eight or nine smooth primary spirals on the base.

Height, 41.0 mm.; diameter, 41.0 mm. Spire angle, 81°.

Holotype: Auckland Museum, presented by the late Mrs. J. G. Smith.

Locality: Eastern Otago, ca. 70 fathoms (Holotype and paratype only).

The species seems to be nearest to Tomlin's *megaloprepes* (1948, B.A.N.Z. Ant. Res. Exped. vol. 5 (5), p. 225) from Macquarie Island which has the same kind of basal sculpture, including the paired stronger spirals margining the umbilical callus.

Pachymelon (Palomelon) smithi n. sp. Pl. 7, figs. 1 and 2.

Shell large, solid, narrowly fusiform, sculptured with vertical axial folds, 14-15 per whorl, which reach from suture to suture but are obsolete on the last whorl, strong within the aperture but not fully visible from without. Spire two-thirds height of aperture. Post-nuclear whorls six; nucleus eroded. Columella straight with four very oblique plaits. Basal notch moderately broad and very shallow. Colour uniformly pinkish-buff without colour markings.

Height, 118.0 mm.; diamenter, 45.5 mm.

Holotype: Auckland Museum, presented by Mr. J. G. Smith.

Locality: Eastern Otago, ca. 70 fathoms (The holotype, a dead shell, only).

The species is nearest allied to the Chatham Islands *wilsonae* (Powell, 1933, Rec. Auck. Inst. Mus. 1 (4), p. 204) from which it differs in its narrower outline, taller spire, much less prominent columellar plaits, and absence of axials from the whole of the body-whorl. The absence of colour pattern in the holotype may not be a constant feature.

Iredalina mirabilis Finlay.

1926.—*Iredalina mirabilis* Finlay Proc. Malac. Soc. 17, pp. 59-62.

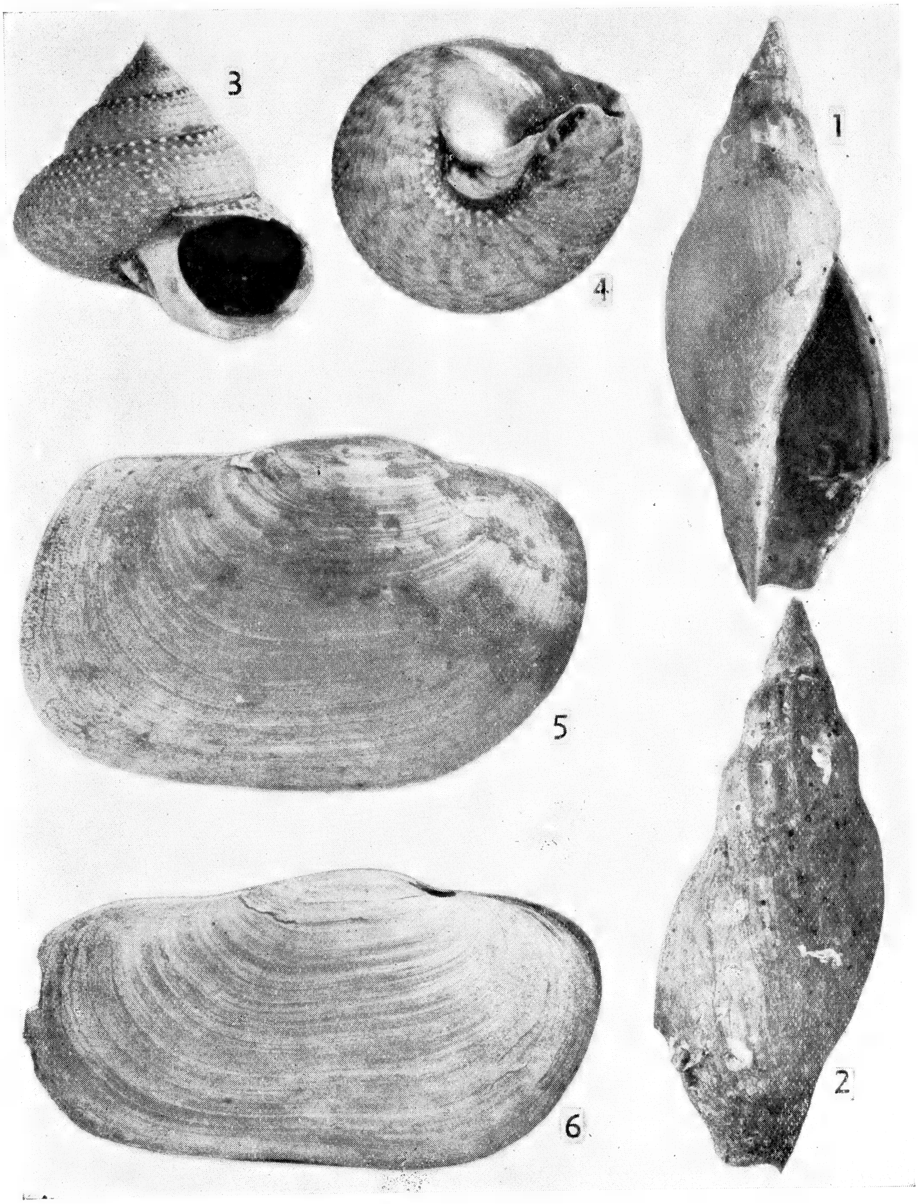
The holotype, which until the present has been unique, was trawled in 40 fathoms off Otago Heads.

Four dead shells in the present collection add a little to our knowledge of the species, which is shown to have a smooth glazed surface and pale salmon coloration without colour pattern. The protoconch is small, conical and symmetrically coiled, but is not well enough preserved in any of the specimens to furnish any further observations.

Finlay compared his genus with the plaitless Kerguelen Island *Provocator* and *Guivillea*, but favoured derivation of *Iredalina* from early Ericusoid stock. This Australian genus, *Ericusa*, however, has well developed plaits, a relatively large nucleus with an oblique apex and a distinctive colour pattern.

My impression is that *Iredalina* is much nearer to *Provocator*, not only on account of the plaitless pillar but also the glazed surface without colour pattern, the small erect nucleus and the deeply retrocurrent trend of the outer lip to the suture.

The holotype of *Iredalina mirabilis* is evidently abnormally elongated. The present specimens have a shorter spire and relatively more inflated body-whorl; i.e., height, 101 mm.; diameter, 42 mm.



Figs. 1 & 2: *Pachymelon (Palomelon) smithi* n. sp. (Holotype).

Figs. 3 & 4: *Venustas blacki* n. sp. (Holotype).

Fig. 5: *Panopea smithae* n. sp. (Holotype).

Fig. 6: *Panopea wanganuica* n. sp. (Holotype).

New Plant Localities in the Auckland Province.

By RUTH MASON, NEVILLE T. MOAR,

Botany Division, D.S.I.R., Wellington,

and ROBERT COOPER, Auckland Museum.

Most of the plants recorded in this paper were collected on a series of field trips in the Auckland Province. Details of the localities visited are given in the list at the end of the paper.

The material collected on the trip made by the three authors in November-December, 1949, was shared in the field as far as possible. The numbers following the initials of R. Mason and N. T. Moar are their collecting numbers and their specimens are deposited in the herbarium of the Botany Division, D.S.I.R., Wellington. Other numbers following the initials of R. Cooper or the personal names of H. Powell and F. Browne refer to the herbarium sheets in the Auckland Museum.

Plants recorded in New Zealand for the first time are indicated by an asterisk (*).

The Cyperaceae in the Auckland Museum collection, referred to in this paper, have been identified by Mr. V. J. Cook, to whom thanks are due. We are also very grateful to Mr. and Mrs. Hayden, Matihetihe Native School, and to Mr. and Mrs. R. H. Michie, Kaitaia, for hospitality and assistance in the field.

NATIVE PLANTS.

Atriplex crystallina Hook. f.

Karikari Bay, R.M. & N.T.M., 286; Sandy beach, north end of Waikuku Beach, North Cape tombolo, H. E. Powell, 26436.

Callitriche verna L.

Medland's Beach, Great Barrier Island, R.M., 448.

Calochilus sp.

Specimens of *Calochilus* with yellow flowers and dark red fimbriae on the labellum were collected at Aranga swamp (R.M. & N.T.M., 88). Mr. Edwin D. Hatch considers it may be a hybrid between *C. campestris* and *C. robertsonii* and that it is practically identical with those specimens from Ahipara, probably of hybrid origin, which he records under *C. campestris* (1949: 248), except that the Aranga specimens have well-developed fimbriae.

Carex gaudichaudiana Kunth.

Swamp alongside Keri Keri inlet road, R.C., 35861.

Carex lucida Boott.

Medland's Beach, Great Barrier Island, R.M., 464.

Carex pseudocyperus L.

Kaitoke, Great Barrier Island, R.M., 505.

Carex stellulata Good.

Otoroa, R.C. & N.T.M.

Cladium huttoni T. Kirk.

Kaitoke, Great Barrier Island, R.M., 424; Muir's Lake, Waiuku, N.T.M., 462; Thompson's Lake, Waiuku, N.T.M., 475; Ototoa, Kaipara Harbour, N.T.M., 562; North Head, Kaipara Harbour, N.T.M., 606

Danthonia bromoides Hook. f.

Seacliffs at Leigh, R.M., 583.

Drosera pygmaea D.C.

Karikari Bay, R.M. & N.T.M., 274; Lake Ohia, R.M. & N.T.M., 304, R.C., 35778.

Eleocharis acuta R. Br. var. *tenuis* Carse.

Kerikeri swamp, R.M. & N.T.M., 365, R.C., 35867; Otekairangi, R.M. & N.T.M., 410; Oruru Stream near Taipa, R.C., 35996.

Eleocharis neo-zelandica C. B. Clarke ex T. Kirk.

Waihopai Stream, R.M. & N.T.M., 178.

Gleichenia flabellata R. Br.

Whangaparapara Valley, Great Barrier Island, R.M., 500.

Glossostigma elatinoides Benth.

Medland's Beach, Great Barrier Island, R.M., 446.

Hydatella inconspicua Cheesem.

L. Rotokawau, North Head, Kaipara Harbour, N.T.M., 584; L. Pouto, North Head, Kaipara Harbour, N.T.M., 571; L. Waiparera, near Waiharara, H. E. Powell, 26434.

Juncus holoschoenus R. Br. var. *multiflorus* Carse.

Tokerau Beach road, R.M. & N.T.M., 301.

Juncus pallidus R. Br.

Kaiangaroa, R.M. & N.T.M., 322; Merita, R.C., 36160.

Korthalsella salicornioides (A. Cunn.) Van Tiegh.

Parasitic on *Leptospermum ericoides* at Kapowairua, Spirits Bay, R.C., 24435.

Mazus pumilio R. Br.

Waihopai Stream, R.M. & N.T.M., 140.

Metrosideros albiflora Sol. ex Gaertn.

Warawara Kauri Forest, R.C., 35577.

Myriophyllum robustum Hook f.

Whareana Creek, North Cape, H. E. Powell, 26439; Poutu, Kaipara Harbour, N.T.M., 610.

Myriophyllum votschii Schindler.

Ahipara Hill, R.M. & N.T.M., 327, R.C., 35738; Lake Ngatu, R.M. & N.T.M., 265, R.C. 35775; Karikari Bay, R.M. & N.T.M., 297; Lake Kanono, N.T.M., 588.

Nertera setulosa Hook. f.

Waipoua Forest, K. W. Allison; Kaihu River, R.M. & N.T.M., 84, R.C., 35504; Warawara State Forest, R.C., 35620, 35624; Waihopai Stream, R.M. & N.T.M., 165, 171; Wairoa Stream, R.M. & N.T.M., 193; Otekairangi, R.C., 35914; Oruru Stream, Taipa, R.C., 36018; Pekerau, north of Taipa, H. E. Powell, 26438; Lake Waiparera, near Waiharara, H. E. Powell, 26432.

Nothopanax anomalum (Hook. f.) Seem.

Near summit of Ounuwhao, 950′, Spirits Bay, R.C., 24477.

Pittosporum pimeleoides R. Cunn. ex A. Cunn.

In remnant of kauri forest on south bank of Oruru River, one mile west of Taipa, R.C., 36009; H. E. Powell, 26437.

Pomaderris edgerleyi Hook f.

Near Babylon, R.M. & N.T.M., 64, R.C., 35483.

Potamogeton cheesemanii A. Bennett.

Medland's Beach, Great Barrier Island, R.M., 445.

Pseudowintera axillaris (J. R. & G. Forst.) Dandy.

Near summit of Ounuwhao, 950′, Spirits Bay, R.C., 24475.

Schoenus apogon Roem. et Schult.

Warawara State Forest, R.C., 35571; Waihopai Stream, R.M. & N.T.M., 149, 156; Ahipara Hill, R.C., 35707; between Whangatupere Bay and Brodie's inlet, R.C., 35792; Otoroa, R.C., 35841.

Schoenus carsei Cheesem.

Ahipara Hill, R.M. & N.T.M., 211, R.C., 35704; Kerikeri swamp, R.M. & N.T.M., 373.

Schoenus nitens (R. Br.) Poir.

North Kaipara Head, N.T.M., 605.

Schoenus nitens (R. Br.) Poir. var. *concinnus* (Hook. f.) Cheesem.

Karikari Bay, R.M. & N.T.M., 308.

Scirpus caldwellii V. J. Cook.

Tokatoka, R.M. & N.T.M., 50, R.C., 35466a.

Scirpus medianus V. J. Cook.

Tokatoka, R.M. & N.T.M., 49, R.C., 35466b; Tryphena, Great Barrier Is., R.M., 461; Lake Kanono, North Kaipara Head, N.T.M., 591.

Scirpus perviridis V. J. Cook.

Omapere, R.M. & N.T.M., 118, R.C., 35545; Lake Tongonge, R.M. & N.T.M., 323; north of Lake Pokoroa, Waiuku, N.T.M., 493.

Scirpus sulcatus Thouars var. *distigmatosa* C. B. Clarke ex Cheesem.

In crevices among wet boulders under Keri Keri Falls, R.C., 35932.

Solanum aviculare Forst. f. var. *albiflora* Cheesem.

Kaiarara Bay, Great Barrier Island.

Utricularia delicatula Cheesem.

Aranga swamp, R.M. & N.T.M., 105; Ahipara Hill, R.M. & N.T.M., 215, R.C., 35709; Otoroa swamp, R.M. & N.T.M., 332.

Utricularia novae-zelandiae Hook. f.

Lake Ohia, R.M. & N.T.M., 318, R.C., 35806; Lake Pouto, N.T.M., 583.

Utricularia protrusa Hook. f.

Lake Rotokawau, Opoe S.D., R.M. & N.T.M., 251, R.C., 35766, 25780; Karikari Bay, R.M. & N.T.M., 282; Wilson's Lake, N.T.M., 513; Pouto, North Kaipara Head, N.T.M., 582.

Zoysia matrella (L.), Merr.

Kaitoke, Great Barrier Island, R.M., 423.

INTRODUCED PLANTS.

Alisma plantago-aquatica L.

Kaitaia, end of Bonnett's Road, R.M. & N.T.M., 249, R.C., 35754. This plant, without flowering stalks, was also seen in the stream running behind the motor camp at Kaitaia. According to Mr. R. H. Michie it has come into the district within the last fifteen years. The leaves of the Kaitaia plants are subcordate at the base, whereas the leaves of plants from Wellington southwards have cuneate bases. The Wellington plants are also larger in size. In view of the differences between the northern and southern plants, and the distance between the occurrences, it is possible that they have come from separate introductions.

Anacharis canadensis (Michx.) Planch.

Muir's Lake, Waiuku, N.T.M., 444. In the neighbourhood of Auckland this is known only from the Waikato River and Western Springs, and was not seen at all north of Auckland. The specimens collected by R. H. Matthews and recorded by Cheeseman (1925: 1054 as *Elodea*) seem to be the only ones so far collected in North Auckland.

Anthemis nobilis L.

Otekairangi, R.M. & N.T.M., 405, R.C., 35900.

Apium tenuifolium (Moench) Thellung.

Medland's Beach, Great Barrier Island, R.M., 450.

Arum sp., either *Arum maculatum* L. or a closely allied species.

Near site of old house, Okupu Bay, Great Barrier Island.

Aster subulatus Michx.

Some plants were seen at the head of Whangaparapara Harbour, Great Barrier Island.

Blackstonia perfoliata (L.) Huds.

Karikari Bay, R.M. & N.T.M., 291.

Cardamine pratensis L.

Woodhill, R.M. & N.T.M., 10, 17; Kaitaia motor camp, R.M. & N.T.M., 206, R.C., 35698; Otekairangi, R.M. & N.T.M., 385.

Carex divulsa Good.

Whangarei station, R.M. & N.T.M., 413, R.C., 35915; Leigh, R.M., 516.

Carthamus lanatus L.

Mangawai, Miss F. Browne, 36183.

**Cyperus sanguinolentus* Vahl.

Waihopai stream, R.M. & N.T.M., 147, 160. These specimens were compared with material from the National Herbarium of N.S.W., Sydney, and seem to agree well, except that the New Zealand specimens have smaller inflorescences with no rays and fewer spikes.

Eichhornia crassipes Schlecht.

Muir's Lake, Waiuku, N.T.M., 445. This was deliberately planted in the lake.

Erechtites atkinsonae F. Muell.

Whangaparapara Harbour, Great Barrier Is., R.M., 501. November was too early to find this in flower and no specimens were collected, but young plants were seen frequently wherever we went north of Auckland.

Erechtites valerianaefolia D.C.

Kaitoke Valley, Great Barrier Island, R.M., 507, 512.

Erica baccans L.

Te Ahumata, Great Barrier Island, R.M., 471; ridge between Kaitoke Valley and Awana Valley, Great Barrier Island, R.M., 508.

Eupatorium adenophorum Spreng.

In damaged bush near Otekairangi swamp, R.M. & N.T.M., 403, R.C., 35899.

Festuca arundinacea Schreb.

Great Barrier Island.

Galium palustre L.

Woodhill, R.M. & N.T.M., 12, R.C., 35429; Kaihu River, R.M. & N.T.M., 79, R.C., 35494; Lake Tongonge, R.M. & N.T.M., 253, R.C., 35758; between Taumarere and Kawakawa, R.M. & N.T.M., 353.

Galium parisiense L.

Road between Medland's Beach and Tryphena Harbour, Great Barrier Island, R.M., 453.

Glyceria sp.

In the gully near the wharf in Blind Bay, Great Barrier Island, there is a patch of *Glyceria*, probably *G. fluitans*.

Hakea acicularis R. Br.

Kaitoke, Great Barrier Island, R.M., 418. This is widespread in the scrub country on Great Barrier Island. It was, however, more abundant to the south of Port Fitzroy Harbour than south of Mt. Hobson and Mt. Young.

Hakea pubescens Schrad.

Kaitoke, R.M., 514. This is also widespread in the scrub country on the Great Barrier Island, but appears to be much the most abundant species south of Mt. Hobson and Mt. Young.

**Hedychium oblongum* K. Schum.

Kaeo, a large patch by the roadside in the town, R.M. & N.T.M., 333, R.C., 35831. This plant fits the description of *H. oblongum* K. Schumann (1904: 48) quite well, except that the bracts are rather hairy at the upper end and almost tomentose at the middle of the extreme tip.

Kyllinga brevifolia Rottb.

Waihopai Stream, R.M. & N.T.M., 146, 157; Kaitoke, Great Barrier Island, R.M., 481; Wilson's Lake, N.T.M., 525.

Lavatera arborea L.

Rawene, R.M. & N.T.M., 122, R.C., 35538. On waste land near the wharf there were several plants of a variegated form of *L. arborea*, smaller than the normal green form. *L. arborea* was not noticed at any other coastal localities.

**Ligustrum sinense* Lour.

Kaeo, R.M. & N.T.M., 334, R.C., 35832. This plant is common on roadsides and in waste spaces about Auckland City. It agrees with the description of *L. sinense* but there is no authentic material for comparison in the Botany Division and Auckland Museum herbaria.

Lotus angustissimus L.

Great Barrier Island.

Lotus uliginosus Schkuhr.

Great Barrier Island.

Ludwigia palustris (L.) Ell.

Near Babylon, R.M. & N.T.M., 80; Kerikeri swamp, R.M. & N.T.M., 356, 376; stream alongside Puketona-Paihia road, one mile above Haruru Falls, R.C., 35856; Otekairangi, R.M. & N.T.M., 408, R.C., 35902; Kaitoke, Great Barrier Island, R.M., 441; Muir's Lake, N.T.M., 456; Wilson's Lake, N.T.M.

Mariscus congestus (Vahl.) C. B. Clarke.

Karikari Bay, R.M. & N.T.M., 294; Sandy track, Merita, R.C., 36076; Pekerau, north of Taipa, H. E. Powell, 26435; Muir's Lake, N.T.M., 450; Thompson's Lake, N.T.M., 478.

**Nymphaea alba* L.

Stream alongside Puketona-Paihia road about a mile above Haruru Falls, R.M. & N.T.M., 355, R.C., 35855; Muir's Lake, N.T.M., 446. This may have been planted.

Opuntia monacantha Haw.

Okupu Bay, Great Barrier Island. Several plants not far from site of old house.

Panicum lindheimeri Nash.

Kaitoke Valley, Great Barrier Island, at head of valley near eastern hot springs. R.M., 506, 508.

Paspalum dilatatum Poir.

Great Barrier Island.

**Passiflora edulis* Sims.

Mangapiko Saddle, Great Barrier Island, R.M., 497. There were a number of fruiting plants growing wild among short *Leptospermum* scrub near an old hut where the tram tracks pass between Mangapiko and Mt. Young.

Pennisetum clandestinum Hockst.

Roadside, Kaitoke Valley, Great Barrier Island.

Physalis peruviana L.

In bush gully between Whangatupere Bay and Brodie's Inlet, R.C., 35793.

**Phytolacca americana* L.

Matai Bay, R.C., 35783. These specimens fit the description of *P. americana* by H. Walter (1909: 52-55) much better than that of any other species, but have 12 stamens instead of 10 and sometimes the base of the raceme is paniculate. However, according to P. Wilson (1932: 263), the number of stamens may be 9 to 12.

Phytolacca octandra L.

Medland's Beach, Great Barrier Island, R.M., 452.

Pinus sp.

A species of *Pinus*, probably *P. maritima*, is spreading in the scrub in the valley behind the post office and wharf at Tryphena, Great Barrier Island. In the scrub on the open hill on the south side of Kaiarara Bay there are also small pine trees scattered here and there.

Polygala myrtifolia L.

Kaitoke, Great Barrier Island, R.M., 503. odd plants under *Leptospermum ericoides*. It was also seen near Cooper's wharf, Port Fitzroy.

Polypogon lutosus (Poir.) Hitchc.

Omapere, R.M. & N.T.M., 119, R.C., 35541; Koware Trig, above Matai Bay, R.C., 35786; track from Brodie's inlet to Merita, R.C., 36066.

Potamogeton crispus L.

Thompson's Lake, Waiuku, N.T.M., 480.

Psoralea pinnata L.

Tryphena Harbour, Great Barrier Island, R.M. 463. This was common near the shore at the north end of the harbour. One or two plants were noticed on the road leading from Blind Bay.

Ranunculus flammula L.

Kerikeri Swamp, R.M. & N.T.M., 357, R.C., 35857; between Taumarere and Kawakawa, R.M. & N.T.M., 352, R.C., 35850.

Ranunculus fluitans Lam.

Wilson's Lake, N.T.M., 515. This was recorded by Cheeseman (1925: 1064, as *R. aquatilis*) "from the Waikato southwards," and by Allan (1940: 48) as "frequent in streams and ponds in both Islands." It was not seen north of Auckland city and no specimens seem to have been collected there.

**Rubus sp.*

Near the junction of the Pawarenga-Broadwood and Broadwood-Herekino roads, R.M. & N.T.M. 205, R.C., 35695. This is a plant with an upright habit, somewhat like that of a raspberry but of denser growth; the leaves are palmately divided. It was the only introduced species of *Rubus* noted from the car as we drove from the Broadwood turn-off through the Herekino gorge until Kaitaia was reached. It was common and often growing in dense masses by the roadside and in damp paddocks.

Rubus sp.

A few poorly developed canes of blackberry were noticed in the Kaitoke valley, Great Barrier Island, mostly on farmland.

Rumex conglomeratus Murray.

Medland's Beach, Great Barrier Island, R.M., 451.

**Rumex hydrolapathum* Huds.

Helensville, N.T.M. & R.M., 21, R.C., 35435. These plants were scattered in a patch about eight yards long on a low stopbank on the town side of the bridge across the Kaipara River.

Scleropoa rigida (L.) Griseb.

Woodhill, R.M. & N.T.M., 11, R.C., 35427; North end of Taipa Beach, R.C., 36043.

Sisyrinchium micranthum Cav.

Ahipara Hill, R.M. & N.T.M., 246, R.C., 35772.

Soliva anthemifolia (Juss.) R. Br.

End of Bonnett's Road, Kaitaia, R.M. & N.T.M., 258, R.C., 35761.

Stenotaphrum secundatum (Walt.) Kuntze.

Great Barrier Island.

Tradescantia fluminensis Vell.

Okupu Bay, Great Barrier Island, near wharf—a small patch at edge of stream near site of old house.

Trifolium glomeratum L.
Great Barrier Island.

Tropaeolum majus L.
Okupu Bay, Great Barrier Is., near site of old house near wharf.

Ulex europaeus L.
This was recorded by Kirk (1869: 154) as occurring on the Great Barrier Island, but no further details were given. At present it is growing abundantly about Port Fitzroy, but it was not seen at all in the south of the island and local residents hope that its spread southwards will not take place.

Vitis vinifera L. ?
Road between Medland's Beach and Tryphena, Great Barrier Island, R.M., 454. Grape vines are growing over several cuttings on this road and are well established.

**Wahlenbergia* sp.
Otekairangi, R.M. & N.T.M., 406, R.C., 35901. This plant fits the description of *W. tadgellii* Lothian (1946: 228-229), but there is no authentic material with which to make a comparison in the Botany Division and Auckland Museum herbaria.

Watsonia bulbillifera Matthews et Bolus.
Woodhill, R.M. & N.T.M., 13, R.C., 35430; Kaitaia motor camp, R.C., 35701. This plant is a common wayside weed north of Auckland and was noted near Warkworth, at Wellsford, in and about Dargaville, Waimamaku, Omapere, Pangaru, and Mangonui, and it was abundant at Kaeo, where it was first recorded.

Watsonia meriana Mill.
Henderson, R.M. & N.T.M., 1, 2, R.C., 35418, 35420; Ruawai, R.M. & N.T.M., 44, R.C., 35463. The specimens collected at Henderson included both white (Nos. 1 and 35418) and mauve (Nos. 2 and 35420) flowered forms.

Zantesdeschia aethiopica Spreng.
Mitimiti sand dunes, R.C., 35654; Lake Tongonge, R.M. & N.T.M., 255.

Zizania latifolia Turcz.
Wilson's Lake, South Kaipara Head, N.T.M., 531.

LOCALITIES COLLECTED.

Most of the plants recorded in this paper were collected on the following field trips: Mangonui, Spirits Bay, Kerr Point, Kaitaia, in the North Auckland Botanical District. (February, 1949. R. Cooper.)

Auckland, Henderson, Woodhill, Helensville, coast road to Tauhoa, Warkworth, Topuni, Maungaturoto, Ruawai, Tokatoka, in the South Auckland Botanical District. Dargaville, Babylon, Maitahi, Kahui, Aranga swamp, Waipoua Forest, Omapere, Rawene, Narrows Landing, Pangaru, Mitimiti, Warawara State Forest, down coast to Waihopai stream and swamp in upper part of valley, down Wairoa stream from road near Reena, Runaruna, Herekino Gorge, Kaitaia, Ahipara Gumlands Road, Lake Tongonge from end of Bonnett's Road, Lake Ngatu, Lake Rotokawau in Opoe S.D., Karikari Bay and swamp by way of Wairahoraho stream, Matai Bay, Brodie's Inlet, Tokerau Beach road, Lake Ohia, Kaiangaroa swamp, Mangonui, Kaeo, Otoroa swamp, swamp on Kerikeri inlet road, Paihia, Kawakawa, Whangarei and Otekairangi swamp, in the North Auckland Botanical District. (November-December, 1949. R. Mason, N. T. Moar, R. Cooper.)

Great Barrier Island, in the Thames Botanical District: Okupu, Blind Bay to Kaitoke Valley, Te Ahumata (Whitecliffs), Whangaparapara, Port Fitzroy by way of ridge between Kaitoke and Whangaparapara valleys, foot of Mount Young and Mangapiko to road and main wharf, up valley from Kaiarara Bay and old track to saddle between Mount Hobson and Mount Young, landing at Cooper's, Port Fitzroy; road from Kaitoke to Tryphena Harbour and old bridle path over to Blind Bay, hot springs in Kaitoke Valley and over old track to ridge and down into Awana Valley. (Christmas, 1949. R. Mason.) Since Kirk (1869: 144-154) published an account of the botany of the Great Barrier, which included a list both of native and of a considerable number of introduced plants, there have been only occasional new records from the island. A good many introduced plants that grow on the mainland have reached the Barrier and a number of new records, mainly of introduced weeds, are included here. Where no collecting number is given, no specimen was collected. No attempt was made to make a complete list of introduced, escaped and naturalized plants, and no doubt many more new records will be found.

Mangonui, Taipa, Brodie's inlet, Matai Bay, Merita, Whatuwhiwhi, in the North Auckland Botanical District (January, 1950. R. Cooper).

South Auckland Botanical District.—Franklin County: Thompson's Lake, Map N51 195E O92N; Muir's Lake, Map N51 21OE O67N; Lake Pokoroa, Map N46 15OE 19ON; Lake Okaihou (Houghton's Lake), near Muriwai. South Kaipara Head: Wilson's Lake, Map N37 18OE 92ON; Lake Kuwakatai, Lake Ototoa. North Kaipara Head: Swan Lake (Lake Pouto), Lake Rotokawau, Lake Waingata, Lake Kanono, Lake Humu Humu. North Auckland Botanical District.—Mangonui County: Lake Ngatu, Lake Rotokawau in Opoe S.D., Lake Waiparera. Map references are given for lakes for which no names were found on a map. (January-February, 1950. N. T. Moar.)

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Notes to Accompany a Topographical Map and a Provisional Geological Map of Great Island, Three Kings Group.

By M. H. BATTEY, Auckland Museum.

The maps presented herewith have been compiled from surveys carried out during a visit of five days' duration to Great Island as a member of an expedition conducted by the Auckland War Memorial Museum, under the leadership of Dr. Gilbert Archey, in January, 1951. Some observations on the geology of the narrow waist of the island had been made during an earlier visit in 1948, when four hours were spent ashore.

TOPOGRAPHIC WORK.

The bases of previous maps of the Three Kings Islands have been a sketch map of Great Island made by S. Percy Smith in 1887 (Cheeseman, 1891) and the Admiralty Chart of the whole group at the scale of 1:100,000 revised in 1911. Mr. E. G. Turbott, who spent five weeks on the island in 1946, took a number of compass bearings which he used to correct existing maps. His final map of the whole group (*Rec. Auck. Inst. & Mus.*, vol. 3, p. 190, 1948) unfortunately lacks a scale.

The horizontal control of the map now presented is a triangulation by prismatic compass bearings taken to prominent hill features and coastal promontories. Mr. Turbott, in his observations, used some of the same natural features as points of bearing and his readings have been checked with those of the later survey and show satisfactory agreement. Those taken from the conspicuous Rocky Knoll (750′) at the head of Castaway Valley west of the narrow waist of the island were particularly useful.

The map depends for scale upon a short and roughly measured base between Bald Hill (601′) and the spot height 577′ on the crest of a rocky bluff to the south-east. A longer and more carefully measured base is the first requirement in any further work. Sites for such a base are few, but the open ridge north-north-west and south-east of Bald Hill offers scope for a much improved base-line, which could be expanded by observations to Rocky Knoll (750′) and to the highest point of the island (920′) on the cliffs above North West Bay, west of the landing place. A bearing picket on this high point would be helpful, as it is poorly defined from points of view lying to the south and south-east.

Vertical control was established by aneroid barometer corrected as far as possible for diurnal barometric changes by repeated readings. Weather conditions throughout the survey were exceptionally steady. The camp site was used as a base for the daily traverses, its height being taken as 315ft., the approximate mean of five pairs of reading at the camp and at sea level taken with the least possible lapse of time between them.

A great amount of detail was plotted with the aid of a large collection of excellent photographs of the island (particularly its coastline) taken by many different visitors and assembled by Mr. A. W. B. Powell, Assistant Director of the Auckland Museum.

GEOLOGY.

In 1936 the late Professor J. A. Bartrum described spilite lavas and keratophyres from Great Island, this being the first record of the occurrence of rocks of the Spilitic Suite in New Zealand. The spilites were seen to exhibit pillow structure at a point which Professor Bartrum described to me in conversation as lying near sea level perhaps a quarter of a mile west of the landing place in North West Bay. Beyond the conclusion, based on microscopic texture, that the albitic porphyry that he described is a flat-lying sill and that probable keratophyre tuff is present, Professor Bartrum did not deal with the field relations of the rocks. He regarded the greater part of the island as being composed of greywacke.

In the course of the recent work only greywacke was found in the eastern part of the island, but very little sediment outcrops in the western part, to which the succeeding remarks on stratigraphy and structure chiefly apply.

The igneous rocks found in the western part of the island are of two kinds, apparently broadly the same as the two types described by Professor Bartrum. The basic (probably spilitic) lavas are seen to great advantage in the huge blocks that litter the shore east of the Landing Place in North West Bay. They are dark green when fresh, weathering yellow-brown. They are never conspicuously porphyritic, but in some cases long, slender feldspar laths are clearly visible to the unaided eye. The felted texture of fine feldspar microlites can generally be seen with a lens, even in weathered chips. Green chloritic spots are commonly seen, but coarser amygdaloidal structure is an inconstant feature. It may possibly be related in distribution to the tops of flows, for it seems to become more conspicuous as an overlying band of keratophyre is approached.

Pillow form was never observed (the classic locality could not be reached without a dinghy), but a tachylytic breccia forms the top of the crag (603′) above Hapuka Point and the steep walls of this crag are worthy of further examination.

The keratophyres are characterized by their light weathering colours and a tendency to form low bluffs in the inland area. They exhibit in places a structure interpreted as flow-banding (see below). On the fresh surface they are of a vitreous or greasy lustre, dark to pale greenish or pale yellow, with a streaky inhomogeneous appearance and, often, conspicuous pink oblong feldspar phenocrysts in a groundmass that is structureless even under a lens.

A brecciated phase was found in four places, and three of these are believed to be of one horizon. It appears in hand specimen to be of the nature of a flow-breccia and not a consolidated pyroclastic deposit. This view is perhaps borne out by the uncertainty expressed by Professor

Bartrum whether the rock was a tuff or a flow. At a few places, for example near South Point, the rock takes on a nodular appearance, the nodules being the size of small marbles.

A detailed laboratory examination of the rocks collected on Great Island has not yet been made.

The courses of the traverses made during the recent survey are indicated on the geological map by the positions of outcrop symbols. It should be understood that those in the upper basin of Tasman Stream, south of the cliffs above North West Bay, are only approximately located, as the low forest prevents satisfactory compass bearings.

Observations of dip shown in the keratophyres in the basin of Castaway Stream and along the cliff top north-north-west of the camp were taken upon a planar structure in the rock which is interpreted as flow-banding. It is best displayed upon weathered surfaces, which exhibit discontinuous parallel grooves and ridges reaching about an inch in thickness and afford in places quite satisfactory readings. Laminated sediments intercalated in the basic lavas provided evidence of attitude in the northern cliffs and in the bed of Tasman Stream. Orientation of elongated amygdales in some of the lavas proved to be somewhat erratic and of little apparent value in suggesting the attitude.

On the basis of these observations and upon the distribution of the different lithological types the contacts between beds of basic lava and keratophyre have been extrapolated from points where they were found, so that they follow courses appropriate to the topography upon the assumption of a regular easterly dip of 25 degrees.

Important in this interpretation is the presence of a conspicuous and characteristic keratophyre breccia near spot height 823ft. on the crest of the northern cliff and in boulders at the Landing Place in North West Bay, but not eastward of the Landing Place. This is interpreted as indicating that the breccia reaches sea level near the Landing Place, although it is there masked by screes, and further examination is needed to prove its actual position. Similar breccia occurs at the same inferred horizon near South Point. The distribution of richly amygdaloidal basic lavas, interpreted as the tops of flows, appears to conform with the observed outcrop pattern, though the value of this indication is perhaps open to question.

The presence of a reddened zone at the contact of one type of lava with another has been noted at several places and, being conspicuous from a distance, serves as a useful guide to places where contacts may be sought in areas of bare ground. The contacts seen were all poorly displayed. Clayey weathered material usually masked the actual junction of the two rock types. A readily accessible contact, better than some in this respect, between basic lava below and weathered keratophyre above, may be seen on the cliff top on the north side of the narrow ridge joining the two parts of the island, a few yards west of its narrowest and lowest point. A contact between fairly fresh rocks in the northern cliff at 660ft. above sea level below spot height 823ft. shows a very irregular line of junction which, however, cannot be traced far.

The agreement between the observed rock distribution and the inferred boundaries on the map is satisfactory, as far as it goes, except that no keratophyre band was picked up on a traverse made on a fixed bearing westward from Rocky Knoll (750′) to the proximal end of Hapuka Point spur (917′). Outcrops in the place where keratophyre should appear are, however, very sparse and obscure.

While it will be clear that much more remains to be done to check the correctness of the outcrop pattern, it is hoped that the accompanying maps will serve as a guide to future investigators. In particular, they provide a base upon which the positions of further rock samples can be fixed by any visitor who is not a geologist, and in this way advances in our knowledge may be made from time to time.

A few simple tests of the stratigraphic picture may be mentioned. The keratophyre encircling the head of Castaway Valley forms conspicuous white weathering bluffs and lines of boulders. The course of the inferred contact between the keratophyre and the underlying basic lava can easily be checked by any visiting naturalists.

A suite of specimens taken at intervals up the lower course of Tasman Stream, where it flows in a rocky channel, would be of immediate service, as would samples from the spur of white-weathering rock west of the mouth and lower part of Tasman Stream.

Careful work on the northern cliffs would also serve to verify the relationships. Unfortunately, screes obscure much of the accessible part; nevertheless, accessible outcrops are plentiful. A climb from the Landing Place to the cliff top, west of the route usually followed, appears quite feasible and would afford much information.

The relationship of the greywacke of the eastern part of the island to the igneous rocks is not known. The slopes around the head of South East Bay may afford information on this question. The material on the crest of the ridge linking the two parts of the island is weathered to clay, and the nature of the contact between greywacke and keratophyre cannot be seen. The extension of the greywacke to the cliff tops west of South East Bay is entirely hypothetical.

A large part of the eastern section of the island has a smooth, sloping surface underlain by sandy soil and, at East Point and the Point south of it, well-rounded pebbles that have weathered out of this sandy covering litter the ground. This surface, varying in height from 250ft. south of East Point to 325ft. where it merges into the higher ground along the cliffs east of North West Bay and into the ridge running south from these near their highest point (602′), is regarded as an elevated plain of marine erosion and deposition, with shore pebbles and a sandy cover upon it.

A cavernous buff sand-rock, often quite hard, is conspicuous in blocks in many parts of the island on both the eastern and western portions. A little east of the highest point (602′) of the eastern part it overlies greywacke and encloses pebbles of igneous rock and greywacke with characteristic red weathering crusts upon them. Outcrops of this cavernous buff deposit also cap the cliffs near East Point and south of it. Masses of it have been found in the western portion of the island also, sometimes at heights greater than that of the plain of marine erosion in the east, and with them pieces of igneous rock with a reddish weathering-crust. In general, it would seem that pieces of rock with this red weathering-crust should be regarded with deep suspicion, wherever they are found, although, in areas of poor outcrops in the upper Tasman Valley, it is tempting to accept them as float from the bed rock. This reddened crust on loose blocks is quite distinct from the reddening at stratigraphic contacts noted above.

A satisfactory explanation of the origin and distribution of the cavernous buff rock has not yet been found. The balance of probability seems to favour its origin as a superficial accumulation of some earlier higher stand of the sea. I believe that it should not be confounded with a compact buff clayey rock, generally soft, that occurs, for example, just below the lip of the cliff immediately north of the Castaways' Depot, as well as at other places, and seems to be sediment associated with the keratophyres.

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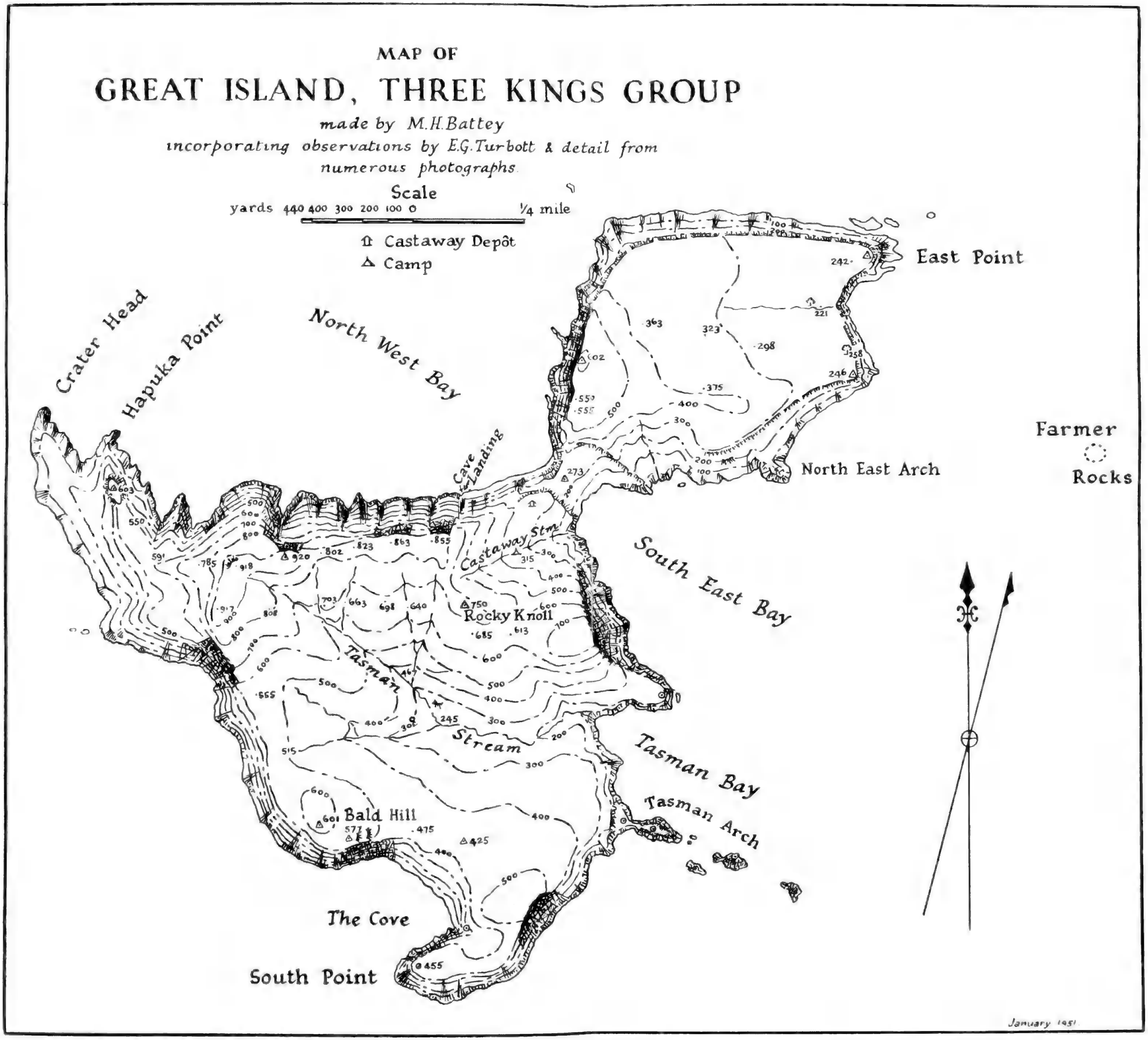
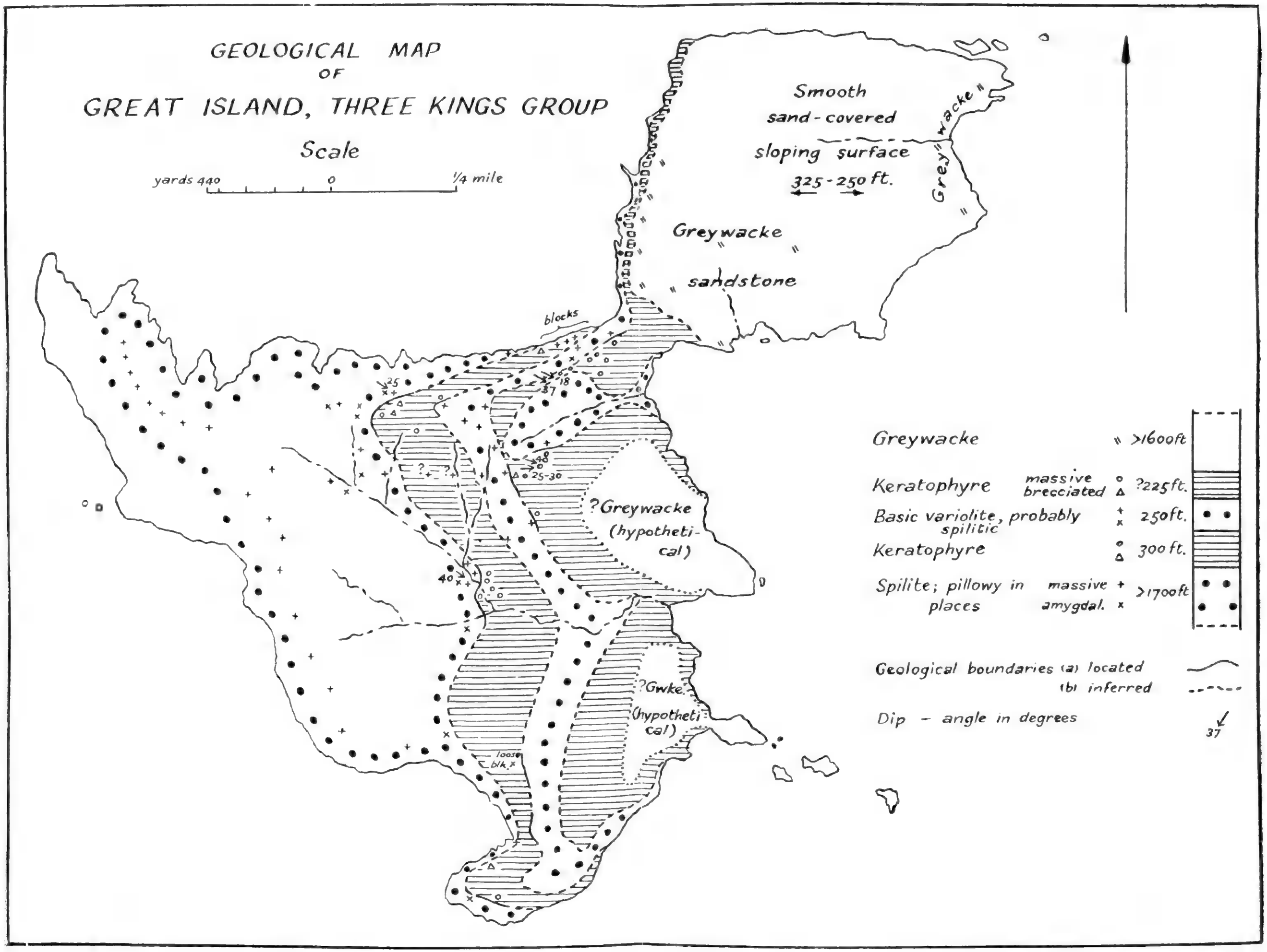

MAP OF
GREAT ISLAND, THREE KINGS GROUP
made by M.H.Battey
incorporating observations by E.G.Turbott & detail from numerous photographs
Scale
yards 440 400 300 200 100 0 ¼ mile
Castaway Depôt
Camp
Crater Head
Hapuka Point
North West Bay
Cave Landing
East Point
North East Arch
Farmer Rocks
Castaway Stm
South East Bay
Rocky Knoll
Tasman Stream
Tasman Bay
Tasman Arch
Bald Hill
The Cove
South Point
January 1951


GEOLOGICAL MAP OF GREAT ISLAND, THREE KINGS GROUP
Scale
yards 440 0 1/4 mile
Smooth sand-covered sloping surface 325-250 ft.
Greywacke
Greywacke sandstone
blocks
?Greywacke (hypothetical)
?Gwke (hypothetical)
loose blk.
Greywacke >1600ft
Keratophyre massive brecciated ?225ft.
Basic variolite, probably spilitic 250ft.
Keratophyre 300 ft.
Spilite; pillowy in places massive amygdal. >1700ft
Geological boundaries (a) located (b) inferred
Dip - angle in degrees

Elingamita (Myrsinaceae) a New Monotypic Genus from West Island, Three Kings.

By G. T. S. BAYLIS, University of Otago.

In January, 1950, Major M. E. Johnson succeeded after several unsuccessful attempts in landing on West Island at a point from which it was possible for him to climb the cliffs to the vegetation on the upper slopes. There he made a comprehensive plant collection, which he handed to me. It established that this small island though steep and windswept has a considerable flora and is of much ecological interest. In January, 1951, thanks to the skilled boat work of Mr. E. Beaver, of Whangaroa, I accompanied Major Johnson on a second visit. A subsequent paper will give an account of the vegetation of West Island together with that of the other outliers of the Three Kings Group. The present purpose is to describe a new tree first collected in fruit by Johnson and found to be both flowering and fruiting in the following January. Meanwhile, fruits had been submitted to the Herbarium, Royal Botanic Gardens, Kew, whence Dr. Melville reported that they appeared to be referable to the *Myrsinaceae*. The floral structure has confirmed that the tree belongs to this family but the monograph by Mez (1902), which remains the standard treatment, requires the erection of a new genus for its reception. The flowers have now been examined at Kew also, and I am indebted to the Director, Sir Edward Salisbury, for a report that "they do not seem to fit any genus of *Myrsinaceae* hitherto described."

ELINGAMITA n. gen.

Flores hermaphroditi, 4-6 meri. Sepala valvata, punctata, libera. Corolla brevior sepalis, tubulosa, truncata vel margine obscure lobulato. Filamenta corolla fere omnino libera et eadem in maturitate bene excedenta. Anthera elliptica dorso affixa, tota longitudine dehiscenta. Ovarium ovoideum in stylum crassiusculum attenuatum, stigmate punctiformi. Ovula perpauca in parte superiore placentae uniseriatim immersa. Fructus drupaceus, globosus, apice stylo persistento mucronatus, endocarpio crustaceo, monospermus. Albumen sphaeroideum, corneum, album, pulvino lato e placenta formato sedens. Embryo cylindraceus, obliquus vel transversus, paululo cervatus.

Arbor foliis alternis, exstipulatis, simplicibus, punctis. Inflorescentiae terminales, paniculatae, primo obtectae bracteis latis caducis.

A ceteris generis distat corolla deminuta sepalis breviore, omnino vel fere omnino tubulosa. Typus *E. johnsoni n. sp.*

Flowers hermaphrodite, 4-6 partite. Sepals valvate, punctate free. Corolla shorter than the sepals, tubular, truncate or with an obscurely lobed mouth. Filaments almost wholly free from the corolla and in mature flowers much exceeding it. Anthers elliptical, dorsifixed, splitting down their whole length. Ovary ovoid narrowed into a rather stout style with a stigmatic pit at the apex. Ovules very few immersed at one level in the upper half of the placenta. Fruit a drupe, globose, crowned by a persistent style, one-seeded with a brittle endocarp. Endosperm rounded, horny, white, seated on a broad cushion of placental tissue. Embryo cylindrical, oblique or transverse, almost straight.

A tree with alternate, exstipulate, simple, gland-dotted leaves. Flowers in terminal panicles concealed in bud by broad deciduous bracts.

Differs from all other genera in possessing a reduced corolla shorter than the calyx and wholly or almost wholly tubular. Type *E. johnsoni* n. sp.

Elingamita johnsoni n. sp. Pl. 10, figs. 1, 2. Text figs. 1-6.

Arbor glaber cortico leve, foliis coriaceis, integris, utrimque manifeste pinnate venosis, obovatis, in petiolos brevissimos gradatim contractos, c.100-180 mm. longis, c.45-90 mm. latis. Paniculae florales lutescentae, c. 50 mm. longae ex aequo latae, fructiferae c.100 mm. Flores pedicellis c.5 mm. longis, corollis c.2.5 mm. latis. Ovula 2-4. Fructus ruber, c.17 mm.

West Island, Three Kings, New Zealand.

A glabrous tree with smooth bark. Leaves leathery, entire, on both surfaces strongly pinnate-veined, obovate, about 4-7 inches long and $1\frac{3}{4}$-$3\frac{1}{2}$ inches wide, narrowed gradually into very short petioles. Panicles in flower yellowish about 2 inches in length and breadth, in fruit 4 inches. Flowers on stalks about $\frac{1}{4}$ inch long, corolla about 1-10th inch diameter. Ovules 2-4. Fruit red about 2-3rd inch diameter.

The very reduced tubular corolla lacking well defined free lobes and shorter than the calyx appears to be unique in the *Myrsinaceae*. The placenta has the uniseriate ovules of the tribe *Myrsineae* but the terminal paniculate inflorescence, non capitate stigma and well developed filaments separate *Elingamita* substantially from *Myrsine*, *Suttonia* and *Rapanea*, the genera to which the other members of the family indigenous in New Zealand have been, at one time or another, referred (Hosaka 1940, Allan 1947, Oliver 1951). Closer allies are presumably to be sought in the Pacific Islands and Malaya, but both the genera of this region with the same form of inflorescence, placenta and stigma (*Labisia* and *Tetrardisia*) are peculiar monotypes. Geographically, the nearest genus with a paniculate inflorescence is *Tapeinosperma*, which is well developed in New Caledonia and which has moreover a punctiform stigma. However, these resemblances are offset by a pacenta less like that of *Elingamita* than is that of *Myrsine*. Unfortunately, the vegetative anatomy of the family does not appear to be sufficiently well known for it to be employed as guide to the relationships of the new genus.

Elingamita johnsoni is represented by perhaps a dozen trees on West Island, but they are members of a windswept forest scrub in which the true habit cannot be seen. Like the other Three Kings monotypic genus *Plectomirtha* Oliver it has the general aspect of a karaka (*Corynocarpus laevigata*). The cream-coloured inflorescences are not very conspicuous, but the ripe fruit is brilliant red and produced in large bunches. The tree thus appears well worthy of cultivation, and it

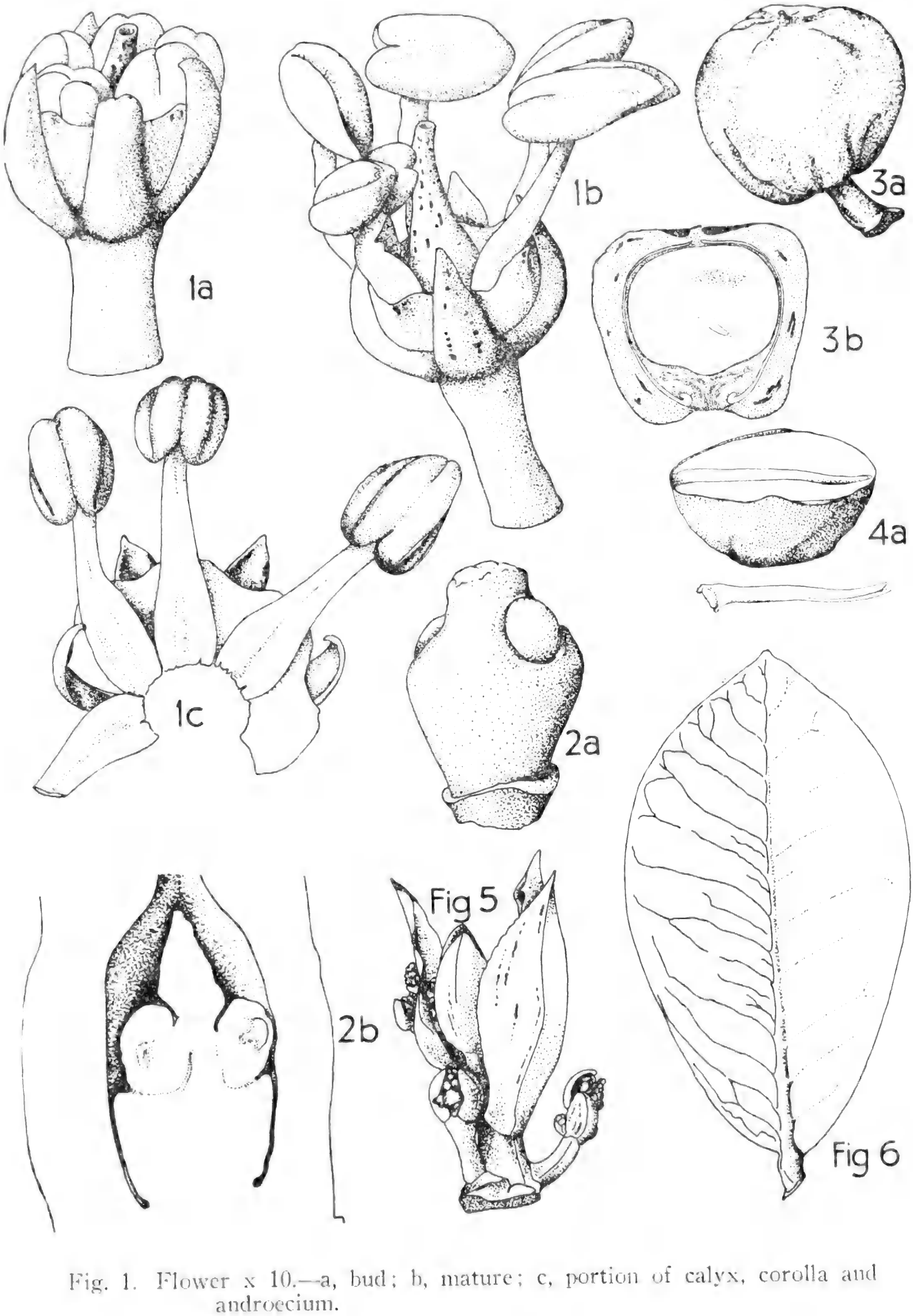


Fig. 1. Flower x 10.—a, bud; b, mature; c, portion of calyx, corolla and androecium.

Fig. 2. Placenta x 44.—a, entire; b, in L.S. of ovary.

Fig. 3. Fruit x 1.5.—a, entire: b, L.S. (persistent calyx not shown).

Fig. 4. Embryo x 2.—a, in situ in the endosperm; b, dissected out.

Fig. 5. Young inflorescence showing caducous bracts x 1.75.

Fig. 6. Underside of leaf x 0.5.

is a pleasure to dedicate the species to its discoverer, Major Johnson, on whose enterprise, skill and persistence the exploration of the smaller islands of the Group has greatly depended. The generic name commemorates the tragic wreck in 1902 of the inter-colonial passenger steamer *Elingamite* beneath the cliffs on which the tree grows.

I have to thank the late Major G. A. Buddle for the negative of Plate 10 and Dr. M. Holdsworth for all the drawings in this paper.

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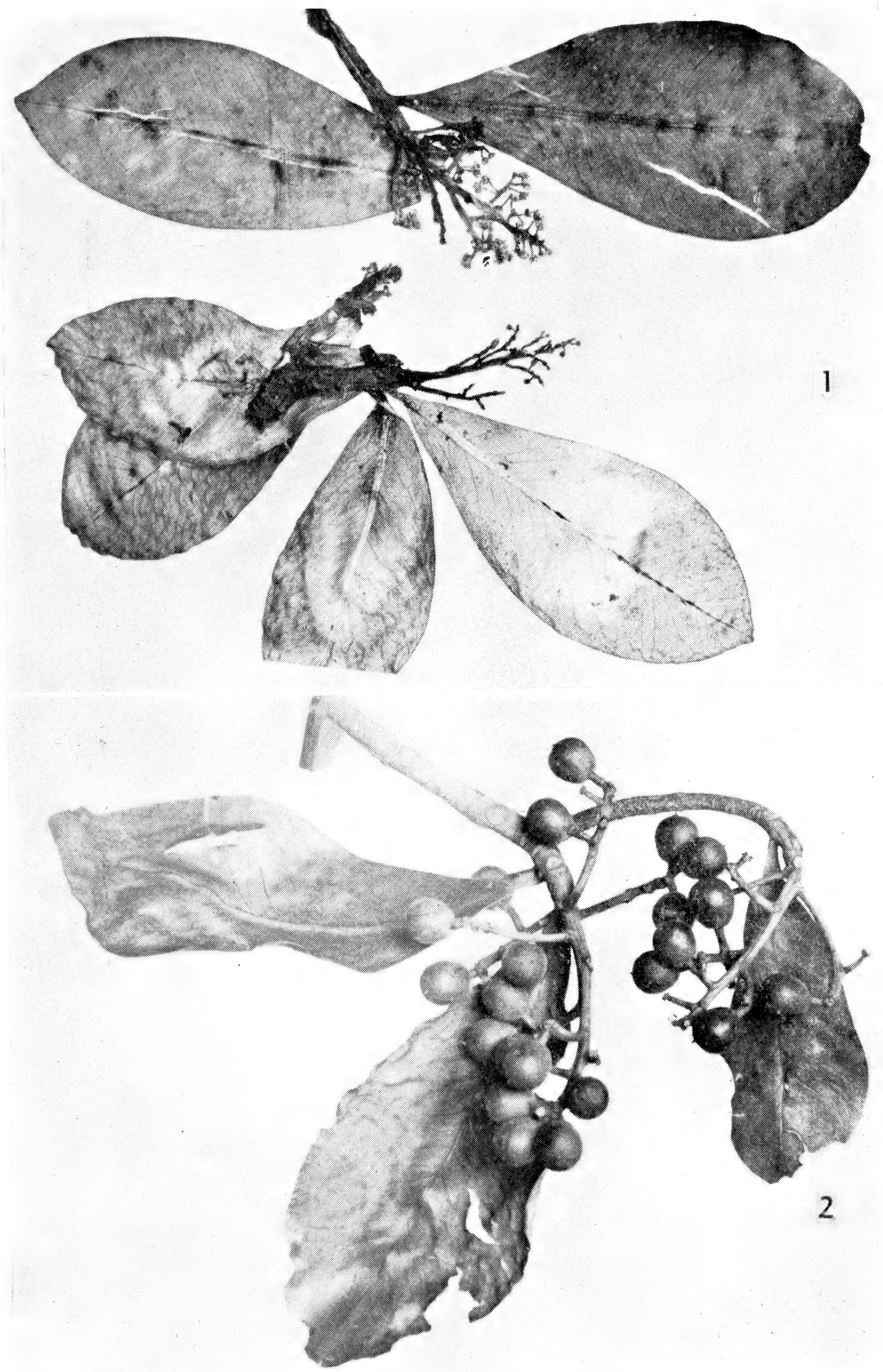

Herbarium material: 1, in flower; *2*, in immature fruit.
Elingamita johnsoni n. sp.

Incipient Forest Regeneration on Great Island, Three Kings Group.

By G. T. S. BAYLIS, University of Otago.

A previous paper (Baylis, 1948) attempted to trace the history of the vegetation on Great Island and reached the following conclusions. The bulk of the island was originally covered by mixed coastal forest. This was destroyed by a long period of Maori occupation, through which most of the component species probably persisted as single specimens and small groups. A period of regeneration, probably impeded to a small extent by goats, followed the departure of the Maoris about 1840, so that by 1889 a variety of shrubs and small trees mingled with a general covering of *Leptospermum.* Most of these failed to survive when the goat population grew large, and probably for about half a century prior to their complete destruction in May, 1946, these animals so thoroughly searched the island for food that trees other than two unpalatable species of *Leptospermum* were rarely, if ever, able to re-establish themselves from seed. Latterly *L. ericoides* (kanuka) had been more successful in this respect than *L. scoparium* (manuka), so that when the goats were destroyed, kanuka covered almost the entire island, the principal exception being a piece of *Zoisia* grassland. The trees of the mixed coastal forest persisted only as scattered individuals and small groups among which more than half the species were represented by five trees or less. At least two of the presumed components of this forest (*Meryta sinclairii* and *Elingamita johnsoni*) had disappeared entirely.

In 1946 most of the kanuka on Great Island was senescent and open. Since its seedlings are very intolerant of shade its re-establishment never occurred until the parent plants had died, and not always promptly then, sometimes through the presence of sedge undergrowth, sometimes—notably on the eastern plateau—because the soil was by this time windswept and eroded. The opportunities for entry of shade tolerant seedlings and even for light-demanding seedlings hardier than kanuka were thus extensive as soon as the goats ceased to make their establishment impossible. It did, however, appear that on the eastern plateau and elsewhere (e.g., the southern scrub area) the soil might have deteriorated overmuch for other trees, both through poor quality of *Leptospermum* humus (Scott Thomson and Simpson, 1937) and because of erosion in the replacement phases.

An account of a brief survey of Great Island in December, 1947, has already been published (Baylis, 1948). This paper sets forth observations I made in January, 1951, while encamped for six days on the island with a party organised for the Auckland Museum by its Director, Dr. Archey, and Ornithologist and Entomologist, Mr. Turbott, to whom I am much indebted for this opportunity. A re-charting of Turbott's (1946) quadrats was simultaneously undertaken. These charts are presented and discussed in an accompanying paper (Holdsworth, 1951). Some results of a short visit that I was able to pay in January, 1950, through the kindness of Major M. E. Johnson are included here. Expenses have been met by a grant from the Research Fund of the University of New Zealand.

SEEDLING ESTABLISHMENT UP TO JANUARY, 1951.

Trees with seedlings intolerant of shade.

Only the species of *Leptospermum* and *Metrosideros excelsa* (pohutukawa) appear to fall in this class.

(a) *Leptospermum*

Shade tolerant tree-seedlings are not yet sufficiently widespread to cause a general halt in the cycle of death and re-growth of kanuka (*L. ericoides*). Nevertheless, over much of the island it no longer continues. In all moist places herbaceous undergrowth is tall and dense and promises to deny the ground to kanuka seedlings over much wider areas than hitherto, so that, though open patches of rank sedge or *Colensoa* are still few and small, they seem certain to increase (figs. 1 and 2).

The eastern plateau is dry, but here kanuka is encountering competition from manuka (*L. scoparium*). This was the area in which the latter species was in 1946 more plentiful than in any other part of the island. Nevertheless, it was much less in amount than kanuka, which appeared to be replacing it. It was here also that soil deterioration was most obviously retarding re-establishment when old *Leptospermum* died, so that there were many open places. Since removal of the goats there has been no obvious increase in the rate of colonisation of these spaces by kanuka, but many of them have filled with manuka seedlings (fig. 3). This suggests that manuka is the species better adapted to maintain itself on the drier parts of the island but that in the seedling stage it was the more liable to damage by goats. There remains little reason to doubt that considerable replacement of manuka by kanuka accompanied growth of the goat population between 1887 and 1945, and that the reverse change is now under way.

The *Zoisia* area is also a dry one and the grass has not grown too long to prevent a general invasion of the sward by kanuka seedlings (fig. 4). This is in accordance with the familiar invasion of mainland pasture by *Leptospermum* which occurs when stocking is inadequate (e.g., Levy, 1949), and the fact that *L. scoparium* is not present here also is accounted for by the remoteness of any seed source.

(b) *Metrosideros excelsa*

The pohutukawa is demonstrating its ability to invade a grass turf on part of the *Zoisia* sward, over about a quarter acre of which its seedlings promise to compete with kanuka for dominance (fig. 4). A few dozen plants have also established themselves on bare soil between kanuka bushes at one place on the eastern plateau (fig. 5). To a tree of this colonising power Bald Hill, the entire *Zoisia* area, the grassy interspaces of the adjacent kanuka scrub and all the open strips of the eastern plateau should be available; nevertheless, most of the pohutukawa standing on or close to these areas have as yet no seedlings associated with them.

Trees with shade-tolerant seedings.

The remaining trees have seedlings that are in some degree shade tolerant and can establish themselves under a mature or thinning canopy of kanuka—in fact, none are found making their initial growth wholly without such protection. These species are components of mixed coastal forest which is believed to be the climax vegetation.

(a) *Cordyline australis*

Cabbage trees were well dispersed over the island in 1945 and were flowering abundantly. Seedlings are now common in kanuka forest and shrubland, but since they remain unbranched for a long time and develop only a tufted crown this species may not exercise much controlling influence on others.

(b) *Meryta sinclairii*

Puka seedlings are now common on the slopes which face S.E. Bay east of the depot, i.e., in the vicinity of Quadrat I (fig. 6) and adjacently in the lower part of Castaway Valley. They grow rapidly and cast a heavy shade, so that it is possible that a puka canopy will develop over some of this area. Elsewhere under comparable conditions of soil and shelter this species is seen only occasionally. It is rare in Tasman Valley, and there are a few young plants under Hapuka Point and in the shelter of pohutukawa below Bald Hill.

Even Cheeseman did not record *Meryta* on Great I., which means that it is over 50 years since seeding trees grew there. If the possibility of buried seeds lying dormant for over half a century cannot be dismissed (Crocker, 1938), at least some unusual soil disturbance would be necessary to break the dormancy of such substantial numbers. It seems beyond reasonable doubt that puka forests on North-East I. and South-West I., particularly the former because of its proximity, are the main seed source and red-billed gulls (*Larus novachollandiae*), whose droppings on Great I. have been found to contain *Meryta* seed, are the principal carriers. Many nest on the island's coast line and they are constantly to be seen hovering about the forest roof, a habit ascribed by Turbott (1951) to their feeding on cicadas. Admittedly, the part of Great I. closest to North-East I. is virtually devoid of *Meryta* seedlings. However, the depleted aspect of this eastern plateau area has already been mentioned, and the poor growth of the only young *Meryta* found upon it confirms the impression that it is at present inhospitable to that tree.

(c) *Brachyglottis arborescens*

The two moribund groves, and the few single trees along the western side of South East Bay are the nuclei of thickets of seedlings up to 6ft. high. That from the eastern grove extends for about 50yds. up the slope, that from the western grove for about 100 yards—in both cases beneath old kanuka (fig. 7). Occasional seedlings are seen much further from these sources, particularly on the northern side of South East Bay, but the species has yet to enter Tasman Valley.

(d) *Pittosporum fairchildii*

The large specimen close to the western *Brachyglottis* grove has several seedlings in its vicinity (fig. 8), and though it is dispersed by birds and the *Brachyglottis* by wind, occasional young plants of both are met with comparable frequency on the high lying land between the parent trees and the summit of the island. The remaining *Pittosporum* trees are close to Quadrat I and from these there is little spread as yet.

(e) *Cyathea medullaris, Paratrophis smithii, Melicytus ramiflorus, Coprosma macrocarpa, Litsaea calicaris, Melicope ternata.*

Old trees grow at intervals among the Tasman Stream and young plants of all, and particularly of *Cyathea* (fig. 9), are now common in the valley bottom. A similar spread of *Litsaea, Paratrophis* (fig. 11), *Melicope* and *Melicytus* centres round the specimens in the valleys east of the depot. So far *Litsaea* alone is spreading actively from the clump of mixed trees in Castaway Valley, and here its exceptional shade tolerance is apparent, seedlings occurring beneath kanuka too dense to allow of any other undergrowth. *Cyathea* has not yet spread to Castaway Valley, but a few seedlings of *Coprosma macrocarpa* have appeared there.

(f) *Hiemerliodendron brunoniana, Planchonella costata var. austromontana (Sideroxylon novozelandicum), Olea apetala, Corynocarpus laevigata, Hedycarya arborea, Alectryon grandis, Vitex lucens*

These are all species with very few parent trees on the island and seedlings at present confined to the immediate vicinity of one or more of the specimens. The minimum increase is shown by *Vitex*. The two trees fruit well, but so far only one seedling has appeared. No seedlings of *Alectryon* were found by either of the trees on the 1945 map, but in its preparation a small gulley on the northern side of the northern headland of Tasman Bay was overlooked, and this proves to contain two further trees of *Alectryon* together with two *Planchonella* and six *Brachyglottis*. *Alectryon* seedlings are plentiful for about 50 yards along the gulley bottom. *Planchonella* has spread rather less, and *Brachyglottis* somewhat further.

(g) *Rapanea (Suttonia) dentata, Plectomirtha baylisiana*

Seedlings were not seen beside any of the existing trees of *Rapanea*. It has only been observed fruiting at Hapuka Point, where there were two trees together, one of which is now dead. Probably it is, like several of the genus, dioecious. Surprisingly, however, a few seedlings which seem to be of this species occur about the camp site in Castaway Valley —a full quarter mile from any mature tree.

The sole known tree of *Plectomirtha* has failed to establish any seedlings on the stony ground which surrounds it, although the adjacent *Olea* has done so. The nature of the ripe fruit is still unknown, and it may be that none has matured. Certainly many of the panicles decay soon after flowering.

Lianes.

Old vines of *Clematis paniculata (C. indivisa)* and *Tetrapathea tetrandra* in the valleys east of the depot have made rampant growth, and produced exceptionally large leaves. This applies especially to *Tetrapathaea*, which has also established abundant seedlings there.

Parsonia heterophylla and *Clematis* in the Tasman Valley have not as yet spread conspicuously, and there is no evidence that the single *Tecomanthe speciosa* vine has seeded though it is thriving and has layered itself at one point well removed from the old base.

Soft wooded species.

Three quickly maturing soft-wooded species have become conspicuous—*Entelea arborescens*, which is a small tree, *Solanum aviculare* var.*albiflora*, which is a shrub attaining a maximum height of about 8 feet, and *Colensoa physaloides*, which is a large herb forming hydrangea-like clumps up to 5 feet high (figs. 2, 9, 13). *Colensoa* was abundant in 1887 (Cheeseman, 1888) and a few plants persisted in damp places in 1945. Now it forms large patches both in the Tasman Valley and on the slopes which face S.E. Bay, east of the depot. The *Solanum* is most plentiful over the area in which *Meryta* is most abundant, and it seems likely that its seed came by the same means though its presence on North East I. is not established. In addition, it occurs by the western *Brachyglottis* grove (fig. 8). *Entelea* was collected on Great I. as late as 1934. Transport of its large burred fruits from adjacent islands is hard to imagine, and in the light of published work (Millener, 1949) it may be that the odd plants still appearing come from dormant seed, while the small thickets—one in the Tasman Valley and one by the western *Brachyglottis* grove—are the product of precociously fruiting plants.

Other shrubs and herbs.

When goats browsed beneath the kanuka in most places there was a turf in which *Gnaphalium collinum, Lagenophora pumila, Cotula australis, Haloragis procumbens* and *Centella asiatica* were prominent. These creeping plants have been displaced by a vigorous growth of the accompanying grasses coupled with a large increase in the frequency of some hitherto not plentiful, i.e., *Agropyron kirkii, Microlaena stipoides, Poa anceps, Poa seticulmis.* Quail are common and may have aided their dispersal. Two liliaceous herbs, *Dianella intermedia* and *Arthropodium cirrhatum,* have also become widespread. *Arthropodium* was previously restricted to inaccessible cliffs and *Dianella,* now specially abundant on the eastern slopes of Tasman Valley, was found chiefly on the eastern plateau.

A list of herbs which colonised bare soil and the finer scree material on cliffs soon after removal of the goats has already been given (Baylis, 1948). It is apparent that on sea-cliffs the prostrate ecotype of *Myoporum laetum* is gaining possession, but on Bald Hill (fig. 10) the only woody plant so far established is the endemic *Hebe insularis.* No form of *Myoporum* capable of developing into a tree is present on Great Island. Seedlings often appear on the hills, but their growth is spindly and they soon die.

Additions to the species list since December, 1947.

In December, 1947 (Baylis, 1948), 18 species were collected that had not been observed while goats were plentiful, though the possibility of their being present in out of the way places could not be precluded.

The following are now added with the same reservation. The date (1887) or (1889) means that the species was recorded by Cheeseman (Oliver, 1948), though it is possible that 1889 records relate not to Great I. but to South-West I.

Anagallis arvensis L.
Arthropteris tenella (Forst. f.) Sm. (1889).
Bromus catharticus Vahl.
Calystegia soldanella R. Br.
Calystegia tuguriorum (Forst. f.) R. Br. (1887).
Erechtites atkinsoniae F. Muell.
Erigeron canadensis L.
Hierochloe redolens R. Br.
Paspalum scrobiculatum L. (1889).
Polystichum richardi (Hook.) Sm. (1887).
Sarcochilus adversus (Hook. f.).
**Solanum aviculare* Forst. f. var. *albiflora* Cheesem. (1889).
Trifolium glomeratum L.
Uncinia uncinata (L) Kirk (1887).
Veronica plebeia R. Br.

DISCUSSION.

All species that were expected to occupy more ground after removal of the goats have begun to do so except the two rarest, *Tecomanthe* and *Plectomirtha*, each of which is still represented by a single plant that may not have fruited.† The short life cycle of the herbs has enabled some to spread extensively, the most striking examples being *Colensoa*, *Arthropodium*, *Dianella* and two grasses, *Agropyron kirkii* and *Microlaena stipoides*, both first noticed in 1947 and now widely diffused. The distribution of woody species, however, remains in general closely related to the seed source. Even *Meryta* and *Solanum* which seem to have come from a distance show this. Though birds appear to have carried these species from other islands they have failed as yet to bring in *Macropiper* in comparable quantity. The only markedly discontinuous dispersal observed upon Great I. itself was the presence of *Rapanea* and *Coprosma macrocarpa* at the camp site in Castaway Valley. As the headquarters of collectors this place is suspect. Striking examples of persistent localisation are *Cyathea* and *Tetrapathaea*, both still restricted to the valleys containing the parent plants, but spreading abundantly there.

Chance factors of distribution promise to exercise a major influence on the composition of the new forest. These include the position of the old forest relics; how far the ground immediately about each tree was

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*Seedlings seen in 1947 were identified as the type, but the flowers prove to be paler, the habit more slender, and the leaves unlobed except in the seedling stage. Cheeseman's record is simply *S. aviculare*, but he did not erect the variety until 1920.

†Mr. J. Horton has successfully propagated *Tecomanthe* from cuttings at the Plant Diseases Division, Auckland. Further attempts will be made to establish *Plectomirtha* by this means.

suitable for seedlings and thereby for an early increase in seed production close to the original centre; whether or not in the first few years any seedlings arose at a distance to become separate centres of seed supply.

A character which should assist some species is precocious fruiting. The oldest seedlings of the fast growing trees *Brachyglottis, Meryta* and *Hiemerliodendron* (fig. 12) are already themselves in flower, the first two sometimes bearing an inflorescence when only two feet high. Another distributional accident which may prove significant is the extent to which ground adjacent to parent trees came early within the orbit of aggressive temporary occupants. In this role *Solanum aviculare* var. *albiflora, Colensoa* and *Entelea* are becoming conspicuous. Even a dense sedge growth, since it is capable of excluding kanuka, can in the absence of other seedlings cause local deforestation.

It will be interesting to observe which tree first secures all stations suited to it. The progress of *Meryta* in view of its abundance on North-East I. and South-West I. may be rapid when the seed supply is augmented by a substantial seed crop on Great I. itself. However, the exploration of these lesser islands is affording evidence that pure stands of this araliad are not, as was earlier suggested (Baylis, 1948), a stable climax even close to the sea.

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The Flora of the Three Kings Islands: Additional Notes: with Note on Suttonia.

By W. R. B. OLIVER, Wellington.

The following notes are intended to be read with the paper I published on The Flora of the Three Kings Islands in *Records of the Auckland Museum,* vol. 3, pp. 211-238, 1948.

Alectryon grandis Cheesem. (Oliver, *l.c.*, p. 226).

Mature fruit similar to that of *A. excelsum* but larger, globose, brown, pubescent, a lateral longitudinal flange extending to but decreasing in prominence towards the apex; length 18 mm., diameter 12 mm. Seeds black, shining. The fruits, usually, perhaps normally, are joined together in twos on the flanged sides for practically the whole length. The lateral flanges, except at the apex, are accordingly suppressed in the joined fruits.

Clematis paniculata Gmelin, in Linn. *Syst. Nat.* ed. 13, 1791, replaces *C. indivisa* Willd., 1800.

Rehder, *Jour. Arn. Arb.*, 26, 70, 1945, has shown that both these names were founded on *C. integrifolia* of Forster (not Linnaeus, 1753), and as Gmelin's name is earlier than Willdenow's it should be accepted for our species.

Planchonella costata (DC) Lam, var. **austro-montana** Lam, *Blumea,* 5, (1), 5, 1942.

This name should replace *Sideroxylon novo-zelandicum* of my former paper (*l.c.*, p. 231). Lam quotes Pierre as the authority for the combination *Planchonella costata* but gives what appears to be only a herbarium reference. Var. *austro-montana* is the typical variety of the species.

Rapanea dentata (Oliver) n. comb. for *Suttonia dentata* Oliver, Rec. Auck. Mus., 3, 320, 1948.

The petals are united at the base, not free as I described them; accordingly, the species falls into the genus *Rapanea.* Although there is a *Myrsine dentata* Spreng., it is apparently a synonym of a species of *Rapanea,* but it has never been transferred to that genus so the combination *Rapanea dentata* is not preoccupied.

NOTE ON SUTTONIA.

The genus *Suttonia* A. Rich., if based on the free petals, cannot be maintained because of 16 species in the Hawaiian Islands, undoubtedly forming a natural group of *Rapanea* facies, which have the petals free or united. In several cases both conditions are found in the same species. Hosaka (*Occ. Pap. Bishop Mus.*, 16, 28, 1940) argues for the inclusion of both *Rapanea* and *Suttonia* with *Myrsine*, but *M. africana*, its type species, has the filaments of the stamens united into a flange on the inside of the corolla, a structure not at all like any seen in either *Rapanea* or *Suttonia*. I would agree with Hosaka in uniting *Rapanea* and *Suttonia*, but not in merging the combined genus in *Myrsine*. The change here recommended involves the following new combinations:

Rapanea australis (A. Rich.) Oliver, n. comb. for *Suttonia australis* A. Rich., *Fl. Nouv. Zel.*, 349, pl. 38, 1832.

Rapanea chathamica (Muell.) Oliver, n. comb. for *Myrsine chathamica* Muell., *Veg. Chatham Is.*, 38, pl. 7, 1864.

Rapanea coxii (Ckne.) Oliver, n. comb. for *Myrsine coxii* Ckne., *Trans. N.Z. Inst.*, 34, 318, 1902.

Rapanea montana (Hook. f.) Oliver, n. comb. for *Myrsine montana* Hook. f., *Handb. N.Z. Fl.*, 184, 1864.

Rapanea divaricata (Hook. f.) Oliver, n. comb. for *Myrsine divaricata* A. Cunn., *Ann. Nat. Hist.*, 1, (2), 47, 1838.

Rapanea nummularia (Hook. f.) Oliver, n. comb. for *Myrsine nummularia* Hook. f., *Handb. N.Z. Fl.*, 184, 1864.

1. Re-establishment of kanuka checked by sedges (*Scirpus nodosus, Carex testacea*)—Jan., 1950.
2. Re-establishment of kanuka checked by *Colensoa*. The *Meryta* seedling right of centre was in flower—head of S.E. Bay, January, 1950.
3. Manuka seedlings, E. plateau. All surrounding bushes are kanuka—Jan., 1951.

4. Kanuka and pohutukawa seedlings on the *Zoisia* sward—Jan., 1951.

5. Pohutukawa seedlings on bare soil—E. plateau, Jan., 1951.

6. *Meryta, Melicytus* and *Pteris comans*—edge of Quadrat I, Jan., 1950.

7. *Brachyglottis* beneath kanuka near eastern grove—Jan., 1951.

8. *Pittosporum, Solanum* and *Brachyglottis* (right) beneath dead kanuka—near western grove—Jan., 1951.

9. *Cyathea* and *Colensoa* beneath kanuka —*Cordyline* canopy—Tasman Valley bottom—Jan., 1951.

10. *Scirpus nodosus* and *Cyperus* tussocks, mats of *Disphyma* and *Gnaphalium luteo-album*—Bald Hill, Jan., 1951.

11. *Litsaea* (foreground) and *Paratrophis* (right and rear) seedlings in Tasman streambed—Jan., 1951.

12. The figure stands behind a flowering seedling of *Hiemerliodendron* and points out one of the largest *Litsaea* seedlings for comparison—near Quadrat I, Jan., 1951.

13. *Colensoa* colonies and a single *Entelea* (behind the figure)—Tasman valley bottom, Jan., 1951.

Effect of Goats on Great Island, Three Kings: The Permanent Quadrats Resurveyed.

By M. HOLDSWORTH, University of Otago.

The Permanent Quadrats in 1948.

On 6th October, 1948, a landing on Great Island was made from the launch "Alert" but only four hours were spent ashore. The party included E. G. Turbott and L. C. Bell.

Insufficient time was available before dark to take a complete series of photographs corresponding to those of 1946, but representative ones were secured on each of the quadrats—Plates 15-17, figs. 1-6.

The following observations are a condensation of Turbott's field notes on Quadrats I and II with the addition of information supplied by Bell on Quadrat III.

Quadrat I

The most striking addition to the cover of Quadrat I was drifts of *Colensoa physaloides,* a plant not represented at all on this plot before the goats were exterminated. *Tetrapathea tetrandra* was another addition noted as widely distributed. Abundant new shoots had put out from the lower parts of the trunks of *Cordyline australis* (especially), *Melicytus ramiflorus* and *Litsaea calicaris. Clematis indivisa* seedlings were noted adjacent to the groups of parent plants recorded in 1946. [All the lianes of *Clematis* appeared to be of about the same age in 1951 and the groups did not appear to have extended their territory, so these seedlings probably have not survived.] Seedlings up to 3′ of *Meryta sinclairii* and *Brachyglottis arborescens* were frequent, especially about the position marked "P" in Pl. 24, fig. 18.

The four marked seedlings (see Turbott, 1948, p. 267) were remeasured:

No. 1. *Melicope ternata*	2′ 10″ high
No. 2. *Melicytus ramiflorus* (thought to be *Litsaea calicaris* in 1946)	1′ 4″ high
No. 3. *Melicope ternata*	2′ 6″ high
No. 4. *Tetrapathea tetrandra* (thought to be *Litsaea calicaris* in 1946)	2′ 0″ high

[In 1951, Nos. 2 and 4 could not be identified and probably have not survived. The nearest plant to 2 was a *Melicytus* (1′ 9″), but this was on the side facing away from the number. There was no seedling at all adjacent to No. 4.]

Quadrat II

Changes on this plot were much less remarkable than on I, but seedlings of *Meryta sinclairii, Cordyline australis, Tetrapathea tetrandra* and *Clematis indivisa* were observed. [The last named did not survive until 1951.]

Among the herbs, *Dianella intermedia* had already established several clumps and there were a few of *Arthropodium cirrhatum*. Both these plants were not present in the quadrat in 1946. It was recorded that the herbs, generally, were more flourishing than they had been during the goat occupation.

Quadrat III

Invasion of this grassland area by kanuka seedlings had begun and the sward itself was longer than in 1946.

The Permanent Quadrats in 1951.

The opportunity was taken during the 1951 Auckland Museum Expedition to the Three Kings Islands to re-map the permanent quadrats laid down by E. G. Turbott in 1946 (Rec. Auck. Inst. Mus., 1948, q.v.). Observers in the meantime (Baylis, 1951) have remarked the obvious and rapid changes which have occurred in the vegetation of Great Island since the extermination of the goats, but a remapping of the quadrats establishes these changes in numerical terms—an interval of about five years since the last census seems appropriate and it is hoped that it will be possible to take subsequent censuses at the same interval.

Methods

When Turbott made the original observations on these plots, the vegetation on each was so open that mapping could be accomplished by sighting on to flag markers set up on the side lines. On Quadrat I, this is no longer possible. The vegetation is already so dense that vision is limited to a few metres and it was found necessary to lay a grid of strings (two-metre squares were adopted) over the whole plot. Turbott himself gave assistance in finding the boundaries of this quadrat, but even so it is evident from a comparison of his Plate 50, fig. 20, with Plate 23, fig. 17, that there are discrepancies in the positions of individual trees between the two records. Errors thus introduced have been allowed for in the discussion that follows.

Quadrat I

In Turbott's photographs of this quadrat, taken in 1946, the vegetation looks old and decrepit for the trees are overaged and there is no new growth below. Now, in 1951, although the condition of the kanuka trees has still further declined, the forest looks quite flourishing, for the upspringing of large numbers of tree seedlings has added a fresh greenness to the plant cover. In some places the appearance of rejuvenescence has been intensified by vigorous growth of the passion vine, and in others by the spread of *Colensoa*.

Along the western boundary, however, there is relatively little change in the appearance of the forest (Cf. particularly fig. 7 with Turbott's fig. 3). Roughly, this zone corresponds with a belt of cabbage trees as shown in Turbott's Pl. 50, fig. 20, and Pl. 23, fig. 17, here. Pl. 24, fig. 18, in which the young trees are plotted, shows also a wide band free of seedlings down the right half of the diagram. But this area has nevertheless changed in general appearance since 1946, for here has appeared a dense swathe of *Colensoa* along both branches of the watercourse shown in Turbott's diagrams.

Fig 1. Quadrat I, 6th October, 1948. (Corresponds to Fig. 3A in Turbott, 1948.) The sedges are more luxuriant than in 1946.

Fig. 2. Quadrat I, 6th October, 1948. (Fig. 4B in Turbott.) Vigorous new shoots have grown from the bases of the cabbage trees. The fern in the foreground is *Pteris comans* and the bush to its right is *Melicytus ramiflorus*.

Photos: E. G. Turbott.

The canopy

Analysis of Turbott's diagram shows that, in 1946, the canopy was constituted by 92 mature trees rooted inside the quadrat, of which 50 were kanuka and 29 cabbage trees, other species contributing but a few specimens each. By 1951, the total number had fallen to 80. The figures are not exactly comparable, for there are some discrepancies between the two records in the inclusion of trees on the boundary lines. However, from their positions it is possible to identify 91 of the trees present in 1946 in Pl. 23, fig. 17. Of these, 19 (all kanuka) are represented now by dead boles, i.e., in five years more than a third of the mature kanuka trees have died.

Most of the gaps in the stippling representing the canopy in Pl. 23, fig. 17, can be related to the positions of the dead trees, the rest are gaps already present in 1946, probably marking the positions of trees which had died previously to Turbott's census.

The undergrowth

Though the total number of trees forming the canopy has declined by a fifth, the loss has been more than compensated for by the appearance of seedlings. These are not, however, kanukas. On this quadrat there are in fact no kanuka seedlings that can be said with certainty to be new. It is true that the total of them is now 73 compared with 43 in Turbott's diagram, but there are still none outside the two thickets shown there and the difference is almost certainly due to the difficulty of defining a single plant in a thicket.

The other young trees and bushes recorded by Turbott were: *Melicope ternata*, 15 seedlings; *Coprosma rhamnoides*, 9; and *Myoporum laetum*, 7. The present complement of this layer of vegetation is shown in Pl. 24, fig. 18, and summarised in Table 1: It can be seen that first place has now passed to mahoe, with almost as many seedlings as the rest put together. Kanuka has fallen to second place and ngaio has actually declined.

Geniostoma, *Brachyglottis* and *Entelea* were not present on the plot in 1946, and *Meryta*, as far as can be known, was not present anywhere on Great Island.

Table 1.

QUADRAT I.

Trees forming the canopy:

	1951	1946 (from E.G.T.)
Leptospermum ericoides A. Rich.	34	50
Cordyline australis (Forst. f.) Hook. f.	33	29
Melicope ternata Forst.	5	5
Litsaea calicaris (A. Cunn.) Hook. f.	4	4
Paratrophis smithii Cheesem.	2	2
Melicytus ramiflorus Forst.	1	1
Pittosporum fairchildii Cheesem.	1	1

Young trees and shrubs:

Melicytus ramiflorus Forst.	238	0
Leptospermum ericoides A. Rich.	73	43
Litsaea calicaris (A. Cunn.) Hook. f.	52	0
Melicope ternata Forst.	51	15
Coprosma rhamnoides A. Cunn.	27	9
Meryta sinclairii (Hook. f.) Seem.	15	0
Cordyline australis (Forst. f.) Hook. f.	7	0
Myoporum laetum Forst.	5	7
Paratrophis smithii Cheesem.	5	0
Pittosporum fairchildii Cheesem.	4	0
Entelea arborescens R. Br.	3	0
Geniostoma ligustrifolium A. Cunn.	3	0
Brachyglottis arborescens Oliver	2	0

No significant numbers can of course be quoted for the individual plants of the lianes *Muehlenbeckia complexa*, *Tetrapathea tetrandra* and *Clematis indivisa*, but the first is a new arrival on this plot with about 5 established colonies; *Tetrapathea* has certainly increased since 1946 (about 40 colonies); whereas *Clematis* is confined to the same 3 colonies marked by Turbott. Established seedlings around the parent plants were recorded by Turbott in 1948 but these do not seem to have survived.

The Herbs

Most of the ground herbs mapped in Pl. 25, fig. 19, could not be recorded as individuals; furthermore, the stippling used to represent the grasses and sedges records only whether they were present at all in the squares of the grid, not the actual area covered.

The most conspicuous event in the ground layer has been the invasion of the damper parts of the quadrat by *Colensoa physaloides*. The areas affected are almost pure stands of this plant—the only herb which has survived being engulfed by *Colensoa* is *Pteris comans*. With the exception of 5 remaining tussocks, *Colensoa* has completely cleared the watercourses of the *Carex* shown in Turbott's Pl. 51, fig. 21.

The areas bare of ground cover are approximately the same as indicated by Turbott—a large space in the S.W. quarter of the plot, two spaces under the young kanuka trees and patches along the W. boundary. However, the large area in the S.W. quarter, truly bare in 1946, is now a shrubbery of tree seedlings (cf. Pl. 24, fig. 18, and Pl. 25, fig. 19).

No attempt, on this occasion, was made to sort out the composition of the areas occupied by "grasses." Casual survey, however, showed that the principal components are still *Oplismenus undulatifolius* and *Echinopogon ovatus*, as recorded by Turbott. The squares marked as containing "sedges" included very little *Carex virgata*, which has probably declined in favour of *C. testacea* since 1946.

Two new arrivals among the plot's complement of herbs are *Erigeron canadensis* and *Haloragis erecta*. The first was not recorded anywhere on the island by Baylis in 1946 (see list, p. 247 et seq. Baylis, 1948). It is now found sporadically everywhere in the open kanuka forest, but is not frequent on the plot itself and has not been recorded in Pl. 24, fig. 19. *Gnaphalium collinum* and *Oxalis corniculata* are probably now absent from this plot, but no opinion can be given about the other small herbs mentioned by Turbott as they were not specifically looked for in 1951.

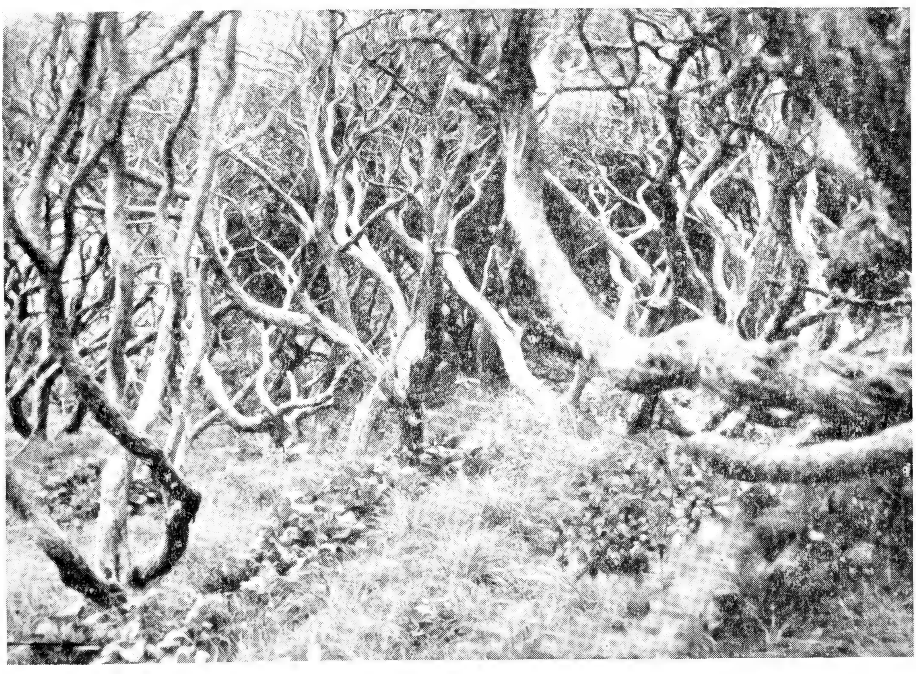

Fig. 3. Quadrat I, 6th October, 1948. (Fig. 5C in Turbott.) Young kanuka in opening, new shoots arising from the trunk of *Cordyline australis*. *Colensoa physaloides* in right foreground. The young *Entelea arborescens* in the left foreground had completely obscured this view by 1951.

Fig.4. Quadrat I, 6th October, 1948. (Fig. 8F in Turbott.) Sedges more luxuriant than in 1946. *Colensoa physaloides* has appeared along the water-courses (centre and right foreground). Young *Melicope ternata* and *Brachyglottis arborescens* in right foreground.

Photos: E. G. Turbott.

Fig. 5. Quadrat II, 6th October, 1948. (Fig. 10H in Turbott.) Sedges more luxuriant than in 1946. *Coprosma rhamnoides* in centre and to right. Young *Cordyline australis* and *Dianella intermedia* in line to extreme right.

Photo: E. G. Turbott.

Fig. 6. Quadrat III, 6th October, 1948. (Fig. 13L in Turbott.) The tussocks are *Scirpus nodosus*. The young kanuka seedlings shown by 1951 (Pl. 22, fig. 15) are not yet apparent. The white lines are the boundaries of the plot with the west corner in the foreground.

Photo: L. C. Bell.

Quadrat II

As can be seen by comparing Pl. 45, figs. 9 and 10, in Turbott's paper with Pl. 21, figs. 13 and 14, superficially little change has occurred in the general appearance of this plot, for the tree seedlings are still too small to add an additional layer to the vegetation. However, the areas of turf have mostly been replaced by sedges throughout the whole plot and *Dianella* is a new and prominent component of the herb layer.

With the exception of the cabbage tree in the E. corner, Turbott did not mark the positions of the trees on this quadrat, but records that the canopy was constituted by 46 kanuka trees. The total number of live trees shown in Pl. 26, fig. 20, for the same area is now only 21, including this same cabbage tree. On this plot, too, then, mortality among the kanuka trees has been high, but whereas there is no evidence of regeneration since 1946 on Quadrat I, on this plot there are a few (five) young bushes additional to the thicket shown by Turbott. *Coprosma rhamnoides*, which Turbott mentions as "scattered over the quadrat," is still the dominant shrub and the most numerous tree seedlings are of the cabbage tree. The full complement of tree seedlings is shown in Table 2. The *Melicope* is the same specimen recorded by Turbott and it has grown very little since. During the 1948 landing this tree was noticed to have been severely damaged by cicadas.

Table 2.

Shrubs and tree seedlings recorded on Quadrat II, January, 1951:

	Number of Plants.
Coprosma rhamnoides A. Cunn.	75
Cordyline australis (Forst., f.) Hook. f	17
Leptospermum ericoides A. Rich.	12
Meryta sinclairii (Hook. f.) Seem.	8+
Litsaea calicaris (A. Cunn.) Hook f.	4+
Paratrophis smithii Cheesem.	3+
Melicytus ramiflorus Forst.	2+
Myoporum laetum Forst.	1+
Melicope ternata Forst.	1

Those marked + are new records since 1946.

Only the larger herbs have been recorded individually, and the shading representing *Doodia media* and *Carex (testacea)* in Pl. 26, fig. 20, merely indicates whether these were present in the grid squares. There was no bare ground on this plot except beneath the kanuka bushes: the squares shown blank in the diagram being actually occupied by turf. The nature of this was not investigated carefully, but the principal component was *Oplismenus undulatifolius*.

A list of the larger herbs present is given in Table 3.

Table 3.

Larger herbs recorded on Quadrat II, January, 1951:

	Number of Plants.
Erigeron canadensis L.	30+
Haloragis erecta Schindler	17+
Dianella intermedia Endl.	11+
Arthropodium cirrhatum (Forst. f.) R. Br.	1+
Davallia tasmani Cheesem.	1+

Those marked + are new records since 1946.

Quadrat III

More change has occurred in the general features of Quadrat III than is apparent from a comparison of Pl. 22, figs. 15 and 16, with Turbott's Pl. 47, figs. 13 and 14. The greater part of the plot is still occupied by a short turf of mixed grasses and other herbs, but the interspersed tussocky growth which can be seen in Turbott's photographs is *Scirpus nodosus*, whereas in Pl. 22, figs. 15 and 16, almost the same appearance is given to the photographs by the swarm of windswept cushions of kanuka which has spread west from the original scrub in the north corner. Most of this change has become apparent since 1948 (cf. L. C. Bell's photograph, Pl. 17, fig. 6, with fig. 15), though both Baylis (Baylis, 1948; Turbott, 1948) and Bell recorded the establishment of new kanuka seedlings.

On the other hand, the amount of *Scirpus* has probably not altered —the positions of this shown in Turbott's Pl. 52, fig. 23, correspond with those in Pl. 17, fig. 21 (in the latter it occupies 2.1% of the total area). This means that the area in turf has declined, for the area occupied by kanuka has certainly increased. The area now occupied by *young* kanuka is 24.4% of the total, and though it is not possible to extract a figure from Turbott's data for comparison, the kanuka in his diagram occurs in only two groups of bushes, one of which, that in the N. corner, is now dead. Young trees are already established under the dead branches.

The sedges which Turbott noted under this group of bushes still persist. Beneath the dense cover of the new kanuka, on the other hand, the ground is quite bare.

The composition of the grass sward is presumably much the same as it was in 1946. The following table (Table 4) is an analysis of the strip of metre squares against the S.W. boundary.

Table 4.

Frequency of herbs forming the turf of Quadrat III.

	No. of squares (out of 15) in which species occurred.
Centella asiatica (L.) Urban	15
Deyeuxia crinita (L.) Zotov	15
Aira caryophyllea L.	10
Vulpia dertonensis (All.) Volk.	10
Wahlenbergia gracilis (Forst. f.) Schrad.	9
Aira praecox L.	8
Gnaphalium collinum Lab.	8
Sonchus oleraceus L.	6
Danthonia semiannularis R. Br.	5
Hypochoeris radicata Lab.	5
Oxalis corniculata L.	3
Zoisia matrella (L.) Merrill	3
Carex breviculmis R. Br.	1
Cotula australis (Lieb.) Hook. f.	1
Dichondra repens Forst.	1
Doodia media R. Br.	1
Erigeron canadensis L.	1
Hydrocotyle novaezelandiae D.C.	1

With the exception of *Erigeron canadensis*, it is doubtful whether any of these are new to the plot, for unless they are in flower it is difficult to separate the grasses and probably even this list is not exhaustive.

Fig. 7. Quadrat I, 14th January, 1951. (Corresponds to Fig. 3A in Turbott, 1948.) The white line across the upper part of the picture is the string marking the W. boundary of the plot. The seedling obscuring the right foreground is *Melicytus ramiflorus*.

Fig. 8. Quadrat I, 14th January, 1951. (Fig. 4B in Turbott.) New growth from base of *Cordyline australis* in centre and left. Ground now covered with *Carex*. Young *Melicytus* in foreground and to right. The fern is *Pteris comans*.

N.B.—The view corresponding to Turbott Fig. 5C was completely obscured by a young *Entelea arborescens*.

Fig. 9. Quadrat I, 14th January, 1951. (Fig. 6D in Turbott.) *Coprosma rhamnoides* in centre foreground. *Colensoa physaloides* at base of tree on right. Young *Leptospermum ericoides* on left. The white string is the N. boundary of the plot.

Fig. 10. Quadrat I, 14th January, 1951. (Fig. 7E in Turbott.) New growth from base of *Cordyline* on left. *Colensoa* obscuring foreground.

DISCUSSION.

(a) Regeneration of kanuka forest

On neither Quadrat I nor II is there any evidence that the existing kanuka forest is being replaced as the old trees die out. Thus on both a change to some other type of forest can be forecast. On both the rate of change is rapid: Since 1946, 39% of the kanukas on Quadrat I have died and probably 67% on Quadrat II; yet there is no good evidence of the appearance of a single new kanuka seedling since 1946 on Quadrat I and only a 19.2% replacement on II. On both quadrats there were groups of kanuka seedlings in 1946, and, at least on Quadrat I, it is clear that these had appeared below the only breaks in the canopy, i.e., while the goats were in occupation, the only factor keeping back the growth of new kanukas was the shade cast by their parents, and the appearance of a gap anywhere in the canopy immediately induced a replacement crop more than sufficient to fill the gap.

With the goats removed the sequence is quite different. Kanuka seedlings are still not tolerant of the parental shade, but they are not able to exploit the open spaces either. This is not a question of competition with other tree seedlings, for on Quadrat I the principal open spaces are almost free of them (excepting, of course, the kanuka seedlings existing pre-1946) and on Quadrat II the association of other tree seedlings is nowhere dense enough to offer resistance to colonisation. The reason is therefore probably the coverage provided by the herbs, which is, in fact, most dense below gaps in the canopy. The principal plants involved are *Coleusoa* and the sedges (the grass is nowhere very vigorous), the former of which was completely controlled by the goats and the sedges though present before 1946 are now much taller and denser (cf. in Pl. 18, fig 7, with Turbott, Pl. 42, fig. 3).

Thus, through the control that by browsing and trampling they execised on the coarser herbs, the goats were responsible for the maintenance of the kanuka cycle in the forested part of the island. On the other hand, they also suppressed the seedlings of other trees which are the natural heirs of the kanuka. The degree of regeneration still taking place on Quadrat II reflects the general dryness and poverty of the soil on this plot compared with Quadrat I: the ground herbs are less flourishing and can offer less resistance to the entry of kanuka seedlings.

On Quadrat III, the situation is quite different. The hillside is too windswept to maintain high kanuka forest; instead, the same species here can only attain the status of a stunted and matted scrub. Baylis (1948) has pointed out that the occupation of this area by grass was probably the result of a fire a long time ago (probably even before Cheeseman's visit in 1889) and the goats have delayed its recolonisation by kanuka by inadvertent grazing of seedlings in the sward.

Since the removal of the goats the recolonisation has been greatly accelerated and the grass will presumably eventually be excluded altogether, though in five years less than a quarter of the sward has disappeared on this particular plot.

(b) Alternatives to the kanuka cycle

Though it is certain that the succession of kanuka trees that have forested Quadrats I and II has now come to an end, what is to replace it is not yet defined.

On Quadrat I, mahoe forms nearly half of the generation of seedlings that has sprung up since the goats were eliminated (Table 1). Yet this apparent dominance is probably a temporary phase due to the initial advantage of a freely fruiting parent plant of the same species on the plot. On Quadrat II, for example, mahoe occupies quite a low place in the order of frequency, this plot being further from a seed source. Mahoe dominated forest is occasionally met with (e.g., as a sub-association of rain forest—Thompson and Simpson, 1938), but mahoe is better known as a sub-dominant—a position which it commonly fills in the various types of coastal forest around New Zealand (Cranwell and Moore, 1935; Oliver, 1925, 1944; Hamilton, 1936).

Litsaea and *Melicope,* which follow in the list for Quadrat I, are again probably more numerous on this plot than would be expected in a random sample of the island's vegetation, because of the proximity of their respective seed sources. Both these species are handicappd in the race for succession by a very slow rate of growth. For example, two of the seedlings numbered by Turbott on Quadrat I were of *Melicope* (Turbott, 1948, p. 267) and were then respectively 6″ and 4″ high. Now, nearly five yeares later, they are only 4′ 9″ and 2′ 11″. For comparison, some of the *Meryta* seedlings which have appeared since 1946 are already over 8′. All the *Litsaea* seedlings seen also were small.

There are two species which have a fairly high proportion of seedlings on both plots—*Cordyline australis* and *Meryta sinclairii.* The first of these had a regular place in the forest before 1946, so that its frequent occurrence as seedlings everywhere now that the goats have gone was to be expected. Of *Meryta,* on the other hand, there was no seed source at all on Great Island in 1946, yet this, too, made an early appearance everywhere and on both quadrats it is already a prominent feature of the vegetation.

Baylis (1951 q.v.) has given reasons for anticipating the development of *Meryta* forest as the next successor to the kanuka. It has a very rapid rate of growth (exceeded here perhaps only by *Entelea*) and its large, leathery leaves cast a shade in which few competitors may be expected to struggle for long. Some of the seedlings on the plots will shortly be fruiting themselves, and then, with a nearer seed source than the outlying islands, the competition for dominance on these plots should shortly be decided.

On Quadrat III, the dominance that has been forecast for *Leptospermum ericoides* may here, too, be only temporary, though there is no evidence yet for this on the quadrat itself. However, pohutukawa seedlings, seeded no doubt from the surviving trees along Tasman Bay, have appeared in some numbers in exactly the same type of association not very far away from the quadrat. Since kanuka is so very light demanding, in competition with pohutukawa it may eventually be ousted from this quadrat also.

(c) Shade tolerance of seedlings

It has already been assumed that *Leptospermum* seedlings cannot grow in the shade of the canopy cast by the same species. This is an extreme intolerance, for the canopy of mature kanuka is not particularly dense and within its shade a great number of other species both of herbs

Fig. 11. Quadrat I, 14th January, 1951. (Fig. 8F in Turbott.) *Entelea arborescens* in background. *Colensoa physaloides*, filling water-course from right background to left foreground. *Haloragis procumbens* in right foreground. The sedges shown in Fig. 4 (1948) have now largely been suppressed. The white string is the E. boundary of the plot.

Fig. 12. Quadrat I, 14th January, 1951. From point P in Pl. 24, fig. 18. Young *Meryta sinclairii*. *Pteris comans* in foreground. Young *Melicytus ramiflorus* in centre.

Fig. 13. Quadrat II, 11th January, 1951. (Fig. 9G in Turbott.) N.B.—The direction of this photograph is as in Pl. 26, fig. 20; direction is shown wrongly in Turbott, Pl. 52, fig. 22.

Fig. 14. Quadrat II, 11th January, 1951. (Fig. 10H in Turbott.) Young *Cordyline* at back right and a plant of *Arthropodium cirrhatum* immediately in front of it.

Photos: E. G. Turbott.

and tree seedlings are flourishing. Among them are included *Meryta*, *Melicytus* and *Colensoa*, etc., often themselves quoted as light demanding. The shade cast by the cabbage trees along the W. boundary and by the isolated trees of *Paratrophis* and *Melicope* is much deeper and below these the ground is almost bare. The only tree seedlings that have established themselves in this deep shade are all of *Litsaea calicaris*. Abundant seedlings of this same species are also growing in the thickets of *young* kanuka where otherwise the ground is absolutely bare. This suggests that over a long period of time *Litsaea*, in spite of its slow growth, will become an important constituent of the forest as it will not have to await the death of a canopy tree—whatever that canopy is composed of—before establishing itself.

(d) Other barriers to forest regeneration

Reference to Pl. 24, fig. 18, shows that on Quadrat I the seedlings of any species are numerous only in the S.W. quarter of the plot. This area almost exactly coincides with the area shown as bare ground in Turbott's Pl. 51, fig. 21. It thus seems clear that the herb layer, already considered as controlling kanuka, is also a barrier to colonisation by other species, whether it has the assistance of shade from the canopy or not. The large, coarse herbs *Colensoa* and *Carex testacea* are the most important, of which *Colensoa* is the more aggressive and has successfully competed with the *Carex* itself. All the area now occupied by *Colensoa* is shown in *Carex* in Turbott's diagram.

Colensoa is undoubtedly a brake on the rate of colonisation of Great Island by new trees, but it is everywhere limited to the wetter stations—along watercourses and at the base of damp cliffs. Thus on Quadrat II, which is dryer than I, it is absent altogether. Moreover, it has probably already attained the limit of possible colonisation even on Quadrat I. So the restraint which it can exercise on regeneration is limited. Furthermore, it is not tolerant of extreme shade (e.g., it is absent from the cabbage tree belt) and will not in any case survive the dominance of *Meryta*.

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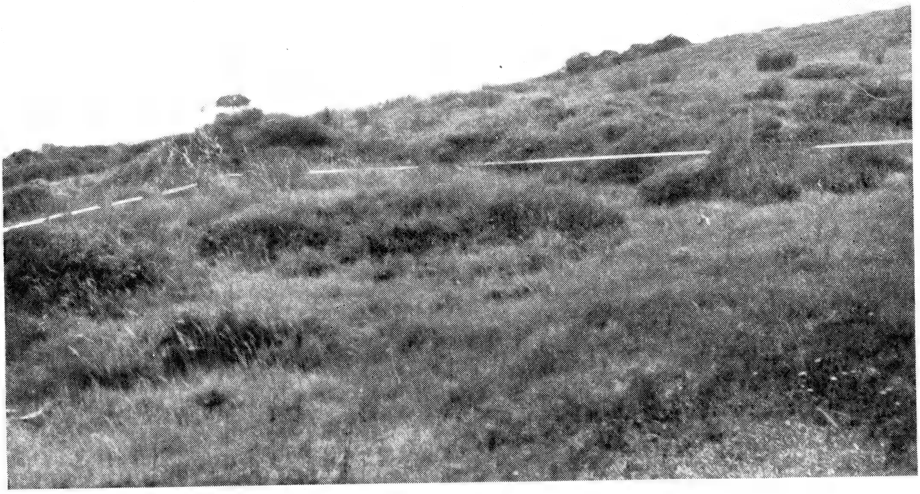

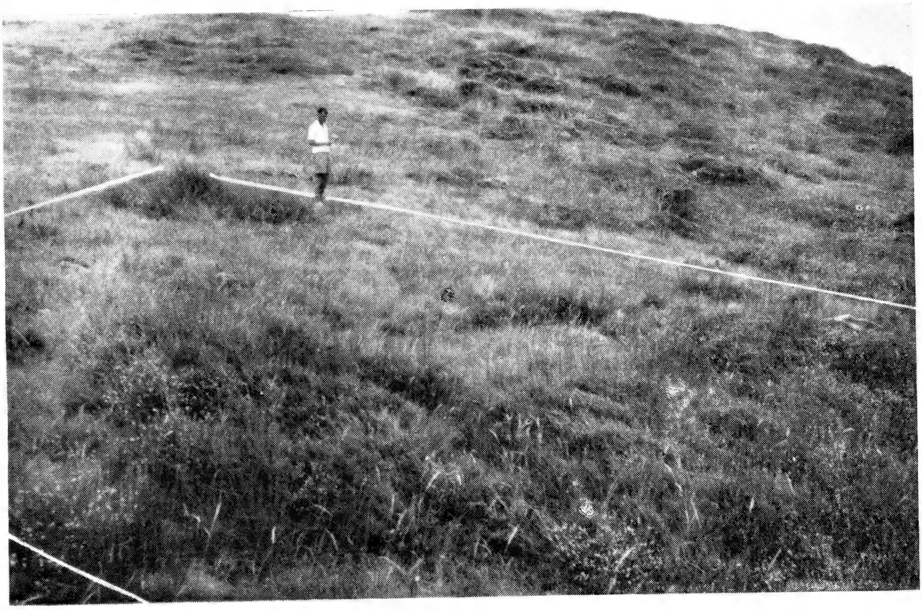

Fig. 15. Quadrat III, 10th January, 1951. (Fig. 13L in Turbott.). *Leptospermum* scrub on left, culms of *Deyeuxia crinita* can be seen in front of them. The white lines are the boundaries of the plot with the E. corner at left centre.

Fig. 16. Quadrat III, 10th January, 1951. (Fig. 14M in Turbott.) The white lines are the boundaries of the plot towards the W. corner.

Photos: G. T. S. Baylis.

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Fig. 17—QUADRAT I.

POSITION OF TREES CONTRIBUTING TO THE CANOPY AND ITS APPROXIMATE DENSITY (stippling).

Extent of the canopy and the positions of the trees contributing to it.

c —*Cordyline australis.*

l —*Litsaea calicaris.*

k —*Leptospermum ericoides.*

m —*Melicytus ramiflorus.*

t —*Melicope ternata.*

p —*Pittosporum fairchildii.*

s —*Paratrophis smithii.*

◯ —Dead tree still standing (*Leptospermum*).

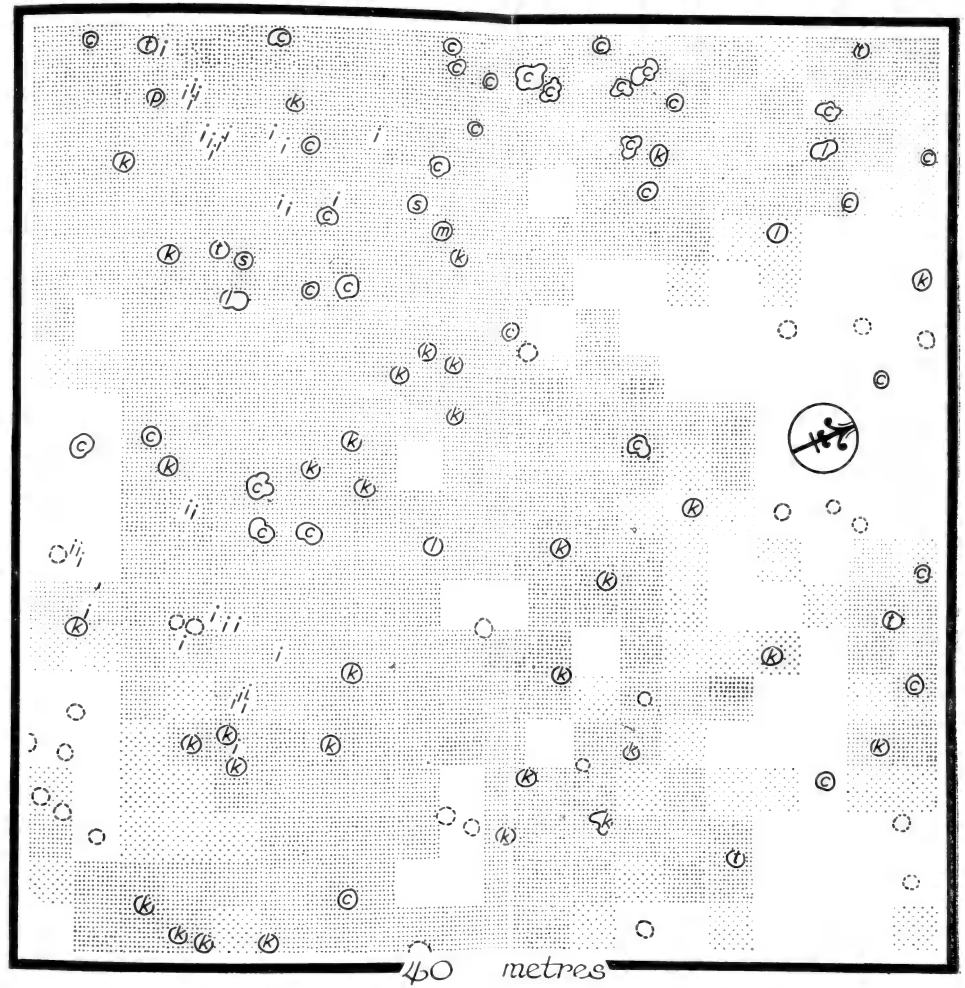
i —*Clematis indivisa* (liane).

The density has been plotted on the basis of two metre squares—

⁙ indicates square entirely shaded.

⁘ square partly shaded, by canopy.

The diameter of the boles shown is arbitrary.



POSITI
SEEDLINGS

a --*Te*
b --*Br*
c --*Co*
E --*En*
g --*Ge*
k --*Le*
l --*Lit*
m --*Mc*
n --*My*
p --*Pit*
r --*Co*
s --*Pa*
t --*Me*
u --*Mi*
y --*Me*

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Fig. 18—QUADRAT I.

POSITION AND RELATIVE SIZE OF YOUNG TREES AND SEEDLINGS.

a —*Tetrapathaea tetrandra.*
b —*Brachyglottis arborescens.*
c —*Cordyline australis.*
E —*Entelea arborescens.*
g —*Geniostoma ligustrifolium.*
k —*Leptospermum ericoides.*
l —*Litsaea calicaris.*
m —*Melicytus ramiflorus.*
n —*Myoporum laetum.*
p —*Pittosporum fairchildii.*
r —*Coprosma rhamnoides.*
s —*Paratrophis smithii.*
t —*Melicope ternata.*
u —*Muehlenbeckia complexa.*
y —*Meryta sinclairii.*

1&3 —Seedlings (*Melicope*) marked by Turbott.

(2), (4) Position of seedlings marked by Turbott which have not survived.

—extent of canopy made by young *Leptospermum* trees (up to 15′ high).

P

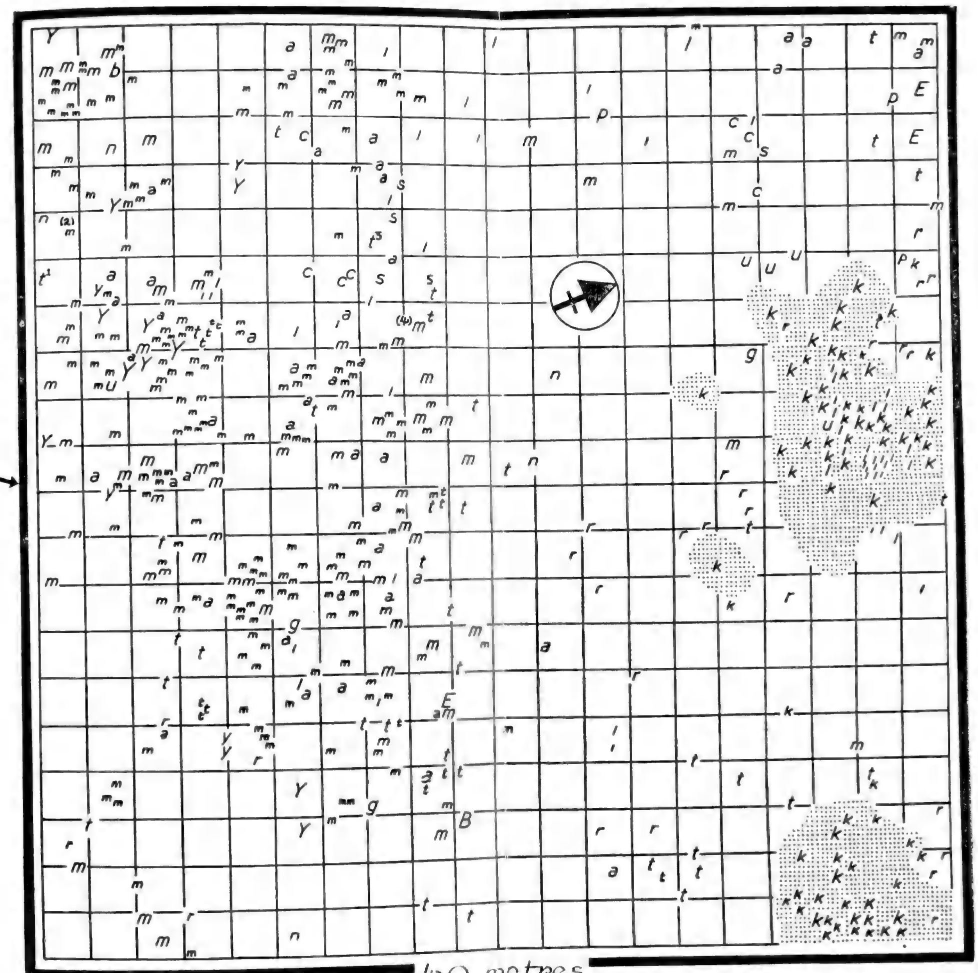

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Fig. 19—QUADRAT I.

POSITION AND COVERAGE OF HERBACEOUS PLANTS.

d — *Dianella intermedia.*

f —*Pteris comans.*

h — *Haloragis procumbens.*

—*Carex testacea* and *virgata* (plotted as 2 metre squares).

—Grasses (plotted as 2 metre squares).

—*Colensoa physaloides.*

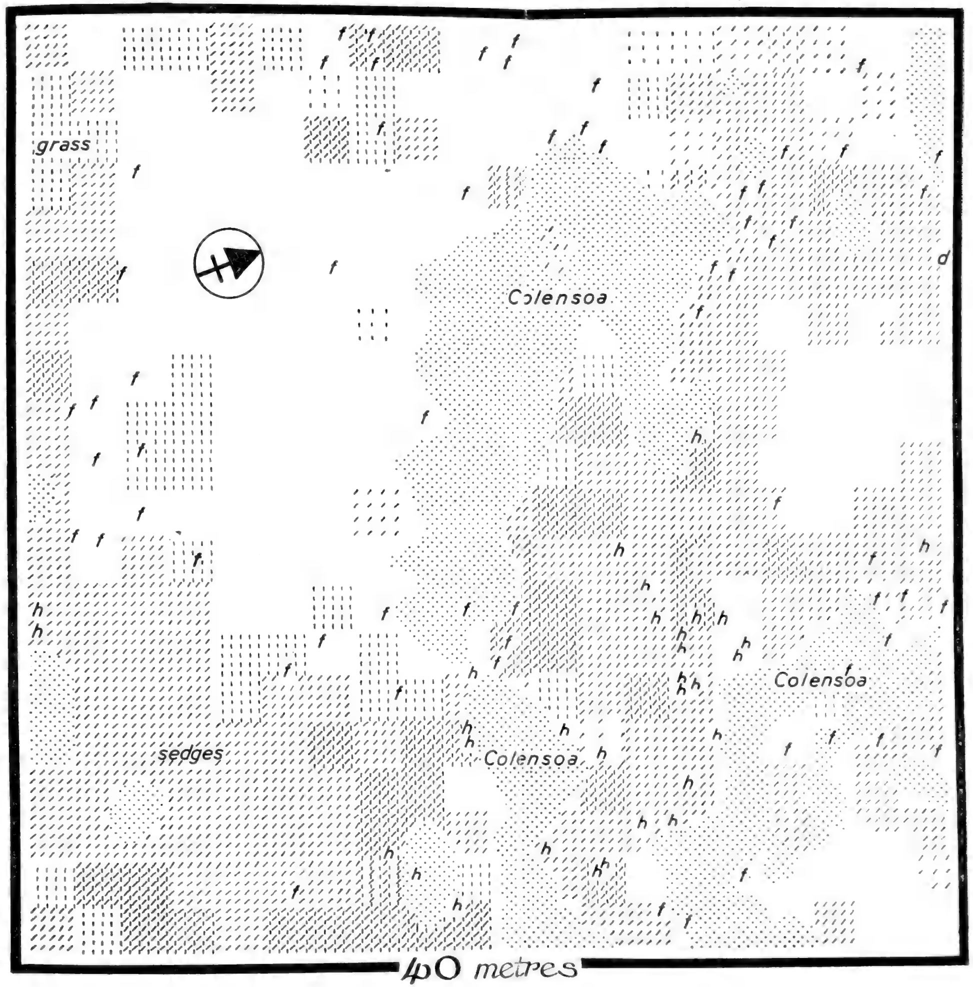


Fig. 20—QUADRAT II.

POSITION OF TREES AND SEEDLINGS AND DISTRIBUTION OF GROUND FLORA.

a —*Tetrapathaea tetrandra.*
c —*Cordyline australis.*
© —Ditto, mature tree.
d —*Dianella intermedia.*
e —*Erigeron canadense.*
h —*Haloragis procumbens.*
k —*Leptospermum ericoides.*
(k) —Ditto, mature tree
l —*Litsaea calicaris.*
m —*Melicytus ramiflorus.*
n —*Myoporum laetum.*
r —*Coprosma rhamnoides.*
s —*Paratrophis smithii.*
t —*Melicope ternata.*
v —*Davallia tasmani.*
y —*Meryta sinclairii.*
z —*Arthropodium cirrhatum.*

—Sedges *Carex testacea* present (estimated on squares of 1 metre).

—*Doodia media* present (estimated on squares of 1 metre).

—Coverage of shade cast by kanuka thicket.

—Dead tree (*Leptospermum ericoides*).

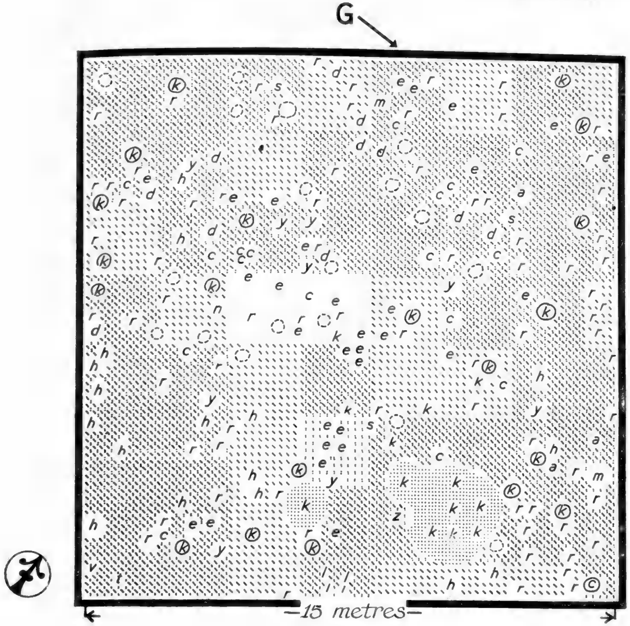


Fig. 21—QUADRAT III.

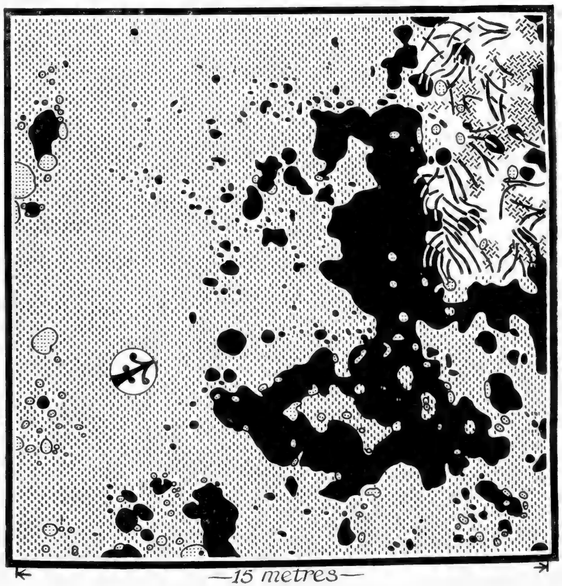
—*Leptospermum ericoides.*

—Ditto, dead.

—*Scirpus nodosus.*

—*Carex testacea.*

—Grassy sward.



Succinea archeyi Powell

By H. E. QUICK, M.B., B.Sc., F.R.C.S., Reading, England.

Abstract.

The anatomy of *Succinea (Austrosuccinea) archeyi* Powell is described and compared with some of the features of other members of the group. The geographical range of *Succinea* s.s., *Oxyloma, Quickella,* and *Austrosuccinea* is discussed.

I am indebted to Capt. F. W. Short for recent shells and alcohol specimens of *Succinea archeyi* from the sand dunes at Taipa, Doubtless Bay, Northland, New Zealand, and to Mr. L. W. Stratton for subfossil shells from Tokerau sand-dunes, Northland. For the original description and figure of the shell see Powell, 1933. As only subfossil shells were known then, it may be added that recent shells are pale amber coloured with a waxy lustre. Powell, 1950, gives an excellent account of the ecology, and a figure of the mantle pattern and the radula.

Description: Alcohol specimens show the usual external and internal features of the family. The pigmented bands on the mantle and body whorl are placed one at the posterior border of the kidney, one at its anterior border, and one, sometimes broken up into spots, near the mantle margin (pigment pattern is often characteristic of species). The genital orifice is an oblique groove terminating at the labial palp (fig. 5). The only difference between Powell's radulae and mine is the possession in mine of a small endocone at the base of the mesocone in most or all of the marginal teeth.

The ovo-testis is of the usual somewhat flattened raspberry shape with a pigmented covering and numerous bifid white follicles. The hermaphrodite duct is pale proximally, densely pigmented in the middle dilated and convoluted middle part and pale distally. At its entry towards the base of the tongue shaped albumen gland are the two pigmented seminal vesicles, united almost to their apices, with one slightly longer than the other and sometimes again minutely bifid. The small fertilisation pouch is as usual unpigmented, figure 1. The folded gelatinous oviduct narrows in its distal half, and the slender pigmented duct of the small globular spermatheca dilates very slightly as it enters the free oviduct so low down that the vagina is exceedingly short.

The compact prostate, also somewhat pigmented, is of the usual bean shape characteristic of Succineidae, and the vas deferens runs forwards under the right tentacular retractor muscle, and back along the penis sheath to enter the epiphallus at its apex. The penis sheath, about 3 mm. long, is a little dilated at the apex and sharply bent over and bound down by the retractor muscle of the penis which splits to enclose the termination of the vas deferens. A narrow neck joins this apical portion to the rest of the sheath. On opening the sheath, figure 2, the penis is seen to have a slight spiral twist. The epiphallus when opened, figure 3, shows three or four circular rows of papillae in its proximal part, and a series of alternating circular folds distally, while the penis has feeble longitudinal folds. In *S. australis* the penis sheath is not bent over at the apex nor dilated, and the epiphallus is relatively shorter and lacks the circular folds, figure 4. *S. striata* Krauss from S. Africa, and *S. andecola* Crawford, from Peru have essentially the same type of penis and epiphallus.

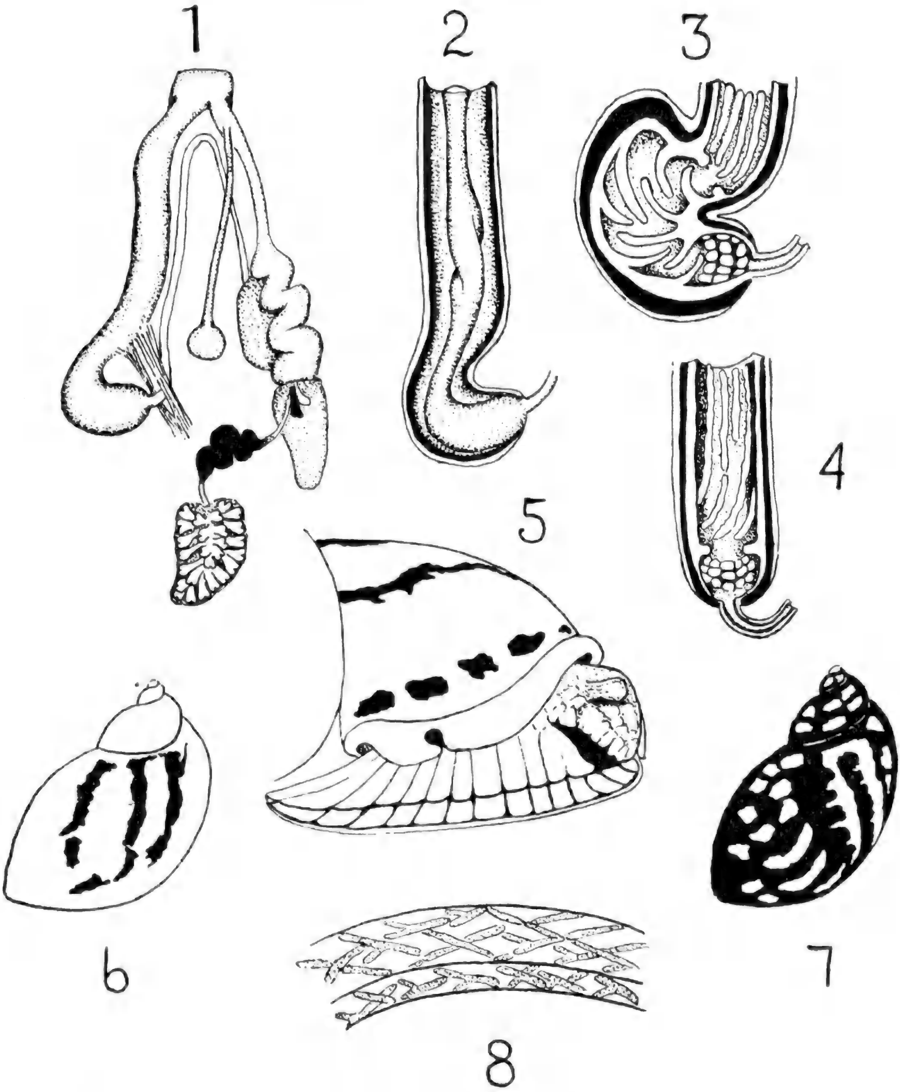
In *S. australis,* figure 7, the pigment pattern of mantel and body almost reverses that of *archeyi,* figure 6, leaving white streaks outlining the kidney, and white spots elsewhere, while *striata* has a dark streak over the centre of the kidney and a different pattern less pigmented over the centre of the mantle, and a dark band near its margin (Quick, 1936), (Powell, 1950). The mantel pattern of *S. andecola* (see Quick, 1939) recalls that of *Limnaea peregra.*

The shells of *S. australis, striata, andecola, caduca, norfolkensis,* and of *solitaria* and *aperta* from Western Australia, all show a curious feather stitch or trellis-like structure, apparently in the substance of the shell, between the lines of growth, figure 8. It is best seen under a 2-3rds. inch objective by transmitted light, looking down on the last whorl through the mouth of the shell. This is not present in *Succinea* s.s., *Oxyloma,* or in *Quickella arenaria.* Seeing that *archeyi* agrees so closely with, at any rate, the first three of the above species it was unexpected to find that this trellis structure was not apparent in its shell. Fresh translucent shells must be used, as the structure is obscured in weathered and sub-fossil specimens.

Discussion: Iredale (1937) proposed a new genus *Austrosuccinea,* type *Succinea australis* Férussac for a group of nine or ten Australian and Tasmanian Succineids as follows: "The Australian specimens dissected by Quick proved unlike the typical *Succinea,* but were nearer a form that is conchologically dissimilar. There may be three or four groups in the Australian fauna and it will be necessary to examine them anatomically. *Austrosuccinea* nov. Type *Austrosuccinea australis* Fér. According to Quick, Victorian specimens resemble *arenaria* in jaw, radula and genitalia, and of *arenaria* he wrote that it differs so much from other British species that it will not fit into either of their sections, and from its jaw it cannot be placed in *Oxyloma,* so another name is required for the type. The Australian type differs entirely from *arenaria,* being more like *elegans* as figured by Quick."

A few paragraphs before the one Iredale quotes (Quick, 1933), Quick showed that in proposing *Oxyloma,* type *Succinea hungarica* Hazay, Hazay was mistaken in supposing that the jaw had no median projection, but as a matter of fact it has a well marked one except perhaps in old worn jaws. *Succinea hungarica* belongs to the same group as *pfeifferi, elegans* and many exotic species forming the section *Oxyloma.* This paragraph was interpolated after the main part of Quick's paper was written and seems to have escaped Iredale's notice, as it makes his reference to the jaw irrelevant. There is no suggestion in the main part of the paper that the genitalia of *arenaria* resemble *australis,* and indeed the absence of penis sheath and epiphalus is described, so the statement towards the end of the paper that *arenaria* resembles *australis* in its genitalia is a regrettable oversight by Quick that escaped correction on proof-reading.

It is generally agreed that the shells of *Succinea* of differing groups are often so much alike, and sometimes so variable in the same



1. *Succinea (Austrosuccinea) archeyi* Powell. Genitalia x 14 circa.

2. *Succinea (Austrosuccinea) archeyi* Powell. Penis sheath opened, showing the penis and epiphallus within, x 14 circa.

3. *Succinea (Austrosuccinea) archeyi* Powell. Epiphallus and proximal portion of penis opened and lying within the sheath, x 16 circa.

4. *Succinea (Austrosuccinea) australis* Fér. Penis and epiphallus opened and lying within the sheath, x 10 circa.

5. *Succinea (Austrosuccinea) archeyi.* Part of alcohol specimen showing the reproductive orifice and other features, x 8 circa.

6. *Succinea (Austrosuccinea) archeyi.* Showing the mantle pattern, x 2.6 circa.

7. *Succinea (Austrosuccinea) australis.* To show how the mantle pattern almost reverses that of *archeyi*, x 2.6 circa.

8. *Succinea (Austrosuccinea) australis.* The "feather-stitch" or decussate shell structure between the striae, x 75.

species, e.g., *pfeifferi*, that they do not form a reliable basis for classification. Iredale, 1937, agrees that dissection is necessary to determine the group to which a species belongs, so it is difficult to see why so many Australian succineids of which the anatomy is unknown are assigned to definite groups. Again, he says (Iredale, 1939) that the Succineidae are at present allowed a world-wide range, but that this is questionable, and that recent researches into British forms show distinct groups in that small compact area. He therefore proposes the genus *Austrosuccinea*, southern or Australian type, and for a second peculiar group, the generic name *Arborcinea*. It is, however, surely wrong to question the world-wide range of the family Succineidae, for snails with the very characteristic assemblage of external and internal features in tentacles, foot, jaw, stomach and genitalia occur all over the world. Probably Succineidae is a misprint for *Succinea* s.s. Succineidae cannot be divided into southern and northern groups, for to take an instance, *Oxyloma* ranges from Greenland to South Africa, and *Succinea* s.s. from the northern hemisphere to S. Africa, and a European species, *arenaria*, which Boettger, 1939, has raised to generic rank *Quickella*, is more nearly related to the Pacific genus *Catinella* than, as far as is known at present to any other European species, though members of this group occur in North America also. *Succinea australis* is nearly related to *striata* Krauss, South Africa, and to *andecola* Crawford, Peru.

I have only been able to examine dried up bodies of *S. norfolkensis* Sykes, after soaking, but it appears to belong to the same group as *australis*, *striata* and *andecola*. If future dissection of *norfolkensis* conconfirms this, Iredale's proposal of *Spirancinea* Iredale, 1945, as a new genus will become unnecessary. Sykes, 1900, proposed *Tapada* for *norfolkensis*, but Studer in 1820 named *putris* as his type, so the name is not appropriate for *norfolkensis*.

The group *Austrosuccinea* is characterised by the presence of a penis sheath, absence of a penial appendix, a very short epiphallus, low entry of the spermatheca duct into the oviduct, genital orifice an open groove, and microscopic feather-stitch shell structure, but the latter feature is absent in *archeyi*.

As *S. archeyi* differs from the other members of this group mainly in its relatively somewhat larger epiphallus, and absence of feather-stitch shell structure, it may also well be included in *Austrosuccinea*.

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Land Mollusca from Four Islands of the Three Kings Group: With Descriptions of Three New Species.

By A. W. B. Powell, Auckland Museum.

In this, my third contribution on the land mollusca of the Three Kings Islands, a presumed moderately complete census of species, distributed on the four forested islands of the group, is presented.

Satisfactory samples of leaf mould were obtained from all four islands and a fairly thorough search for macro-fauna was made on Great Island and North East Island and to a lesser extent on West and South West Islands.

The land molluscan fauna of Great Island is best known, since I have personally collected there on three occasions, including one visit of five days' duration.

Including subspecies, the total of land molusca for the group now stands at 24, and they are distributed thus:

	No. of species.	Endemic	On one other Id.	On two others.	On all 4.
Great Island	19 ***	7	7 *	1	3 *
North East Island	11 *	0	6	2	3 *
South West Island	11 **	1	5	5	3 *
West Island	8 *	0	2	3	4 *

Only three of the twenty-four species and subspecies are found on the mainland: *Tornatellinops novoseelandica* (Pfr.), *Paralaoma lateumbilicata* (Suter), and *Delos* cf. *jeffreysiana* (Pfr.). The asterisks denote the number of these mainland species present.

The following table shows the number of species common to the indicated brackets of islands. The asterisks have the same significance as above.

Great Island + N.E.	9 *	North East Id. + W.	7 *
Great Island + S.W.	8 **	North East Id. + S.W.	6 *
Great Island + W.	4 *	North East + W. + S.W.	4 *
Great Island + N.E. + W.	4 *	South West + W.	3 *
Great Island + N.E. + W. + S.W.	3 *	On all four islands	3 *

LIST OF LAND MOLLUSCA.

	GREAT ISLAND					N.E.	SOUTH WEST ID.				WEST ID.	
	A	B	C	D	E	F	G	H	I	J	K	L
MACROFAUNA:												
Placostylus b. bollonsi Suter	*T	*				*						
,, *b. bollonsi* Form A.											*	*
,, *b. arbutus* Powell					*T							
,, *b. caperatus* Powell				*T								
Rhytida (Rhytidarex) buddlei Powell							*T					
Rhytida (Rhytidarex) johnsoni Powell						*T					*	*
Allodiscus cassandra (Hutton)	*T	*	*		*	*					*	
,, *turbotti* Powell					*T	*						
MICROFAUNA:												
Murdochia annectens Powell		T										
,, *filicosta* Powell						90.T	125	159	28	4	82	208
,, *solitaria* Powell	1.T	3			9							
,, *hirsutissima* n. sp.					5.T							
Therasiella pectinifera Powell	T	8			8	10		2	32			
Egestula gaza (Suter)	T	27	*		16		2	6				
Mocella manawatawhia Powell	T	1		11	2	*		1			1	6
Laoma labyrinthica Powell		41.T			2		158	56	333	1		
Phrixgnathus subariel Powell						24.T					44	158
,, *blacki* n. sp.					2.T							
**Paralaoma latcumbilicata* (Suter)					262		338	37	72	1		
,, *regia* Powell				172	34	54.T				2	214	365
,, *turbotti* Powell		2.T										
,, *buddlei* n. sp.					1		40		78.T			
Laomarex sericea Powell						5.T	78		4	13		
**Delos cf. jeffreysiana* (Pfr.)					4							
**Tornatellinops novoscelandica* (Pfr.)		1		5	3	*	21		2	4	38	121
Number of species	6	10	2	4	15	11	8	6	7	6	8	7
Number of specimens (Microfauna only)		84		188	348	183	762	261	649	25	379	858

* Widely distributed on the mainland also. T = type locality.

The numbers of specimens are inserted as a very rough guide to the frequency of occurrence of the species, but the results are not accurate enough to be termed quantitative. The samples varied in bulk from a 25lb flour bag in samples D, E, and I to about one tenth that amount in samples K. and L. Some samples, I for instance, consisted largely of coarse unproductive debris such as whole puka leaves and large twigs. On the other hand, relatively small samples of humus, F, K and L for example, were phenomenally rich.

LIST OF LEAF MOULD SAMPLES.

A. Great Island. South East Bay and landing slope to vicinity of Provision Depot. A small sample of leaf mould, "Will Watch" Expedition, A. W. B. Powell, Feb., 1934.

B. Great Island. Below rock face, N.E. of Provision Depot. "Arbutus" Expedition, A. W. B. Powell, Dec., 1945, and E. G. Turbott,

C. Great Island. Kanuka forest in depot stream valley. "Arbutus" Expedition, A. W. B. Powell, Dec., 1945. Specimens collected in situ.

D. Great Island. North West Landing slope in stunted ngaio scrub at ca. 500 feet. Site of *Placostylus bollonsi caperatus* colony. "Ocean Star" Expedition, E. G. Turbott, 15:1:1951.

E. Great Island. South West coast, ca. 700 feet. Site of *Placostylus bollonsi arbutus* colony. "Alert" Expedition, A. W. B. Powell, 6:10:1948. Leaf mould from between large boulders in an undisturbed area under *Paratrophis smithii* and *Brachyglottis arborescens.*

F. North East Island. Leaf mould from marginal areas of puka forest, Major G. A. Buddle, Jan., 1948.

G. South West Island. Leaf mould from varied locations. Major G. A. Buddle, March, 1949.

H. South West Island. Leaf mould from varied locations, Dr. G. T. S. Baylis, March, 1950.

I. South West Island. Leaf mould from puka forest on summit ridge, "Ocean Star" Expedition, E. G. Turbott, 13:1:1951.

J. South West Island. Half way up eastern slope under small grove of puka and kanuka, surrounded by scrub. "Ocean Star" Expedition, E. G. Turbott, 13:1:1951.

K. West Island. Leaf mould from varied locations. Major M. E. Johnson, Jan., 1950.

L. West Island. Leaf mould from varied locations. Major M. E. Johnson, Jan., 1951.

ACKNOWLEDGMENTS.

I am deeply indebted to the gentlemen referred to above, who have at the expense of valuable time that could have been devoted entirely to their own interests, generously collected samples and made observations on my behalf.

DISTRIBUTION OF SPECIES.

The distributional results show a high degree of endemicism for Great Island, which is to be expected since it is the largest and highest island of the group and the only one with permanent water.

The few endemics from the three smaller islands, none on North East and West Islands respectively and one on South West Island, points to a fairly recent severing of these islands from the larger mass, Great Island.

From a manuscript by Dr. G. T. S. Baylis on the vegetation of South West and West Islands, I have been given permission to quote some of his observations that have a bearing upon the distribution of snail communities. This may be summarised briefly:

Great Island. Vegetation greatly modified. Induced dominance of kanuka (*Leptospermum ericoides*) brought about by several centuries of Maori occupation followed by a considerable population of goats for over half a century. (See also Baylis and Turbott, Rec. Auck. Inst.

Mus. 3 (4 & 5), pp. 239-252 and 253-272.) The puka (*Meryta sinclairii*), absent during the goat infestation, has reappeared since their extermination in 1946.

North East Island. Induced dominance of the puka (*Meryta sinclairii*), probably resultant from Maori agricultural activities, of which there is plenty of evidence.

South West Island. The dominant puka canopy again suggests that the forest cover is not natural but seral, although evidence of former Maori occupation is not evident. Reduction in the occurrence of two species of tea-tree (*Leptospermum*) to a single example of *L. ericoides*, on the southern end, was noted. This is of significance in respect to the occurrence of the snail *Egestula gaza* (see later).

West Island. The vegetation suggests a climax condition. It is a mixed forest with puka as one of the rarer trees in the assemblage. There is evidence of Maori visitation, but not occupation. Of the four forested islands Dr. Baylis considers West Island alone to be in a natural state.

THE MACROFAUNA.

Placostylus bollonsi. This and two subspecies occur on Great Island. The typical species is abundant on North East Island and was probably intentionally or accidentally transported there by the Maoris from Great Island. No *Placostylus* has been located on South West Island, but much of the island remains to be searched, particularly the western slope. If an intensive search fails to reveal *Placostylus* on South West Island it may be significant that this, the only island of the four without *Placostylus*, is the one without evidence of Maori occupation or visitation, and a different solution of the puka dominance on that island will require to be advanced. South West Island and North East Island both have a dominant cover of puka, and conditions appear similar except that South West is the dryer island. On West Island a small form of *Placostylus bollonsi* is abundant.

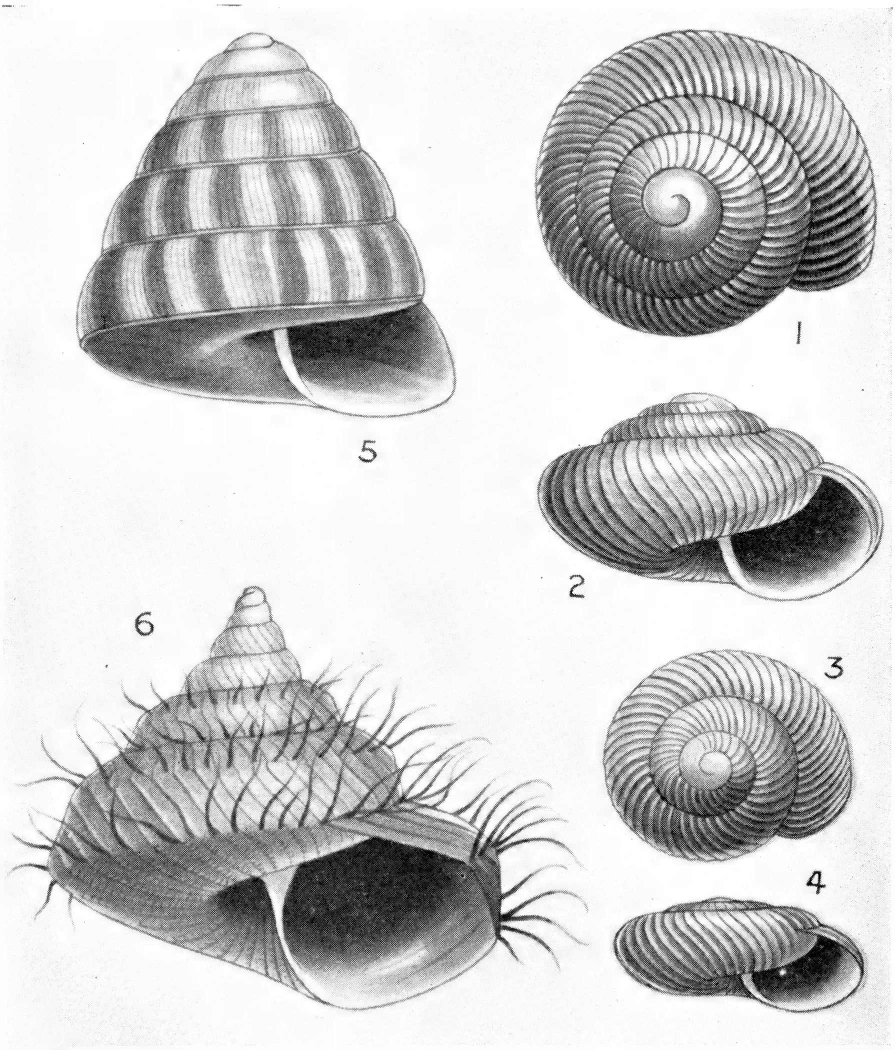
Rhytida (Rhytidarex) johnstoni and *buddlei*. The former occurs on both North East and West Islands and the latter only on South West Island. No *Rhytida* has been found on Great Island. If *Placostylus* survived the modifications to the Great Island flora then *Rhytida*, if it was ever present, should have survived also.

Allodiscus cassandra. Found abundantly on Great Island, North East Island, and on West Island (one dead shell). It may have been carried from one island to another by Maoris.

THE MICROFAUNA.

Egestula gaza. This is the abundant snail throughout the kanuka scrub and forest of Great Island. A very few examples came from leaf mould taken representatively over South West Island, but it is apparently absent from both North East and West Islands.

It would appear that since *Egestula gaza* shows a marked preference for the rather acid condition and poor humus associated with kanuka, the present abundance of the species on Great Island is entirely resultant from the induced dominance of kanuka occasioned by the combined factors of human occupation and browsing activities of goats,



Figs. 1 & 2: *Paralaoma buddlei* n. sp. 1.4 mm. x 2.15 mm. South West Island. Holotype.

Figs. 3 & 4: *Paralaoma regia* Powell, 1948. 0.85 mm. x 1.7 mm. North East Island. Holotype.

Fig. 5: *Phrixgnathus blacki* n. sp. 1.9 mm. x 1.8 mm. Great Island (Holotype).

Fig. 6: *Murdochia hirsutissima* n. sp. 5.6 mm. x 6.0 mm. Great Island (Holotype).

which gave the unpalatable kanuka its chance to spread. This suggests that *Egestula gaza* under natural conditions was a rare local on Great Island just as it is today on South West Island.

It is of interest to note that the species is entirely lacking from the puka forest of the summit ridge on South West Island and its occurrence there must be in marginal scrub. Since Baylis infers a reduction of *Leptospermum* on South West Island to a minimum since Cheeseman's visit in 1889, the scarcity of this snail there can be accounted for.

Future observation on Great Island should show a reduction in the numbers of this snail as the kanuka loses dominance with the development of mixed forest.

Mocella manawatawhia. Living examples of this snail were found only under *ngaio* (*Myoporum lactum*) on the site of the *Placostylus bollonsi caperatus* colony, North West landing slope, Great Island. It is noteworthy that *Egestula gaza* was absent from this location, probably because of extreme dryness since some kanuka was present.

Murdochia filicosta. This is one of the most abundant snails of the puka forest on North East, West, and South West Islands. It has a near relative in the scarce and extremely local *M. annectens* from Great Island. The latter was probably a dominant on Great Island when the original cover included puka. The development of three scarce local species of *Murdochia* on Great Island is probably resultant from isolation in original forest remnants.

The remaining items of the microfauna show a curious haphazard distribution among the four islands and no useful evidence is apparent that suggests any particular linking sequence between the islands.

SYSTEMATIC.

Placostylus (Basileostylus) bollonsi Suter, 1908. Form A.

The race of *bollonsi* from West Island averages a slightly smaller adult size than for the typical subspecies from the South East Landing, Great Island. The epidermis is thinner, of a paler shade of light brown and the aperture tends to be less capacious. These differences, however, are too slight to warrant a new subspecific nomination for the West Island form. The North East Island colony is indistinguishable from the typical species. Since marked subspeciation in *bollonsi* is apparent only on Great Island, it is assumed that both the West Island and North East Island occurrences are resultant from Maori visitations and that in respect to the West Island colony a slightly stunted ecological variant is developing in response to the more exposed nature of the habitat.

Dimensions and other features of ten examples of the West Island form, for comparison with the tables given in my 1948 paper (Powell, 1948, pp. 286-287):

Ht. (mm.)	Diam. (mm.)	Spire ratio.	Spire angle.
77.50	35.00	2.28	33°
84.00	35.00	2.44	37°
84.50	35.00	2.36	34°
85.00	36.00	2.36	34°
85.00	36.00	2.43	37°
85.00	36.00	2.36	35°
85.00	36.00	2.43	36°
86.00	37.50	2.32	35°
87.00	39.00	2.37	35°
87.50	37.50	2.36	36°

The largest example measured 90.5 mm. x 37.5 mm. with an aperture to spire ratio of 2.43 and a spire angle of only 28°. This specimen is abnormally elongated, due to an injury at the second post-nuclear whorl, and has been ignored on this account.

The egg, as with those from Great Island, is exceedingly variable in size and shape: 17.5 mm. x 11.75 mm.; 16.0 mm. x 11.5 mm., and 14.00 mm. x 11.75 mm.

The embryo shows an elongated tendency as in that of *bollonsi arbutus* and *bollonsi caperatus.*

All other characteristics are identical with those of the typical species.

Locality: West Island, Three Kings Group. Abundant over most wooded parts of the Island.

Major Johnson, on his second visit in January, 1951, at my request, endeavoured to include in his collecting the largest examples obtainable. That the West Island race is constantly smaller is thus substantiated.

Average measurements of all the *bollonsi* colonies for comparison with the West Island form:

bollonsi bollonsi	Ht. (mm.)	Diam. (mm.)	Spire ratio.	Spire angle.
S.E. landing, Great Island (type loc.)	91.65	37.15	2.33	36
N. of S.E. landing, Great Is.	94.75	38.70	2.35	36.8
North East Island	95.67	39.55	2.29	42.4
West Island (Form A)	84.65	36.30	2.37	35.2
bollonsi caperatus				
N.W. landing, Great Island (type loc.)	90.20	34.60	2.52	35.3
bollonsi arbutus				
S.W. of Great Is. (type loc.)	108.40	41.45	2.47	32.4
Hapuka Point	97.85	37.15	2.47	32.6

(The average is of ten examples in every case.)

Murdochia hirsutissima n. sp. Pl. 27, fig. 6.

Shell large for the genus, trochiform, umbilicated, with tall, narrowly conical early whorls but rapidly expanded over the last three whorls, which bear complicated epidermal structures produced at the periphery and the middle of the whorls into very long flexuous hair-like processes. Whorls 7½, including a small papillate protoconch of two smooth whorls. Following two whorls narrowly conical and sculptured with numerous retractively arcuate somewhat irregular epidermal axial folds. Remaining three whorls rapidly expanding and biangulate, one angle at the middle of the whorls and the other sutural, which renders the body-whorl sharply carinate. Both angles bear long hirsute processes, those on the middle angle being the longer and more erect than those at the suture which on the spire whorls tend to lie flat against the succeeding whorl. There are about 50 primary radials on the body whorl and most of them bear processes although many are shed or damaged. There are several weaker radials in each interspace that do not develop processes. On the base, all of the primary radials bear dense short backwardly directed bristles. Umbilicus deep, about one seventh major diameter of base. Colour golden-brown, with the early post-nuclear whorls and the longer processes darker brown.

Height, 5.6 mm.; diameter, 6.0 mm. (holotype).

Locality: Great Island, South West coast, ca. 700 feet; site of *Placostylus bollonsi arbutus* colony, in leaf mould amongst large boulders, under *Paratrophis* and *Brachyglottis;* A.W.B.P., "Alert" Expedition, 6:10:1948.

Holotype and paratypes in Auckland Museum

Phrixgnathus blacki n. sp. Pl. 27, fig. 5.

Shell small, elevated-conic, perforate, with keeled periphery. Surface smooth and shining with a distinct regular radial pattern in reddish-brown on a light horn-coloured ground. Whorls 6½, including a low dome-shaped, smooth, colourless protoconch. Spire whorls lightly convex with deeply channelled supra-margined suture. Body-whorl sharply keeled at the periphery and bearing a narrow rounded spiral cord. Surface sculpture of dense concavely arcuate radial riblets, about 30 per mm. Umbilicus narrow and deep, about one tenth diameter of base which is sculptured with subobsolete dense radials and spirals. Colour pattern of clear cut radials, 14-20 per whorl, with interspaces approximately equal to the width of the radials. Base devoid of colour pattern.

Height, 1.9 mm.; diameter, 1.8 mm.

Locality: Great Island, South West coast, ca. 700 feet; site of *Placostylus bollonsi arbutus* colony, in leaf mould amongst large boulders under *Paratrophis* and *Brachyglottis;* A.W.B.P., "Alert" Expedition, 6:10:1948.

Holotype: In Auckland Museum.

The species is nearest allied to *P. erigone* Gray, from which it is at once distinguished by the supra-margined suture, rib margined periphery and clear cut reddish-brown radial pattern recalling that of *Laoma labyrinthica* Powell, which it somewhat resembles in size and shape.

Paralaoma buddlei n. sp. Pl. 27, figs. 1, 2.

Shell small, depressed turbinate, widely umbilicated, finely radially costate, thin, shining, dark horn coloured. Spire equal to height of aperture. Body-whorl with narrowly rounded periphery very slightly above the middle. Whorls 4½, regularly and slowly increasing, including smooth protoconch of 1½ whorls. Suture deeply impressed. Post-nuclear sculpture of numerous crisp retractively arcuate, somewhat irregular, radial ribs, approximately 48 on the penultimate whorl and 60 on the last whorl. Interstices reticulated with microscopic radial threads crossed by numerous spiral lirae. Umbilicus about one fourth major diameter of the base.

Major diam., 2.15 mm.; minimum diam., 1.9 mm.; height, 1.4 mm. (holotype).

Locality: South West Island, in leaf mould in the puka forest on the summit ridge. E. G. Turbott, 13:1:1951. "Ocean Star" Expedition.

Holotype and many paratypes in Auckland Museum.

The species is similar to *regia* in sculptural detail, but has a higher spire, more numerous axials, is darker coloured, and attains a larger size. Named after the late Major G. A. Buddle, D.S.O., whose keen interest in the fauna of the Three Kings Islands has resulted in the finding of several new species of mollusca.

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On Further Colonies of Placostylus Land Snails from Northernmost New Zealand.

By A. W. B. POWELL, Auckland Museum.

Abstract.

This paper is supplementary to my 1947 "Distribution of Placostylus Land Snails in Northernmost New Zealand." Further field work has resulted in the discovery of more living colonies and a number of additional subfossil sites. The primary purpose of this paper is to describe sixteen new subspecies. On the completion of the field work it is proposed to publish a distributional map and to discuss more fully the significance of the distributional pattern.

Placostylus (Maoristylus) ambagiosus michiei n. subsp. Pl. 28, fig. 1.

A lightly built shell of distinctive colouring, with obscure spiral malleations and a simple peristome bearing a weakly developed basal tubercle only. Spire slender, 36°-39°, Aperture 2.12 to 2.20 total height of shell. Colour of epidermis Buckthorn-brown, and Dresden-brown, Mars-brown and Chestnut-brown (Ridgway, Pls. 14 & 15); peristome orange-rufous (Ridgway, Pl. 2); Interior of aperture with a slight bluish grey smear of callus; brown epidermal colour showing through, where not clouded by callus. A narrow white line submargins the suture.

Height.	Diameter.	Apertural ht.	Spire angle.
70.0 mm.	32.5 mm.	33.5 mm.	39° (holotype)
70.5 mm.	31.0 mm.	33.0 mm.	38°
74.5 mm.	31.5 mm.	34.0 mm.	36°

Holotype and paratypes in Auckland Museum.

Locality: Kerr Point herbfield, North Cape block, under the matted aprons of stunted flax (*Phormium*) near the eastern margin of the herbfield and only along the coastal ridge.

Associated plants in the vicinity of the snail occurrences are *Hebe speciosa brevifolia*, Cheesem., *Cassinia amoena* Cheesem., and *Leucopogon richei* R. Br.

The herbfield is sparse and the growth nowhere more than three feet in height. It is on a hard pan and gets very dry in summer. The food plant was not ascertained, but it is certainly not karaka, which is absent from the herbfield. Strangely enough, the apparently better conditions on the seaward cliff face below the herbfield, where a higher growth of coastal scrub with karaka occurs, no examples of *Placostylus* were found.

The subspecies *michiei* seems to have evolved with the herbfield, which would appear therefore to be a community of some antiquity.

I am indebted to Mr. R. H. Michie, of Kaitaia who brought this colony to my notice.

This subspecies and typical *ambagiosus* from Cape Maria van Diemen Island are the only New Zealand members with a chestnut brown epidermis and an orange apertural callus. The true relationship, however, is with *watti*, from coastal forest along the eastern margin of the North Cape block. Both *watti* and *michiei* exhibit spiral malleations, a feature not observed in the other subspecies. From *watti* the subspecies *michiei* is distinguished by its different colouring, thin shell and the reduction of the apertural processes to one basal tubercle.

Placostylus (Maoristylus) ambagiosus watti Powell, 1947.

1947.—*Placostylus (Maoristylus) ambagiosus watti* Powell. Rec. Auck. Inst. Mus. 3 (3), p. 187, pl. 22, f. 10, 11 (only).

Type locality: Midway between Waikuku Beach and North Cape Lighthouse, 10-30 feet elevation and from 25 to 200 feet back from the boulder beach.

Only five examples were taken from the type locality, which has since been destroyed by fire. However, a more extensive colony was discovered by Mr. N. Gardner last year on the cliff face about half a mile south of the North Cape.

I now find that I was mistaken in associating with *watti* the subfossil colonies from Tom Bowling Bay and Waikuku Beach. The latter have all five apertural processes strongly developed, especially the parietal tubercle. This influenced me to regard the apertural formula of *watti*, in the broad sense, to be 3, 3, 3, 3, 3, The norm of *watti* is now shown to be a lightly built shell with an apertural formula of 2, 2, 2, 0, 0, occasional examples, such as the holotype, show a very weak parietal tubercle. Also, the epidermal colour of those living under normal shaded conditions is shown to be darker, a rich dark-chocolate.

Placostylus (Maoristylus) ambagiosus gardneri n. subsp. Pl. 28, fig. 8.

1947.—*Placostylus (Maoristylus) ambagiosus watti* Powell, Rec. Auck. Inst. Mus. 3 (3), p. 187, pl. 22 (in part), f. 12, 13.

This is a heavier shell than *watti* and has all five apertural processes well developed, especially the parietal tubercle. It occurs in the consolidated dunes at Tom Bowling Bay and in the loose dunes at Waikuku and Whareana. Its evolutionary descendant is undoubtedly the recent *ambagiosus whareana*, described following.

Height.	Diameter.	Apertural ht.	Spire angle.
74.0 mm.	35.0 mm.	36.0 mm.	48°
78.5 mm.	36.0 mm.	38.5 mm.	48° (holotype)
81.0 mm.	34.0 mm.	37.0 mm.	44°

Localities: Tom Bowling Bay, along almost the full length of the beach, with *Rhytida duplicata*, weathering out in situ from the underlying consolidated dunes. Remains of trunks and limbs of puriri and pohutukawa indicate the former presence of coastal forest on the site during a post-Pleistocene moist period (type); Waikuku Beach in loose dunes mainly along the middle section of the beach; Whareana Beach in loose dunes extending S.E. from Wharekawa Point to about the middle of the beach and approximately in front of the living colony of *ambagiosus whareana*.

Holotype and paratypes in Auckland Museum.

Placostylus (Maoristylus) ambagiosus whareana n. subsp. Pl. 28, fig. 2.

Evidently the recent descendant of the subfossil *gardneri*, from which it differs in the absence of the parietal tubercle. The apertural formula is 3, 3, 3, 3, 0. No other recent subspecies has the three processes of the inside of the outer lip so heavily and constantly developed.

The coloration is the same as for *annectens;* that is, russet to mars brown, diffused with warm-sepia and very narrow white subsutural line. Aperture deep red-brown within and light ochraceous salmon on reflected edge of peristome.

Height.	Diameter.	Apertural ht.	Spire angle.
79.5 mm.	35.0 mm.	40.0 mm.	44° (holotype)
83.0 mm.	35.0 mm.	40.0 mm.	42°
80.0 mm.	36.5 mm.	40.0 mm.	43°

Locality: Whareana, east coast between Waikuku Beach and Parengarenga in a steep valley to the north of Whareana Stream. Abundant in mixed forest, chiefly under kohekohe (*Dysoxylum spectabile* Hook). It does not seem to occur in the considerable area of forest in the valley of the Whareana Stream. First discovered by Mr. N. Gardner.

Holotype and paratypes in Auckland Museum.

Placostylus (Maoristylus) ambagiosus hancoxi n. subsp. Pl. 28, fig. 3.

Although this subspecies has only a moderate development of the apertural processes the peristome is heavily callused externally as in *watti, gardneri, whareana* and *annectens.* It is of the size of *whareana,* but has much weaker inner lip processes and the addition of a weak parietal tubercle. It is much smaller than *annectens,* in which a parietal tubercle is present also.

The shape and coloration is exactly as in *whareana.*

Height.	Diameter.	Apertural ht.	Spire angle.
79.0 mm.	35.0 mm.	38.5 mm.	43° (holotype)
75.0 mm.	34.0 mm.	38.0 mm.	44°
79.0 mm.	34.5 mm.	38.5 mm.	40°

Locality: Near crest of second coastal ridge N.W. of Maukin's Nook, between Waikuku Beach and Parengarenga Harbour. Only eight adults were taken, apparently the last remnant of a former colony along this ridge, which has been devastated by fires. A considerable area of forest down the southern slope did not produce further material. (A. Hancox, R.A. Prouse, H. S. Prouse, R. H. Michie, and A.W.B.P., April, 1950.)

It would appear that members of the *ambagiosus* series live chiefly on the seaward cliff faces and rarely further inland, to a distance of not more than a mile, but in such cases only on or near the crests of ridges.

Holotype and paratypes in Auckland Museum.

Placostylus (Maoristylus) ambagiosus spiritus Powell, 1947. Pl. 28, fig. 5.

1947.—*Placostylus (Maoristylus) ambagiosus spiritus* Powell. Rec. Auck. Inst. Mus. 3 (3), p. 185.

The type locality for this subspecies is in loose post-Pleistocene dunes two to three miles east of Pandora, Spirits Bay. I have since located numerous former colonies ranging intermittently from the type locality eastwards along the coastal dunes to within a few hundred yards of Maungapiko, at Kapowairua, the eastern end of Spirits Bay Beach.

There is considerable size variation in these subfossil colonies and one, at 1 mile west of Maungapiko, on the first dune from the beach, is the smallest member of the *ambagiosus* series yet discovered. Adults range from 48-64 mm. in height. Subfossil *Austrosuccinca archeyi* were associated, indicating dwarfing and then extinction of the colony by the succession to a sand-grass dune community.

In my 1947 paper I attributed to *spiritus* the then recently discovered Recent colony from the cliff face ¾ mile west of Pandora. A visit to the locality, affording study of ample material, shows that this Recent colony is nearer to the dwarf colony referred to above than to *spiritus*.

It is significant that there is a gap of about three miles between the Recent colony and the nearest subfossil occurrences of *spiritus*.

Table of dimensions of spiritus colonies.

	Max.-size (mm.)	Min. size (mm.)	Average size (mm.) (10 examples)
¼ m. w. of Maungapiko	77.0 x 34.0	—	—
½ m. w. of "	79 0 x 32.0	74.0 x 31.5	76.25 x 31.50
1½ m. w. of "	77.0 x 31.5	69.0 x 31.0	73.50 x 31.15
2 m. w. of "	76.0 x 32.0	69.0 x 28.5	72.55 x 30.90
2½ m. w. of "	75.0 x 30.0	68.5 x 30.5	70.40 x 29.85
3 m. w. of "	73.0 x 30.0	63.5 x 27.0	69.80 x 29 90
3½ m. w. of "	75.0 x 32.0	66.0 x 27.0	70.00 x 28.80
Type loc.	75.0 x 32.0	64.0 x 28.0	68.75 x 29.15

Placostylus (Maoristylus) ambagiosus pandora n. subsp. Pl. 28, fig. 4.

This subspecies is characterised by its small size, and very dark epidermis. Only the basal tubercle is developed. The nearest approach to the epidermal colour in Ridgway is warm blackish-brown (Pl. 39), aperture deep red-brown within and light ochraceous salmon on reflected edge of peristome.

Locality: In a small remnant of coastal forest, half way up cliff face, ¾ mile west of Pandora. The terrain is boulder strewn covered with masses of *Muehlenbeckia*. The snails occur under this growth as well as under boulders and around the bases of *Phormium*, that is within the leaf fall area of several large karaka (*Corynocarpus laevigata*) (type); subfossil on first coastal dune 1 mile west of Kapowairua, Spirits Bay. (A.W.B.P., 21:3:1949.)

Height.	Diameter.	Apertural ht.	Spire angle.
67.5 mm.	31.0 mm.	34 mm.	40° (holotype)
71.0 mm.	31.0 mm.	35 mm.	43°
61.5 mm.	29.0 mm.	31 mm.	43°
64.0 mm.	28.0 mm.	29 mm.	42° (1 m. w. Maungapiko)
48.0 mm.	20.5 mm.	21 mm.	36° (1 m. w. ")

Holotype and paratypes in Auckland Museum.

Placostylus (Maoristylus) ambagiosus paraspiritus n. subsp. . Pl. 28, fig. 7.

A living colony on a small, almost detached headland one mile south of Cape Maria van Diemen and a few hundred yards west of the type locality for *priscus* bears a strong resemblance to subfossil *spiritus*, from the Spirits Bay dunes. The living colony, however, appears to have existed in situ for a long time, as evidenced by subfossil *Placostylus* three to four feet down in consolidated sand underlying the Recent colony. Only one adult subfossil was taken and it is dwarfed and senile, apparently abnormally short and inflated, 63 mm. x 30 mm.; with a *priscus* style of aperture (Pl. 28, fig. 7. Associated with this subfossil *Placostylus* were numerous *Rhytida duplicata*, indicating contemporary coastal forest conditions, and near the surface *Austrosuccinea* remains, pointing to a sand-grass community, now succeeded by a shrub-dune community, resulting in the extinction of *Austrosuccinea*. During the xerophytic sand-grass community phase the *Placostylus* probably survived on the steep seaward cliff face.

Although *spiritus* and *paraspiritus* are very similar in size, form and the apertural processes, it is evidently a case of near convergence, for *spiritus* is a Post-Pleistocene fossil with a Recent derivative, *pandora*, in its own area, which is situated no nearer than six miles from the *paraspiritus* colony and with two subfossil subspecies, *priscus* and *lesleyae* ranged in between. No Recent colony has been located between *paraspiritus* and *pandora*, but the report of a comparatively fresh specimen taken below the lighthouse at Cape Reinga remains to be investigated. See locality map, Powell, 1947, Rec. Auck. Inst. Mus. 3 (3), p. 188, Pl. 23.)

Compared with *spiritus*, *paraspiritus* differs in having the three outer lip processes weakly developed and no thickening on the columella. In *spiritus* the uppermost process of the outer lip is mostly quite as well developed as the basal tubercle. Neither has a parietal tubercle. The apertural formula for *spiritus* is 2, 2, 3, 1, 0 and for *paraspiritus* 1, 1, 2, 0, 0. (See folder plate, Powell, 1947, l.c.p. 188, pl. 25.)

Coloration warm blackish-brown. Aperture deep red-brown within and light ochraceous salmon on reflected edge of peristome.

Height.	Diameter.	Apertural ht.	Spire angle.
72.25 mm.	32.0 mm.	35.5 mm	40° (holotype)
72.00 mm.	32.5 mm.	36.0 mm.	41°
70.50 mm.	30.5 mm.	34.0 mm.	39°

Max. size.	Min. size.	Average size (10 examples).
73.5 mm. x 31.0 mm.	66.5 x 29.5 mm.	70.80 mm x 31.75 mm.

Locality: On steep seaward face of small rounded headland about one mile south of Cape Maria van Diemen. Under flax, small karaka and other stunted coastal scrub. First discovered by Mr. R. H. Michie, of Kaitaia.
Holotype and paratypes in Auckland Museum.

Summary of distribution of Placostylus ambagiosus & subspecies.

(† = new locality records)

Placostylus ambagiosus ambagiosus Suter, 1906.

Recent. Cape Maria van Diemen (Island), Small colonies in flax (*Phormium*) clumps on the south-west cliff face. (Type) Restricted to the Island. x (see footnote).

Placostylus ambagiosus hinemoa Powell, 1947.

Subfossil. Cape Maria van Diemen (Island), in consolidated sands. Pleistocene or early Post-Pleistocene (type) Restricted to the Island.

Placostylus ambagiosus worthyi Powell, 1947.

Subfossil. Cape Maria van Diemen (Mainland), on north-eastern side of headland, formerly an island but now linked to the mainland by a tombolo of consolidated and drifting sand (type); on a small island, accessible by wading at low tide, half a mile south of type locality (A. Hancox and A.W.B.P., 18:11:1948); in loose sandy humus, with *Austrosuccinea* remains†; on a former islet ¾ mile south of type locality and just off the western escarpment of the "*priscus block*," in coarse cemented shell sand†.

Placostylus ambagiosus consobrinus Powell, 1938.

Subfossil—Recent. Cape Maria van Diemen (Mainland) at type locality for *worthyi* but in the overlying loose sand. A Recent example with epidermis intact was found here last year by Mr. B. S. Bird.

Placostylus ambagiosus priscus Powell, 1938.

Subfossil. Cape Maria van Diemen (Mainland) about three-quarters of a mile east of *worthyi* type locality in consolidated dunes (type); many former colonies on south and eastern slopes of Herangi, 700 feet, down to Te Werahi Stream and Swamp; Twilight Beach between Cape Maria van Diemen and Scott's Point (N. Gardner)†; one mile south of Te Paki Stream and one-quarter mile inland in consolidated dunes (Miss Lesley Keene)†.

Placostylus ambagiosus paraspiritus n. subsp.

Recent. On headland one mile south of Cape Maria van Diemen (Mainland) (type)†.

Placostylus ambagiosus lesleyae Powell, 1947.

Subfossil. Taputaputa Bay, east of Cape Te Reinga, in consolidated dunes (type); in consolidated dune on eastern side of Cape Te Reinga (E. Richardson)†.

Placostylus ambagiosus spiritus Powell, 1947.

Subfossil. Spirits Bay, two to three miles east of Pandora in loose dunes (type); eastward along coastal dunes to Kapowairua†.

Placostylus ambagiosus pandora n. subsp.

Subrecent-Recent. On cliff face three-quarters of a mile west of Pandora (type, Recent); first coastal dune, one mile west of Kapowairua, Spirits Bay (subrecent)†.

Placostylus ambagiosus keenorum Powell, 1947.

Recent. Maungapiko, 50-150 feet, Kapowairua, eastern end of Spirits Bay.

Placostylus ambagiosus annectens Powell, 1938.

Recent. Unuwhao, 900 feet, on track between Spirits Bay and Tom Bowling Bay (type); coastal ridge, north of Unuwhao, 850 feet†; The Huka, 30-40 feet, above stream, east side of headland†.

Placostylus ambagiosus watti Powell, 1947.

Recent. At base of cliff midway between North Cape and Waikuku Beach (type); on cliff half a mile south of North Cape, 50 to 100 feet (N. Gardner)†.

Placostylus ambagiosus michiei n: subsp.

Recent. Kerr Point herbfield, North Cape Block†.

Placostylus ambagiosus gardneri n. subsp.

Subfossil. Tom Bowling Bay in consolidated coastal dunes (type); Waikuku Beach in loose dunes; Whareana Beach in loose dunes†.

Placostylus ambagiosus whareana n. subsp.

Recent. Valley to north of Whareana Stream, between Waikuku Beach and Parengarenga†.

Placostylus ambagiosus hancoxi n. subsp.

Recent. Crest of second coastal ridge north-west of Maukin's Nook, between Whareana and Parengarenga†.

FOOTNOTE:

x Suter (1913, Man. N.Z. Moll., pp. 767-768) recorded *Placostylus hongii* from Kaitaia and Mangonui and *hongii ambagiosus* from Kaitaia. I have examined the material in the Suter collection upon which these identifications were made and find that they are all *ambagiosus ambagiosus*, the typical subspecies, which in the Northernmost block is definitely restricted to Cape Maria van Diemen Island.

However, I am assured by Mr. Harry Matthews, of Kaitaia that his wife collected the Kaitaia snails recorded by Suter from near the bank of a river amongst karaka and flax on her father's farm (Mr. Dunn) three miles south of Kaitaia in about 1888.

Regarding the Mangonui record, Mr. A. Hancox collected six bleached, worn shells of ambagiosus ambagiosus from the dunes at Aurere, southern end of the Tokerau Beach, about 1934.

The Kaitaia locality is too far inland to have been a natural occurrence. A fairly thorough search of the Tokerau dunes was made last year but no further examples of *Placostylus* were seen, although subfossil *Rhytida dunniae* and various *Charopidae* were common.

Since both the Kaitaia and Mangonui localities are about seventy miles distant from the Cape Maria van Diemen Island type locality and that this typical subspecies is clearly the evolutionary product of insular isolation I can only regard these two mainland occurrences as resultant from human transportation.

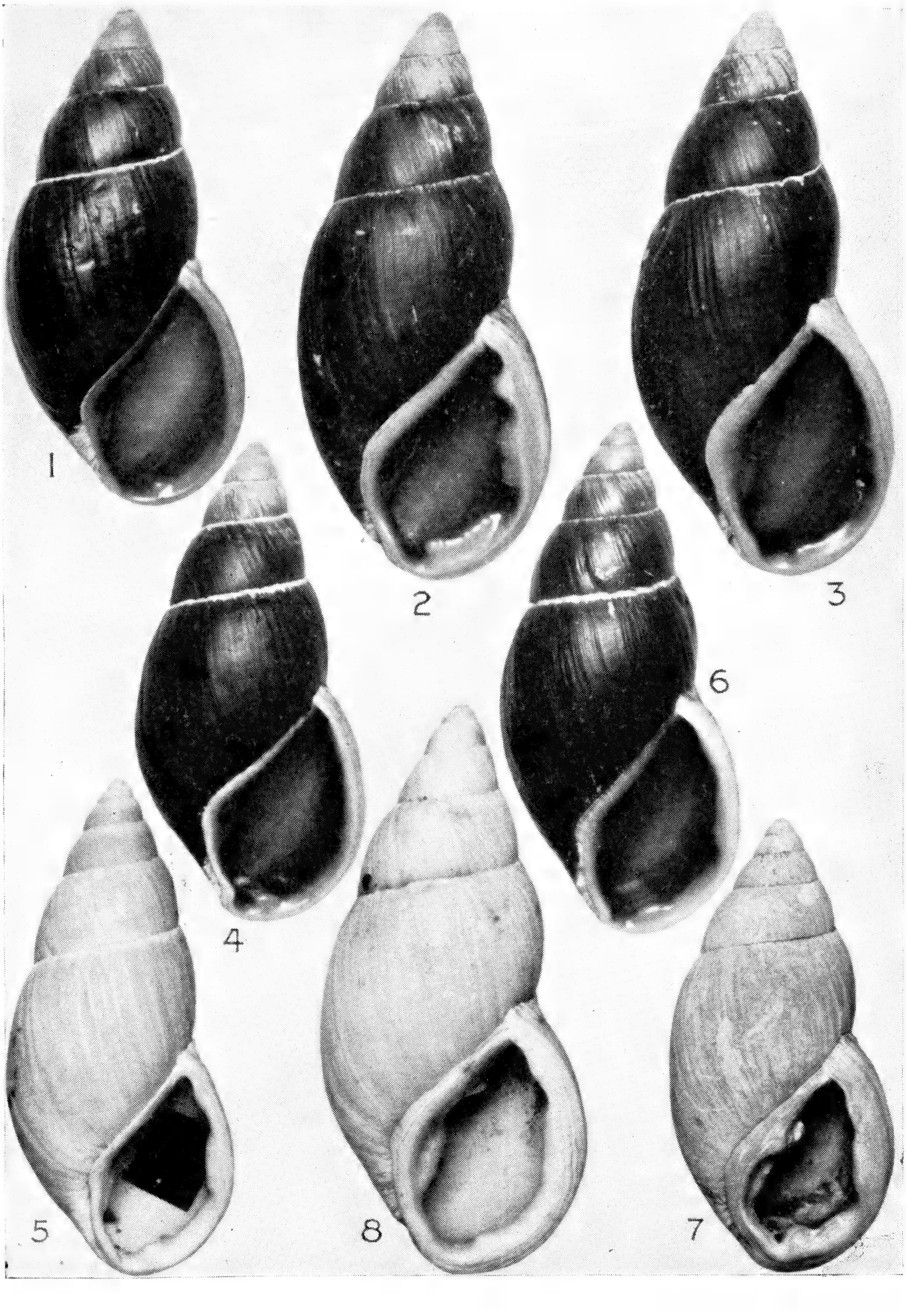

Fig. 1: *Placostylus (Maoristylus) ambagiosus michiei* n. subsp., Kerr Point (holotype. Fig 2: *P. (M.) ambagiosus whareana* n. subsp., Whareana (holotype). Fig. 3: *P. (M.) ambagiosus hancoxi* n. subsp., second ridge N.W. of Maukin's Nook (holotype): Fig. 4: *P. (M.) ambagiosus pandora* n. subsp., near Pandora (holotype). Fig. 5: *P. (M.) ambagiosus spiritus* Powell, 1947, Spirits Bay loose dunes, subfossil (holotype). Fig. 6: *P. (M.) ambagiosus paraspiritus* n. subsp., one mile S. of Cape Maria van Diemen (holotype). Fig. 7: *P. (M.) ambagiosus* subsp. ? 3-4ft. below *paraspiritus* colony in consolidated sand (note: the parietal process is an abnormality). Fig. 8: *P. (M.) ambagiosus gardneri* n. subsp., Tom Bowling Bay, subfossil, consolidated sand (holotype). (All to uniform scale.)

Notes on the Birds of the Three Kings Islands

By E. G. TURBOTT, Auckland Museum.

Since the account by Turbott and Buddle (1948), further observations on the birds of the Group have been made by Buddle (1948, 1949) —on South West Island, Stella Rock and Great Island—and Johnson (1950), who landed on the previously unexplored West Island in early January, 1950. Johnson found a colony of red-billed gulls on the highest point of the latter island (cf. Turbott and Buddle, *ibid*), and noted bell bird and red-fronted parakeet. He saw large numbers of petrel burrows on the main bush-clad slope of the island, but only a few could be examined as the visit was so brief. One burrow contained a young fluttering shearwater.

The following brief observations on the birds of Great Island were made on a visit by an Auckland Museum party in the Marine Department's M.V. "Ocean Star" from 10th-15th January, 1951.

Breeding of the black-winged petrel (*Pterodroma hypoleuca nigripennis*).

The black-winged petrel was discovered on Great Island by P. C. Bull on 3rd December, 1945, when some 24 birds were seen ashore at night at the eastern point of the island. At the Kermadec Islands the eggs are laid in late December and early January, so that it is probable that breeding had not yet reached this stage on Great Island. No further observations were possible at this time.

During the present visit, on 14th January, the black-winged petrel was seen ashore at the same point. During the day, the bare, soft ground beneath the scrub along the cliff-tops was examined, but no burrows of this species could be found amongst the numerous burrows of the fluttering shearwater (*Puffinus gavia*) and, in considerably smaller numbers, of sooty shearwater (*Puffinus griseus*). In the same locality, however, one isolated burrow was found in a small opening in the scrub, and proved to contain a sitting black-winged petrel and egg. The entrance was concealed beneath dense sedge, and outwardly was similar to recently formed burrows of the fluttering shearwater. The bird uttered a soft piping note repeated several times when first disturbed.

Internally the burrow consisted of a straight shaft of uniform diameter approximately 2½ feet in length, at the end of which was accumulated a quantity of dry sedge and other nesting material.

Feeding habits of the red-billed gull (*Larus novaehollandiae*) in relation to the dispersal of puka.

It was found during the present visit that red-billed gulls were feeding on cicadas. This observation is significant in view of the conclusion reached by Baylis (1948, 1951) that transport of seeds by the gulls has enabled the puka (*Meryta sinclairii*) to become established on

Great Island. The puka was absent, apart from one small sapling seen on the cliffs, before the destruction of goats on the island in 1946, but the seedlings appeared shortly afterwards. G. A. Buddle observed the gulls feeding eagerly on puka fruits on South West Island on 3rd January, 1947; and during the present visit droppings obtained on the inland rocks near the castaway depot on Great Island were found to contain seeds of puka and of ngaio (*Myoporum laetum*). It would evidently be possible for the gulls breeding on Great Island to bring seeds back from South West Island or North East Island, on both of which puka is plentiful. Or gulls coming from the breeding colonies on South West Island might bring seed to Great Island.

The transport of seeds of puka into the forest on Great Island requires some explanation other than voiding by gulls passing over the island. During the present visit gulls were seen from time to time hovering over the forest canopy, and it was found on further observation that they were attracted by the large cicada*, which was everywhere numerous and very noisy. The insects made somewhat clumsy flights through the trees, and, when they darted out into the open above the canopy, were caught in flight by the gulls. It also seemed probable that the gulls attempted to catch the cicadas singing on the higher branches.

Although only a few gulls might be observed hovering at any time, it was evident that they were regularly taking the cicadas. The observation was confirmed by the examination of droppings or castings which were found to contain remains of cicadas; and one of the insects was found on the ground still alive with the abdomen missing, having probably been dropped by its captor to the forest floor.

Visits to the Group have not been made regularly enough to provide observations on the arrival and departure of the gulls, but the colonies would probably be in occupation from approximately late August or early September until March, these being the times of arrival and departure recorded by Fleming (1946) at the Mokohinau Group: on the Three Kings the peak of nesting is apparently a little later than on the latter Group.

The cicadas, as is the case on the mainland, probably appears from approximately December to April. The song was not heard and the cicadas had apparently not yet begun to emerge on Great Island during the visit 30th November-6th December (1945) (*fide* A. W. B. Powell), nor were they recorded 13th April-16th May (1946). They were abundant during late February (1934) and early January (1951), and the greatest number would be taken during these months.

As described by Baylis (1951), seedling pukas occur most commonly above South East Bay, only an occasional young plant of this species being found elsewhere on Great Island. Baylis points out that this localised distribution would appear to be explained only in part by the nature of the soil and other environmental factors. Although gulls were seen over the forest at various points, including the upper Tasman Valley, the possible explanation might be suggested that gulls would more frequently take cicadas close to the coast than at any considerable distance inland. The slopes rising above South East Bay would be especially accessible as compared with other portions of the island.

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* *Melampsalta cingulata* (Fabr.).

General Observations

A grey duck (*Anas poecilorhyncha*) was seen on 11th January in the lower Tasman Valley, where it rose from one of the pools near the waterfall at the mouth of the stream. There has been no previous record of this species, and it is apparently a straggler to the Group.

In addition, the following land birds were recorded during this visit: spotless crake (*Porzana tabuensis*), brown quail (*Synoicus*), harrier (*Circus approximans*), morepork (*Ninox novaeseelandiae*), red-fronted parakeet (*Cyanoramphus novaezelandiae*), kingfisher (*Halcyon sanctus*), pipit (*Anthus novaeseelandiae*), fantail (*Rhipidura fuliginosa*), bell bird (*Anthornis melanura*), and starling (*Sturnus vulgaris*). The spotless crake, which had been glimpsed briefly on previous visits, was observed by Dr. Gilbert Archey, who saw one only momentarily on the forest floor in Tasman Valley.

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Human Forms in the Art of Melanesia

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of the Faculty of Columbia University.*

Even a general familiarity with the art of mankind from his distant prehistoric beginnings to the present time reveals the common practice of expressing his ideas, emotions, and imaginings through the rendering of the human figure. This is equally true of the art of primitive peoples and that of the great civilizations. The reason for this is readily ascertainable. Since the subject matter of art is often the crystalization in form, line, and colour of the objective and subjective experiences of man with man, it is evident that the majority of these experiences can be recorded or expressed through the human form.

The sculptures carved for the great cathedrals of the Middle Ages, the painting and sculpture of Michelangelo, and the paintings of Leonardo da Vinci and Rembrandt are classic examples of the importance of the human form in European art. But in no instance do these artists represent the human form scientifically. Instead, certain parts, such as the hands, the head, the bulk of the body, or its verticality, are emphasized. Although these distortions are often slight, and always subtle, they nevertheless exist; and from them this art achieves its greatness, aesthetically and expressively. Terror, contemplation, physical tension and relaxation, excitable imaginative moments, and devoutness can all be presented by the human form. In some instances, facial features are utilized almost exclusively (cf. the "Mona Lisa"), but in other cases the entire figure contributes to the desired expression.

Melanesian art differs from that of the great European masters particularly in the freedom with which the human figure is used. But this freedom is not a matter of personal choice by the artist; rather, the particular forms and patterns, as in the art of all primitive peoples, are largely determined by the cultural tradition of the regions of their origin. It is because the regions dominated by a cultural tradition are numerous in Melanesia, and often diverse in culture, that the art of these islands is so extremely varied in its character. This is particularly true in the different ways the human form is rendered. Although numerous similarities are apparent, the great diversity in this art must certainly be considered an outgrowth of the cultures of peoples who were divided into many small and often unrelated and hostile tribes.

It must be noted, however, that the domination of Melanesian art by tradition did not reduce the artist to the rôle of a mere technician. On the contrary, although he could not deviate very far from the art style of his tribe, these very restrictions relieved the artist of the necessity to invent or devise new forms. He was therefore free to devote his creative energies to the task of interpreting anew within an established tradition. That this did not lead to a dead level of mediocrity is amply

* This study was made by Dr. Wingert while he was working with the Auckland War Memorial Museum collections as the recipient of a grant from the Wenner-Gren Foundation.

evidenced by the many examples of Melanesian art in the Auckland War Memorial Museum. But all of these are not of equal quality. Some stand apart from others as true masterpieces, and make it clear that primitive artists, just as artists of every era and place, were of unequal artistic capabilities. The present concern is with a group of masterpieces of Melanesian sculpture.

Art may be considered the product of an extremely perceptive and receptive sensibility. That no two persons see the same thing when looking at an identical object is a truism. The artist, because of his sensitivity and training, is particularly observant of many of the details of life about him which pass unnoticed by other persons. From these details he selects the characteristic, the expressive, and presents them in his medium in such a way as to give a revealing interpretation to a common reality shared by everyone. The sculptor is particularly sensitive to the structure, proportions, postures, and movements of the human form. Through it he interprets and expresses all moments and aspects of life as he experiences them. The work he creates is therefore a personal document, and through it he shares his experiences with others, whose experiences he in turn enriches. It is his perceptivity to life forms which enables the Melanesian artist to infuse traditional patterns with a personal and sensitive interpretation.

Unlike many European artists of the past and present, the Melanesian sculptor does not work with the human form, nor with examples of his tribal forms before him as models. He has been so sufficiently trained in the latter that his visual memory of them is complete; and he has been so observant of his fellow men that he has in his mind a personal synthesis of these observations. It is for this reason that the human form, although the natural aspects of it are substantially retained in the art of various regions of Melanesia, is not rendered in a scientifically descriptive manner. Rather, its particular character is presented by simplified but vigorous sculptural forms which express the component parts of the body and their integration. This may be called a "naturalistic" rendering.

Sculptures of this type are not, however, common in Melanesia. They appear, in fact, as characteristic forms in only two areas—the western Solomon Islands and the Admiralty Islands. In both of these areas, moreover, the human figure is also rendered in a number of other different ways. In the Solomon Islands sculptures of the naturalistic style have compact proportions and heavy, full-volumed forms (Pl. 29). Each part—arms, legs, body, neck, and head—is given as a distinct entity; and in this way the structural components of the human form are forcefully expressed. This is made even more emphatic by a slight emphasis of the points of articulation, that is the joints, which serve the dual role of separating the parts and of connecting them.

In his rendering of each part, the Solomon Island sculptor gives a simplified synthesis of its basic character, its roundness, shape, and weight. Descriptive modelling or expository details, such as muscles, would weaken the force of his statement. He has succeeded, moreover, in giving a remarkable vitality to his figure through the way all of the parts work organically together and by the slight flexion or relaxation given to the various joints. Since it is not a personalized figure, the facial features are not individualized.

This small figure is an excellent example of a purely sculptural expression. Its aesthetic quality derives from its rhythmic organization of heavy volumes in space; its smooth surfaces, which allow an uninterrupted flow of soft light over the forms; and its concentration on and slight emphasis of essentials of parts. In it the sculptor discloses his knowledge of the human form, and by it he adds to the knowledge of others. That this was the style of a Solomon Island area and not that of an individual is demonstrated by other examples with the same provenience (Fig. 1).

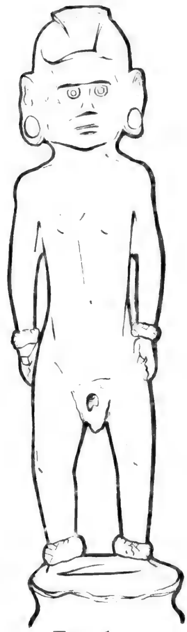

Fig. 1.

In contrast, the Admiralty Island artist in his rendering ignores the roundness of component parts and the significance of their assemblage and, instead, expresses the verticality of the figure as a whole without stressing its individual parts (Pl. 30, Fig. 1). The pose is given a frozen, eternal quality, with not the least suggestion of movement or elasticity. A strict bilateral symmetry adds to this expression of stiffness. The body parts are attenuated and of tight, slightly squarish columnar shapes. Only the spheroidal head is a pure geometric shape. And yet, the quiet upward movement of steady line and the compact unity of slight forms in space express in subtle manner the thoughtful, introspective aspect of man's nature. While the details of Admiralty Island style vary considerably (Fig. 2), the more naturalistic carvings all have this quality of expression.

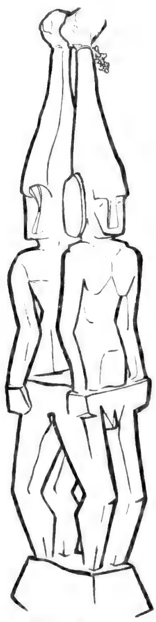

Fig. 2.

In these examples of Admiralty and Solomon Islands sculpture certain characteristics are stressed over others; but a moderate degree of distortion of the human form is also typical of Melanesian art. This treatment has, in fact, a wider distribution than the naturalistic rendering. For expressive reasons it is utilized in many different ways, although it is particularly apparent in the enlargement of the head and in the elongation or compression of different parts of the body.

An excellent example of this style is seen in an elongated female figure from the Solomon Islands (Pl. 30, Fig. 2). This interpretation of human form is further removed from nature than that in the naturalistic styles. The forms of the body and head are now slightly distorted to agree with geometric shapes. While the shapes are separated or marked off so as to reveal with a minimum of description their fundamental geometric character, they are also unified by a strong linear pattern into a system of sculptural relationships, which, in turn, are expressive of those of the human body. A similar treatment is likewise evident in the slightly enlarged shaping of the head and in the interpretation of facial features. Another particularly good example of this style appears in a small figure carved on the handle of a wooden knife from the Banks Islands (Fig. 3).

With few exceptions, a single style of sculpture prevails in each primitive tribe or area.* The style is not only found in ceremonial objects of great importance, but also in the decorative carving on utilitarian objects, whether or not these were intended for ceremonial use. A unity of style is therefore recognizable within an area. For example, the head so magnificently carved on the handle of a New Hebrides adze (Pl. 31, Fig. 1) conforms to the style of sculpture prevailing in a particular part of these Islands. It, too, is rendered in a moderately distorted manner. By pointing the top of the head to agree with a pointed chin a basically diamond shape is achieved. An inversion of natural form is adopted by giving this shape a vertical concavity of surface. Only the rounded plane of the forehead adheres to nature. The huge nose is an exaggeration of the large, fleshy Melanesian nose; while the pierced septum is based on the actual custom, so widespread in Melanesia, of piercing the septum, through which an ornament of some sort was worn. The eyes are very large, sharp, protruding ovoid forms and the mouth a rather restrained simple crescent. Of considerable importance is the flattening out of the facial planes, since by this expedient the eyes and the nose are given added expressive and sculptural force. And yet this head is only moderately distorted, and is clearly derived from natural form.

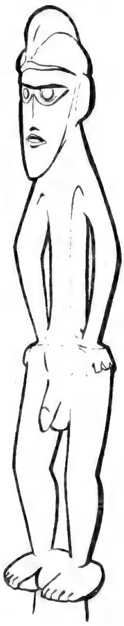

FIG. 3.

An examination of any comprehensive collection of Melanesian art discloses that in by far the greater number of examples distortion of the human form is carried to extremes. In this kind of sculpture the parts of the body and the overall appearance of the human form are frequently far removed from reality. The distortions were generally motivated by the necessity to express a non-physical being, such as a spirit or a supernatural force. These were experienced by certain persons in moments of hysteria or great psychological tension, when their tangible appearance was revealed. The appearance of the being was thereafter established. But it is important to note that the world of normal experience was a strong factor in these moments of abnormal experience, since the distortions are those of familiar normal forms. This group of styles can certainly be considered dominated by expressive desires. Aesthetic principles and elements were, on the other hand, constantly employed to enhance the expressive power of a work, especially when the sculptor was a great artist.

The distribution of these greatly distorted styles covered almost all of the Melanesian islands. It was particularly marked in certain regions of the Solomon Islands, in New Guinea, New Britain, and in New Ireland. A small canoe prow figure from the central Solomons is a superb example (Pl. 31, Fig. 2). The carving expresses a powerful spirit which protected the occupants of headhunting canoes during their grisly expeditions. Characteristic of these figures, the head, its shape and size, and the facial features, are gross distortions; while the

* "Style" may be said to consist of the system of proportions, the interpretation and shaping of parts, the rendering of descriptive or decorative detail, and the use of colour which are adhered to consistently within an area or by a group.

remainder of the carving consists of a pair of arms, with no body but free space between them, and hands clasped under the chin, the hands in some examples represented as holding a small human head. The expression of these sculptural shapes is of dramatic intensity. The tapering elongation of the cranium and the powerful forward thrust of the facial area contribute greatly to this effect. Although the facial forms, which consist of distorted lower and upper jaws, nose, mouth, and teeth, have an animalistic appearance, an examination of a number of these carvings shows that they are merely exaggerations of the prognathism, fleshy noses, and full-lipped mouths of the Solomon Islanders. In this and many other objects from these Islands a very careful shell inlay is used on the black surfaces to define further structural parts and details.

Human figure distortions are in some Melanesian sculpture combined with non-human forms. Many examples from the Sepik River area of New Guinea have heads with bird features attached to a distorted human body (Fig. 4). These were made for use in ancestor rites or as containers of ancestor spirit power, the concept being that at death the spirit departed as a bird, hence the combined representation of the spirit and physical aspects of an ancestor. But the bird features are also distorted, so that the resulting figure is both related to and unlike reality. It is rather a tangible and aesthetically exciting sculptural expression of a concept.

FIG. 4.

From the extreme south-eastern part of New Guinea another style within this group is represented by a small squatting figure carved as the handle of a lime spatula* (Pl. 32). This carving, too, has a large animal-like head; but a wooden comb carved as projecting above the back of the head establishes it clearly as a distorted human figure. These distortions have decorative as well as expressive intent. The expression is that of a squatting figure holding his knees in his hands in the pose of balancing on the small platform at the base of the blade. The arms and legs, as slender curvilinear projections from the body, are interlocked in a rhythmic pattern which conveys the balance and tension of the pose. The enlargement of the head serves the practical function of a knob or firm hand-grip at the top of the handle; but in the ovoid shape of the head are presented the curves so effectively developed in the forms below. Even the flattened planes of the face follow the curvature of the surface of the head. The design of this little carving is a masterpiece of rhythmic relationships.

In still another example from New Guinea, from the Huon Gulf area on the north east coast, human figures are used in a distorted manner as supports for a neck-rest (Fig. 5). This style, in common with those from various other parts of Melanesia, consists of non-naturalistic

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* Spatulas such as this were used in the betel-nut chewing habit to transfer lime from a container to the mouth.

figures composed of a unique assemblage of freely interpreted parts of the human form. It suggests that there was initially a dismemberment of the human body. The parts were then geometrically re-shaped and were re-combined in a new order so as to effect a sculptural expression of the dynamic forces of the human figure. In the Huon Gulf sculptures, the body is a heavy trapezoidal block; the stiff, piston-like arms at the sides emphasize the vigorous downward thrust of this block: the legs are curving, flexible forms, resembling the springy, curved legs of a tubular metal chair, and are well capable expressively of supporting this thrust, while the head, shaped as a very high relief form on the surface of the upper part of the body (the neck has been discarded), exerts an even greater downward thrust parallel to that of the body. There is a powerful compression in these small carvings and an adroit balancing and counterpoising of thrusting forces. In their analysis of the dynamics of the human figure, they show an amazing perception of reality; but their component parts are pure sculptural devices for the realization of this expression.

FIG. 5.

The step beyond the Huon Gulf style is the creation of geometric or abstract equivalents for the various parts of the human figure. In a few regions in Melanesia, such a scheme or pattern, often approaching pure geometrization, is used to indicate the human form or the human head. This is strikingly evident in a group of wooden knives from the Banks Islands (Fig. 6 and cf. Fig 3), where the body parts are presented as geometric shapes arranged in an open pattern. Some designs, however, especially those from the Papuan Gulf area on the south coast of New Guinea, represent a schematic transcription on a two-dimensional surface of three-dimensional forms (Pl. 33). When flattened out a rounded form such as the forehead here becomes a wide crescent, and an open mouth a deep V-shape. It is as though a frontal view of a form were bisected and the two halves juxtaposed on a flat surface. These Papuan Gulf patterns, often restricted to the human head or face, are rendered in wide lines or bands usually cut in low relief, and are combined at times with purely geometric elements (Fig. 7). The various parts of the design are further defined by the extensive use of colour, the pigments being white, black, and various shades of red. Many of these designs approach an abstract interpretation of life forms. Such near-abstractions occur in other parts of Melanesia, particularly in New Britain, New Ireland, and the Sepik River area of New Guinea.

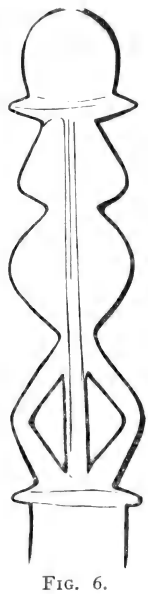


FIG. 6.

The human form is rendered with very great variety in the sculpture of Melanesia. This often spectacular and always aesthetically arresting art demonstrates conclusively that the expressive possibilities through the use of the human form are almost limitless. It also reveals that masterpieces will result in any art, regardless of tradition and motivation, since capability, perception, and sensitivity are shared in common by great artists of all times and places.

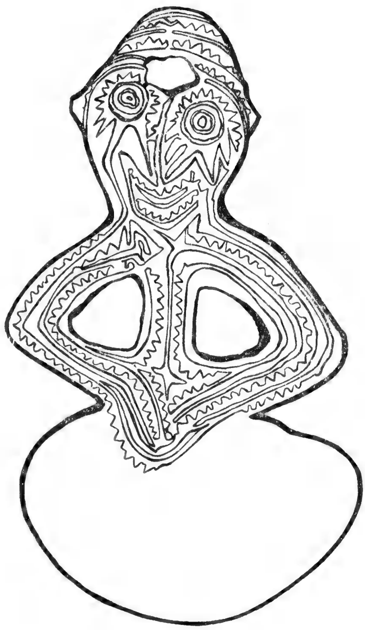


FIG. 7.

Standing figure in hard, close-grained wood. $19\frac{1}{2}$ inches high. Solomon Islands.

Fig. 1. Ancestor figure. 52 inches high. Admiralty Islands.
Fig. 2. Female figure. 26 inches high. Solomon Islands.

Fig. 1. Adze decorated with carved head. 20 inches long. New Hebrides.
Fig. 2. Canoe ornament with shell inlay. 11 inches high. Solomon Islands.

Handle of lime spatula. 10 inches long. Massim area, S.E. New Guinea.

Shield from the Gulf of Papua. 30 inches high.

A Note on the Geology of the Albatross Point District, Kawhia.

By A. P. MASON, Associate Geologist, Auckland Museum.

Abstract.

Molluscan and plant fossils collected from Albatross Point, Kawhia, indicate that the Mesozoic rocks of the area, previously regarded as Triassic, are not older than mid-Jurassic. The presence of a major fault is suggested to explain the absence, west of Arawi Point, of 10,000 feet of Upper Triassic and Lower Jurassic strata.

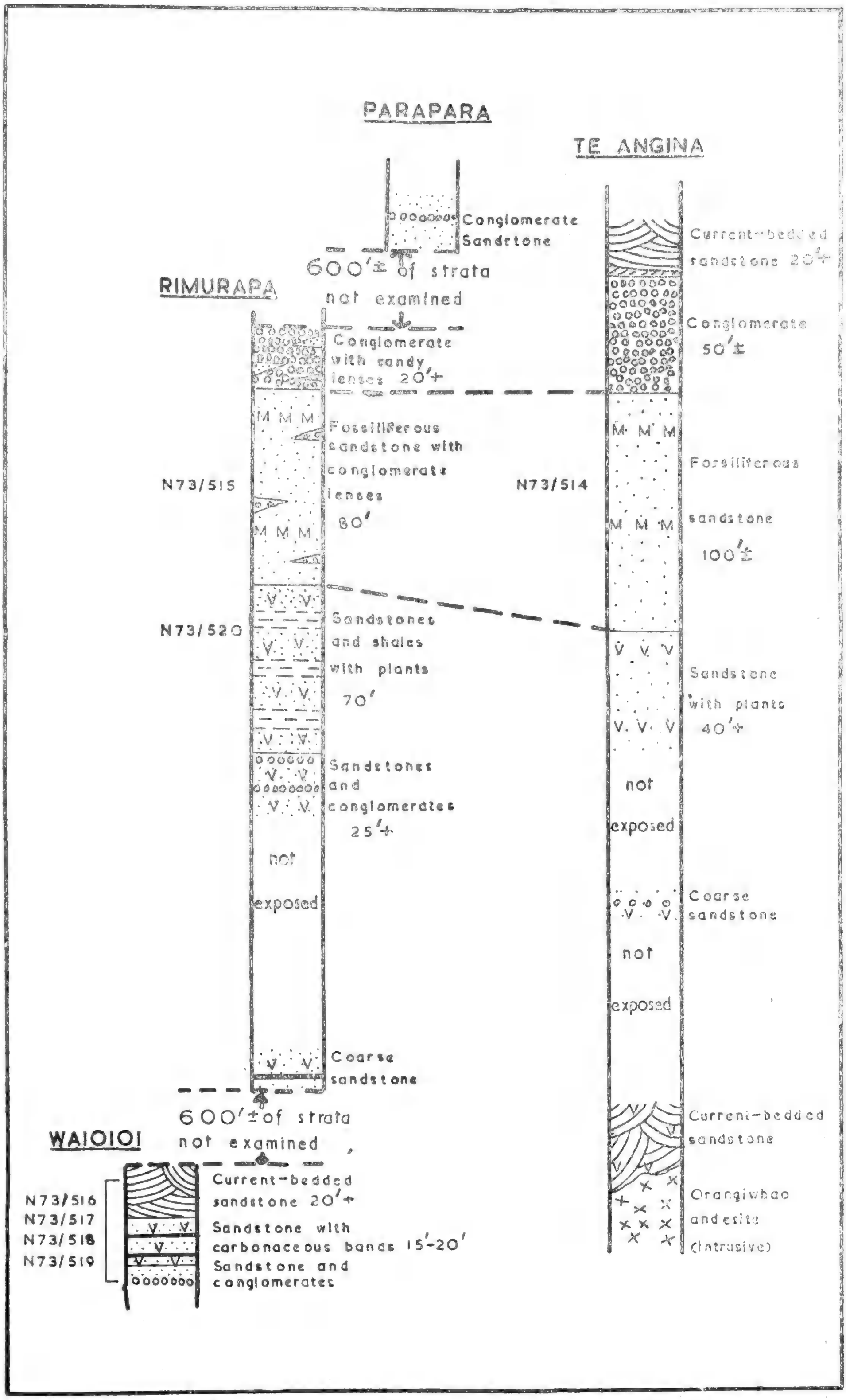
INTRODUCTION.

As the Kawhia section provides one of the most nearly complete sequences of Triassic and Jurassic rocks in New Zealand it has received considerable attention in geological literature. However, Albatross Point, on the outer coast of the harbour, has been strangely neglected in most accounts, evidently because of its isolated situation. McKay (1884) did not examine the rocks at Albatross Point, but noted the westerly dip of the beds on the west side of the Orangiwhao andesite intrusion and considered that they belonged to the Wairoa or a younger series. Henderson and Grange (1926) failed to collect fossils west of Arawi Point, but as the beds closely resembled the Upper Triassic beds further east they were correlated with them.

In January, 1950, the writer had the opportunity of spending several days in the Albatross Point area and this account is based on observations made during that visit. The outer coast is extremely rugged and it was not found possible to examine the section at Albatross Point itself nor that between Rimurapa and Waioioi. Thus, although the total thickness of beds exposed in the area is approximately 1,800 feet, 1,200 feet of these were not examined.

STRUCTURE.

The regional structure, from the Orangiwhao andesite mass, west of Arawi Point, to the outer coast, is an assymetric syncline which plunges in a direction a few degrees west of south. On the west wing of the syncline the beds strike consistently at about 340° and dip to the east at 40°. This structure is given surface expression in the trends of the outer and inner coasts and in the fine example of a dip slope on the inner side of the point. On the east wing, however, the disposition of the beds is less consistent, due to the influence of the Orangiwhao andesite intrusion, and it is probable that the westerly dip of the beds is largely due to the upward movement of the intrusion. The geological map of Albatross Survey District (Henderson and Grange, 1926) shows two faults between Parapara and Te Angina to explain this irregularity



Text fig. 1. Stratigraphic columns for Albatross Point area.

in disposition of the beds. The succession contains several distinctive beds (massive conglomerates and fossiliferous sandstones) which allow correlation of the two arms of the syncline.

STRATIGRAPHY.

The entire sequence is obviously of shallow-water origin, with thick bands of coarse conglomerate, current-bedded sandstones, and abundant plant remains (Text-fig. 1). The lowest beds seen were those exposed in the coastal section from 15 to 50 chains south-south-east of Waioioi. The coast is here a strike coast, so that no great thickness of strata was observed. The lowest bed is a gritty sandstone with conglomerate lenses which is succeeded by 15 or 20 feet of alternating sandstones and carbonaceous bands with indistinct plant remains and fragments of wood up to 2 feet in length. There then follows a massive, current-bedded sandstone at least 20 feet thick (upper limit not observed).

The inaccessible nature of the coast prevented examination of the 500 or 600 feet of strata exposed between Waioioi and Rimurapa. At Rimurapa, a hard, coarse, gritty sandstone is overlain by 3 feet of coarse, soft sandstone that contains wood fragments and occasional plant remains. This is followed by alternating sandstone and carbonaceous bands, and there is then a gap in the sequence of approximately 100 feet due to lack of exposures. The next beds seen are sandstones, grits, and conglomerates (at least 25 feet thick) with fragments of wood up to 3 feet in length. Following this are 70 feet of alternating sandstones and shales, in bands 1 foot to 2 feet thick, with well-preserved plant remains. Next is a massive sandstone (80 feet) containing lenses of fine conglomerate and layers very rich in *Gervillea* n. sp. This is overlain at a sharp contact by at least 20 feet of conglomerate (upper limit not seen) with lenses of sandstone. The pebbles in this conglomerate have a maximum length of 6 inches.

Precipitous cliffs prevented examination of the succeeding 600 feet of strata and the next beds seen were the gritty sandstones exposed along the strike coast on the inner side of the point. At Parapara, these are overlain by 6 feet of coarse conglomerate (pebbles up to 3 inches long), which in turn are followed by shattered sandstone—the highest bed seen in the area.

The section on the eastern arm of the syncline, between Parapara and Tokatapu, is similar to that at Rimurapa. The massive conglomerate, which was the highest bed seen at Rimurapa, is exposed on the west side of Te Angina. It is approximately 50 feet thick and is succeeded by alternating bands, 2 to 3 inches deep, of coarse and fine cross-bedded sandstone. The lowest bed exposed is a coarse, cross-bedded sandstone with carbonaceous bands and rare wood fragments. It rests directly on the Orangiwhao andesite mass, about 300 yards south-east of Tokatapu. Isolated outcrops of sedimentary rock occur further east involved with the andesite, but their stratigraphic position is uncertain.

Marine fossils were collected from the massive sandstone at Rimurapa and from its equivalent east of Te Angina, whilst well-preserved plants occur in the underlying sandstones and shales. Fossils were also found in beach boulders south of Waioioi. The writer is indebted to Dr. J. Marwick and Mr. R. McQueen for the following identifications:

Sheet Fossil Number	N73/514	N73/515	N73/516	N73/517	N73/518	N73/519	N73/520
Gervillea n. sp.	×	×					
Meleagrinella sp.		×	×				
?*Astarte* sp.			×				
?*Tancredia* sp.			×	×			
Cladophlebis denticulata (Brong.)					×	×	×
Elatocladus sp.						×	
Taeniopteris spatulata McClelland					×		
Cladophlebis australis (Morris)							×

N73/514.—East side of Te Angina (Grid reference 234068).
N73/515 and N73/520.—10 chains east-north-east of Rimurapa (217077).
N73/516.—Beach boulders 40 chains south-south-east of Waioioi (219055).
N73/517 and N73/518.—Beach boulders 15 chains south-south-east of Waioioi (217062).
N73/519.—Beach boulder 20 chains south-south-east of Waioioi (218057).

The stratigraphic positions of the fossils are indicated in the columnar sections in Text-fig. 1. Collectively, they indicate a Middle or Upper Jurassic age for the Albatross Point beds. Correlation of the pelecypod fauna with those of other parts of New Zealand suggests that the beds belong to the Temaikan stage, but present knowledge of New Zealand's Mesozoic flora is too incomplete to allow close correlation of the plant beds.*

DISCUSSION.

The discovery that the rocks of the Albatross Point Block are Jurassic in age is rather surprising, for at Arawi Point, 1 mile to the east and on the opposite side of the Orangiwhao andesite intrusion, Otamitan (*Mytilus problematicus*) beds occur at the base of the western arm of the Kawhia syncline. East of Arawi Point, successively younger beds, dipping consistently eastward, outcrop in regular succession for a distance of 7 or 8 miles. Between the Otamitan (Carnian) beds at Arawi Point and the Temaikan (Bajocian-Bathonian) beds at Te Maika (with which the Albatross Point beds may be correlated) are approximately 10,000 feet of strata which are not represented west of Arawi Point.

The Albatross Point Block is nowhere in contact with the main mass of the Kawhia Mesozoic succession and it is therefore difficult to interpret the relation between the two. However, it appears highly probable that the area west of Arawi Point has been down-faulted in relation to the country further east. South of Kawhia Harbour, the coastal area between Tongaporutu and Marakopa is characterised by

* Private communications.

a series of *en echelon* faults which trend a few degrees east of north (Henderson and Ongley, 1923; Marwick, 1946). These constitute the great fracture zone that separates the Herangi Range from the narrow, depressed coastal strip on its western margin. The northernmost fault (Whakahau Fault) reaches the coast near Marakopa, and north of this point the depressed coastal strip passes beneath sea level. However, it is reasonably certain that the fracture zone (and the Whakahau Fault) continues north of Marakopa, and it is here suggested that the Albatross Point Block is a northern remnant of the depressed coastal strip of Te Kuiti Subdivision. In Whareorino Survey District are two andesite masses, Pehimatea and Whareorino*, which are closely similar to that of Orangiwhao (Henderson and Grange, 1926, p. 66; Williamson, 1932, p. 8). Both Pehimatea and Whareorino occur along the surface trace of the Whakahau Fault, and as similar rocks do not occur elsewhere in Huntly-Kawhia or Te Kuiti Subdivisions, it seems more than coincidence that the Orangiwhao mass should occur on the northward continuation of the same line.

An alternative hypothesis which should, perhaps, be considered is the possibility of an unconformity in the Mesozoic succession east of Arawi Point. The palaeontological evidence, which, however, is incomplete, shows no sign of a break, but the sudden decrease in dip (from 75° to 40°) in the vicinity of the conglomerate band, half a mile north-east of Arataura,, which marks the base of the Jurassic, may possibly indicate an angular unconformity. It is unfortunate that no detailed survey, comparable in scope to those made by recent workers in Southland, is available for the Kawhia section to allow discussion of this suggestion.

ACKNOWLEDGMENTS.

The writer desires to thank Miss H. Macdonald and Mrs. R. L. Oliver for the opportunity of visiting the area. He would also like to express his appreciation to Dr. J. Marwick and Mr. R. McQueen for their palaeontological determinations and to the Lands and Survey Department for permission to publish the aerial photographs used in Plate 34. He is also indebted to Dr. R. N. Brothers for helpful criticism of the text.

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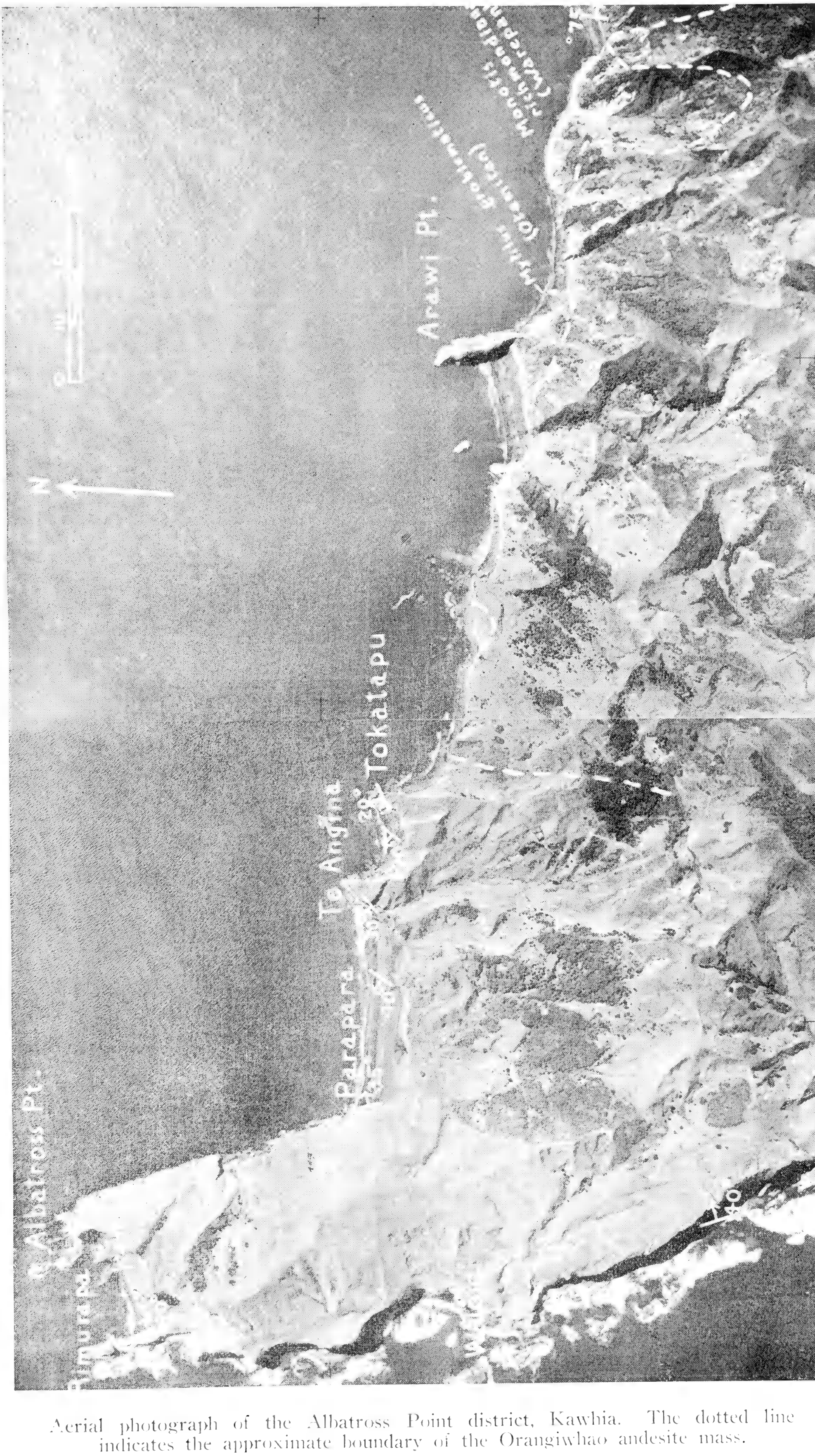
* Hutton (1944, p. 151) classifies the rocks of Pehimatea and Whareorino as dacites.



Aerial photograph of the Albatross Point district, Kawhia. The dotted line indicates the approximate boundary of the Orangiwhao andesite mass.

(Photograph published by permission of the Lands and Survey Department.)

The Genus Rhopalimorpha Dallas (Heteroptera, Pentatomidae.)

By J. G. PENDERGRAST, Auckland.

The original description of the genus *Rhopalimorpha* Dallas is included in a key in a list of Hemipterous insects in the British Museum (Dallas, 1851). Because it is inadequate as a generic description it has been thought advisable to redescribe this genus. Similarly, White's description (1851) of *R. obscura* is now of little value and this species has been redescribed. *R. lineolaris* Pendergrast, the other species recorded from New Zealand, has been described in a previous paper (1950) and identified material of both species is in the collection of the Auckland War Memorial Museum.

The writer wishes to acknowledge his indebtedness to Dr. T. E. Woodward, of the Zoology Department, Auckland University College*, for valuable suggestions and for his generosity in allowing examination of Acanthosomatinae in his collection. He would also like to express his gratitude to Dr. W. E. China, of the British Museum (Natural History), for giving him access to the type material.

FAMILY PENTATOMIDAE.
SUB-FAMILY ACANTHOSOMATINAE.
Genus RHOPALIMORPHA Dallas, 1851.
Rhopalomorpha Mayr, 1866.

Body elongate oval; thorax and anterior half of abdomen of uniform depth; angle between scutellum and pronotum surfaces almost straight, typical "hunched" appearance of sub-family lacking. Head wide, more than half greatest pronotum width; length equalling or slightly exceeding that of pronotum; head width: length:: about 1.25; tylus conspicuous, rounded, projecting beyond juga; maxillary plate region with protuberance in front of antennal base; rostrum never reaching beyond intermediate coxae. Antennae about half body-length; fifth segment slightly longer than fourth, second equalling or slightly exceeding third; first segment reaching or barely surpassing apex of head. Pronotum flat, trapeziform, narrow; pronotum width: body length:: 0.4; lateral margins straight; anterior angles blunt, without terminal papilla; lateral angles not produced. Mesothoracic carina small, ridge-like. Hind femur length: body-length:: about 0.27. Abdomen slender, greatest width not exceeding half body-length; without median

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ventral keel; ventral spine small, reaching scarcely beyond hind coxae; sixth sternum in female with pair of dark circular setose areas, absent on the seventh; in male genital chamber opens caudad.

Type: *Rhopalimorpha obscura* White, in the British Museum (Natural History).

1. **Rhopalimorpha obscura** A. White, 1851.

   Rhopalimorpha similis Mayr, 1864.

   Rhopalomorpha similis Mayr, 1866.

   Rhombocoris similis (Mayr) Walker, 1867.

   Rhopalimorpha ignota Hutton, 1898.

Length: Female, 7.5-9.5 mm. Male, 7.0-8.5 mm.

General Colour: Dorsally usually ochreous, sometimes olivaceous, hemielytra darker. Ventrally much lighter except as detailed. Male usually distinctly green.

Head: Dorsally coarsely punctured with black including mid-line; clefts bordering tylus sometimes marked with black. Lateral margins slightly raised. Ventrally glabrous except for pubescent gula and few conspicuous punctures on genae. In front of antennal base maxillary plate with inconspicuous rounded protuberance. Rostrum not reaching intermediate coxae. Second segment of antenna longer than third (1.2 : 1.0), greater parts of fourth and fifth segments dark brown. Eyes dark red to purple; ocelli red.

Thorax: Pronotum and scutellum densely punctured except on callus areas. Mid-line sometimes marked by lighter stripe obscured by punctation; stripe more obvious on scutellum, especially apically. Scutellum apex acute. Hemielytron narrow, corium dark brown, densely punctured, membrane buff, veins brown. Scent gland orifice bordered above by less conspicuous plate than in *lineolaris*. Mesothoracic carina very small, ridge-like. Femora without obvious punctation.

Abdomen: Slender; connexivum somewhat developed, without dark markings, partly projecting laterad of hemielytron. Venter dark in mid-line; ventral spine small, slender, rarely extending cephalad of hind coxae.

Female: Sixth sternum with pair of rather inconspicuous dark circular setose areas. Valvifers somewhat triangular, mesial margins raised. Seventh sternum produced posteriorly into sharp median keel.

Male: Pygophor with strongly convex ventral posterior margin bearing two patches of long bristles. Claspers partially hooked, blunt.

Type: In the British Museum (Natural History).

2. **Rhopalimorpha humeralis** Walker, 1867.

   Described from Queensland, Australia.

3. **Rhopalimorpha lineolaris** Pendergrast, 1950.

Labels for the following figures in the writer's 1950 paper should read as follows:—

Fig. 2. *Rhopalimorpha lineolaris* sp. nov. Apex of scutellum.

Fig. 3. *Rhopalimorpha lineolaris* sp. nov. Male. Ventral view posterior abdominal segments.

Fig. 4. *Rhopalimorpha lineolaris* sp. nov. Female. Ventral view posterior abdominal segments.

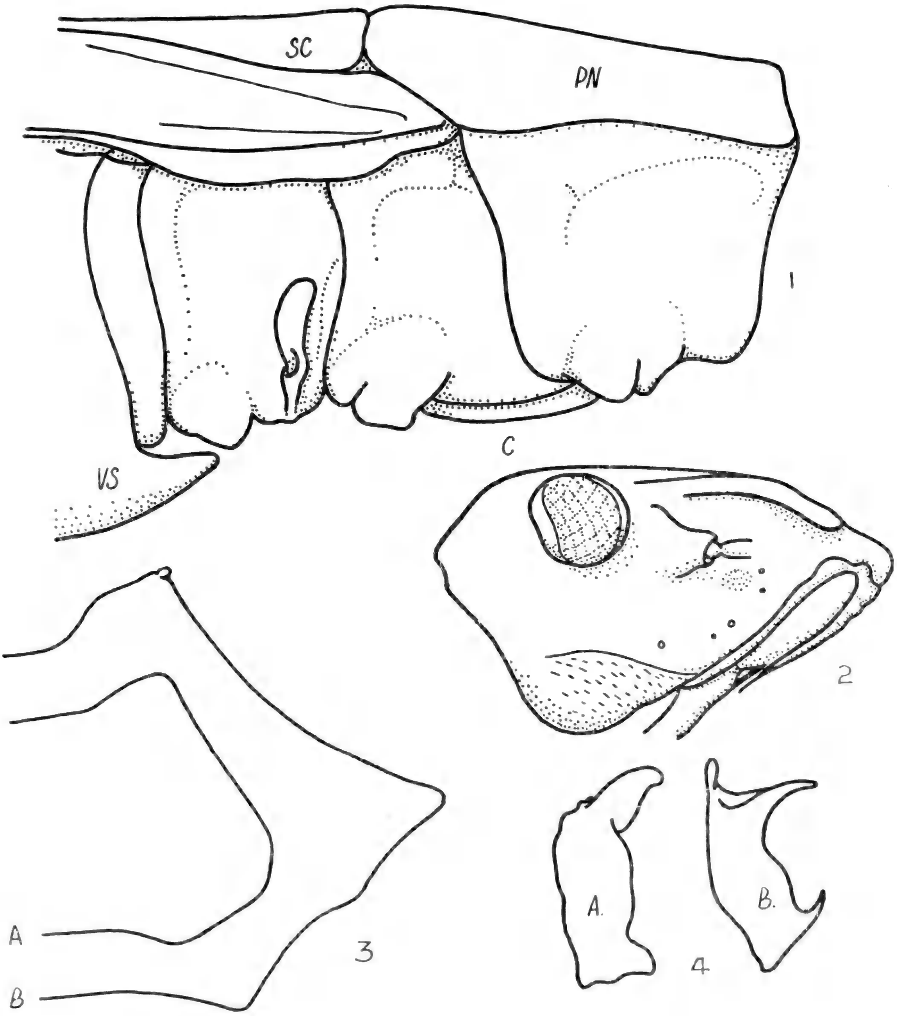

Fig. 1. *Rhopalimorpha obscura* White. Lateral view thorax after removal of coxae. C, Mesothoracic carina: PN, Pronotum: SC, Scutellum: VS, Ventral spine.

Fig. 2. *Rhopalimorpha obscura* White. Lateral view head.

Fig. 3. Comparison of outlines of right halves of pronota of: A, *Rhopalimorpha obscura* White, and B, *Acanthosoma haemorrhoidale* (L.).

Fig. 4. Claspers. A, *Rhopalimorpha obscura* White: B, *Rhopalimorpha lineolaris* Pendergrast.

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Four New Species of New Zealand Land Snails and the systematic position of Gerontia cordelia Hutton.

By A. W. B. POWELL, Auckland Museum.

FAMILY FLAMMULINIDAE

Genus ALLODISCUS Pilsbry, 1892.

Two new species of the group of *Allodiscus dimorphus* are described below. Each occurs in an area presumed to have been separated formerly from the mainland. A third species, *cooperi* Suter, is related to *fallax*, one of the new species, and is known only from the Poor Knights Islands. The fourth member of the group, *dimorphus* Pfeiffer, is widespread over most of the North Island.

The following key provides easy identification of the four species of the group.

A. Spirals absent or microscopic:
- a. Radials on penultimate 45-48 .. .. *dimorphus* (Pfeiffer)
- b. Radials on penultimate 75-80 .. .. *fallax* n. sp.
- c. Radials on penultimate 89-90 .. .. *cooperi* (Suter)

B. Spirals strong, fenestrating radials:
- d. Radials on penultimate 100-104 .. .. *spiritus* n. sp.

Allodiscus fallax n. sp. Text fig. 2.

Shell of similar size and shape to *dimorphus* (Text fig. 1) but with a darker and more clear-cut tessellated pattern, as well as more numerous axials, 75 to 80 on the penultimate, compared with 45 to 48 in *dimorphus*. Interstices of radials with 8 to 10 secondary radial threads compared with 10-12 in *dimorphus*. Very dense and extremely fine spiral threads, only on the latter part of the protoconch, the first post-nuclear whorl and around the closed umbilicus. Whorls 5, including a depressed protoconch of almost two whorls, faintly malleated, with occasional axial growth lines and exceedingly fine dense spirals over the second whorl.

Diameter, 7.25 mm.; height, 4.75 mm. holotype).

Locality: Oruru Bay near Knuckle Point, Rangiawhia Peninsula, Northland, under leaf mould in stunted coastal scrub on steep cliff face near head of bay, 29/1/1950.

The Rangiawhia Peninsula, tied to the mainland by low country and extensive dunes, was probably formerly an island. The species *dimorphus* has not been found in the area.

Allodiscus spiritus n. sp. Text fig. 3.

Shell almost as large as *dimorphus*, a similar but darker and more clear-cut tessellated pattern, more than twice as many radials, 100-104 on the penultimate and dense distinct spiral threads over all whorls, forming a regular interstitial reticulation with the secondary radials, which number 8 to 10 for each interspace. Whorls $5\frac{1}{4}$, including a depressed protoconch of $1\frac{3}{4}$ whorls, sculptured as in *fallax* but with the spirals more distinct. The adult whorls are more rounded and not so deep as in *dimorphus*. Imperforate.

Diameter, 7.0 mm.; height, 4.5 mm. (holotype).

Localities: Waterfall Gully, Kapo Wairua, Spirits Bay, in *Astelia*, Jan., 1950 (holotype); Unuwhao, 750-900 feet east of Spirits Bay, in *Astelia* and under decaying leaves.

The Cape Maria van Diemen-North Cape Block has a distinctive land snail fauna obviously developed during former separation of the area from the Northland Peninsula. The species *dimorphus* is unknown from this area also.

Dentition: 32 + 1 + 32. Radula similar to that of *dimorphus*, Central tooth with the base longer than broad, narrower in front and with a single prominent, long cusp with a minute denticle on either side. Laterals similar to the central tooth but with a distinct denticle on the outer side only. Marginals at first longer than broad but broader than long towards the extremities, with bidentate cusps and 3 to 6 denticles on the outer side.

Genus **THALASSOHELIX** Pilsbry, 1892.

Thalassohelix prousei n. sp. Text figs. 4, 5, 6, 8 and 9.

Shell similar to that of *zelandiae* but peripheral carina almost obsolete, spiral sculpture much stronger and axial growth lines weaker, a wider umbilicus and a characteristic light zone surrounding the umbilical area, the epidermis being here much thinner, allowing the white shell to show through. Whorls 5, including a low rounded protoconch of $1\frac{3}{4}$ whorls, bearing subobsolete microscopic spirals over the last half whorl. Post-nuclear whorls intricately sculptured with dense distinct spiral threads crossed by numerous somewhat irregular weak axial growth lines and a very dense surface pattern of minute wrinkle-striae. There are about twenty spirals on the penultimate. Umbilicus open and deep, one-seventh major diameter. Spire more than half height of aperture. Colour of epidermis pale horny.

Diameter, 5.5 mm.; height, 4.75 mm.

Locality: Paturau River, in small patch of bush on the property of Mr. H. S. Prouse.

Dentition: (14 + 9) + 1 + (9 + 14) (Text figs. 8 and 9). Central tooth with a narrow rectangular base and a relatively short stout mesocone, ectocones obsolete. Laterals with the addition of a short stout ectocone. Marginals long, oblique, awl-shaped without ectocones or denticles.

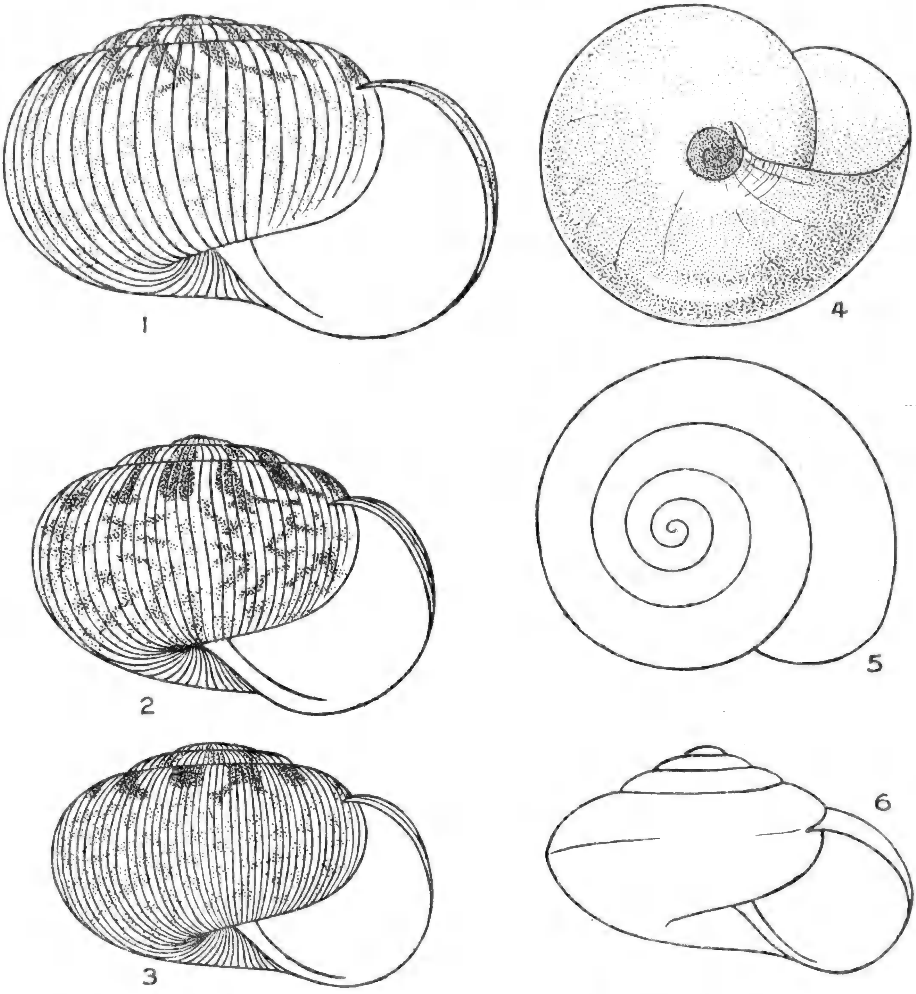

Fig. 1. *Allodiscus dimorphus* (Pfeiffer), Waitakere Range.
Fig. 2. *Allodiscus fallax* n. sp. Holotype, 7.25 x 4.75 mm.
Fig. 3. *Allodiscus spiritus* n. sp. Holotype, 7 x 4.5 mm.
Figs. 4-6. *Thalassohelix prousei* n. sp. Holotype, 5.5 x 4.75 mm.

FAMILY PARYPHANTIDAE

Genus RHYTIDA Albers, 1860.

Rhytida forsythi n. sp. Text fig. 10.

This is a miniature relative of *dunniae* with an adult size of less than half the linear dimensions attained by that species. The egg also is approximately half the size of that of *dunniae*. The peripheral carina is not so sharply keeled. The dentition resembles that of *dunniae* except for the central tooth, which is the same size as adjacent laterals, not half the size.

Whorls 4, including a low rounded smooth protoconch of $1\frac{1}{2}$ whorls. Post-nuclear whorls sculptured, as in *dunniae*, with dense anastomosing radial wrinkles. These wrinkles are irregularly thickened at the periphery but interrupted or spaced, not fused into a continuous ridged keel as in adult *dunniae*. Umbilicus deep, about one-sixth diameter of the base. Colour uniformly fuscous.

Dimensions of shell:

forsythi:	diameter,	13.0 mm.;	height,	6.5 mm.	(Holotype)
	,,	13.5 mm.;	,,	7.25 mm.	(Largest seen, Herekino Gorge)
dunniae:	,,	30.5 mm.;	,,	15.0 mm.	(S. of Kaeo)
	,,	30.0 mm.;	,,	16.0 mm.	(Pekerau)
	,,	25.0 mm.;	,,	12.0 mm.	(Whangarei)
	,,	24.0 mm.;	,,	11.0 mm.	(Type)
	,,	23.0 mm.;	,,	11.75 mm.	(Cornwallis)

Dimensions of egg:

forsythi:	length,	2.6 mm.;	width,	2.15 mm.	
dunniae:	,,	3.5 mm.;	,,	2.75 mm.	(Cornwallis)
	,,	4.5 mm.;	,,	3.75 mm.	(Kaeo)

Dentition: Radula almost identical with that of *dunniae*. Formula 17 + 1 + 17. The outer five laterals increase in size from the margin to the sixth, which is large and massive, then they diminish gradually to the centre. Central tooth as large as adjacent laterals.

Localities: (*forsythi*) one mile up Taipa Estuary, south side (A.W.B.P., 20/1/1950) (Holotype); Whatuwhiwhi, Rangiawhia Peninsula, Doubtless Bay (D. G. Forsyth); Oruru Bay, near Knuckle Point, Rangiawhia Peninsula (A.W.B.P., 29/1/1950); Quarry up valley north side of Taipa-Oruru Road, Mangonui County (A.W.B.P., 1/2/1950); Broadwood, Summit of Mangamuka; Owhata, Herekino Harbour; Moerewa; Okaihau and Waipoua Forest (N. Gardner).

Localities: (*dunniae*) Kaitaia to Thames (fide Suter, 1913); Church Road, ca. 4 miles from Awanui-Mangonui highway; head of Pekerau Valley, ca. 2 miles S.W. of Lake Ohia; subfossil in dunes, Tokerau, Doubtless Bay; Takahui, Victoria Valley, Kaitaia; Kaeo; Whangarei; Kauri Mountain, Whangarei Heads; Parua Bay; Woodcocks; Mangawai Gorge; Kawau Island; Wade River; Cornwallis, Manukau; Centennial Drive, Waitakere Range, at Waiatarua, and near Titirangi.

The species *forsythi* has a restricted range extending from Rangiawhia Peninsula and Mangonui westward across the Peninsula to Mangamuka, Herekino and Waipoua Forest. Its distributional pattern interpolates with but does not seem to overlap that of the northern extremity of the *dunniae* range. I have never found both species at any one locality, but they do occur in an apparent haphazard proximity, especially between Mangonui and Kaitaia.

The differences in carination and dentition indicate that *forsythi* is not merely a size mutant of *dunniae*. Otherwise it could be surmised that lack of lime or some other deficiency is responsible for the size disparity.

Reference to the N.Z. Geological Survey North Island Map, 1947, shows that *dunniae* occurs mostly in association with sedimentary rocks of the Oligocene-Miocene formations 15-18 and *fosythi* in volcanic (No. 3) and Senonian (No. 13) areas. However, there are exceptions, notably in the Waitakere area, where *dunniae*, not a "dwarfed form," occurs in association with a volcanic formation.

Reference to text figures (10 and 11) shows that *forsythi* is undoubtedly adult at 13 mm., for it has the characteristic sag of the outer lip near its junction with the body-whorl. Figure 11 is of an immature *dunniae* from Pekerau; both to same scale. The fully developed radula, complete with central tooth and marginals, and the presence of eggs also show that the species is mature.

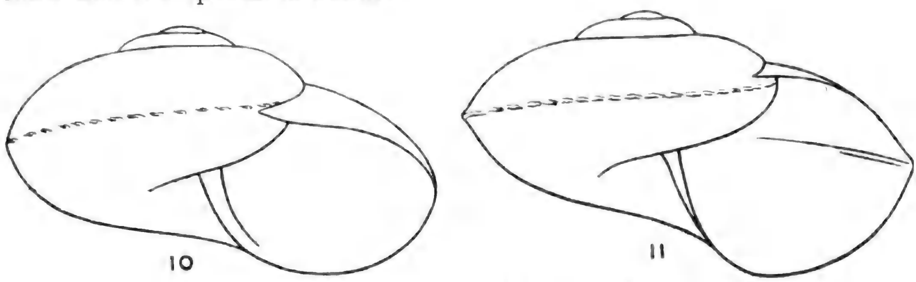

Fig. 10. *Rhytida forsythi* n. sp. Holotype, 13 x 6.5 mm.
Fig. 11. *Rhytida dunniae* (Gray) to same scale (juvenile)

I prefer to consider *forsythi* as specifically not subspecifically distinct largely on account of its local range and curious mode of occurrence, interpolated with *dunniae* but evidently nowhere inter-breeding. The inference is that *forsythi* originated as the result of some previous isolating factor no longer apparent.

I associate the name of Mr. D. G. Forsyth with this species, since he first brought the problem to my notice.

Genus DELOS Hutton, 1904
DELOUAGAPIA New Subgen.

Type: *Gerontia cordelia* Hutton

The small snail long known as *Gerontia cordelia* has been considered a rarity. The type locality was cited as Titirangi, but to my knowledge it has not since been collected from the vicinity of Auckland. I know of it, however, from a number of Northland localities: Maungakaramea, near Whangarei (A. E. Brookes, 1928); the northern headland block, Whangaruru Harbour (A. C. O'Connor and A.W.B.P., Feb., 1948; Oruru Bay, Rangiawhia Peninsula (A.W.B.P., Jan., 1950); Cape Maria van Diemen (mainland), Kapo Wairua, Spirits Bay and Kerr Point near North Cape (A.W.B.P., March, 1949).

At Whangaruru and at Kapo Wairua this snail was found to be arboreal, living in clumps of *Astelia*, epiphytic on the limbs of puriri (*Vitex lucens*). At Kerr Point dead shells were abundant on the ground under clumps of *Astelia* in the stunted and rather sparse herbfield. Again, at Cape Maria van Diemen, *cordelia* was associated with *Astelia*, growing on the ground, there being no tall vegetation at either locality.

It may be noted that shells labelled "*Delos jeffreysiana*, Cape Maria van Diemen," in the Suter collection are *cordelia*.

The dentition and salient features of the animal show that *cordelia* is a carnivorous Paryphantid of the genus *Delos*.

The shell is very similar to that of *Delos jeffreysiana* except for the dark reddish-brown marbled and streaked colour pattern which is more in accord with that of the Melanesian-Polynesian genus *Ouagapia*.

The type of *Ouagapia* is the New Caledonian *raynali* Gassies, a large shell measuring 33 mm. x 17 mm. Its dentition is unknown, but the several small species ascribed to the genus have more aculeate teeth than *Delos*. The formulae range from 12 + 0 + 12-13 + 0 + 13 for the Fijian *ratusukuni* Cooke, 1942, to (20-23) + 1 + (20-23) for the Caroline Islands *oualanensis* Pease, 1866.

The dental formula for both the New Zealand *Delos coresia* and *jeffreysiana* is 9 + 0 + 9 and that of *cordelia* 12 + 0 + 12. (Text fig. 7.) The teeth in all three are stout, relatively broad-based and slightly hooked. In *Delos* typical, the second tooth from the centre is largest, after which they regularly diminish. In *Delouagapia* the fourth tooth from the centre is disproportionately large, then regularly diminishing from the fifth to the twelfth.

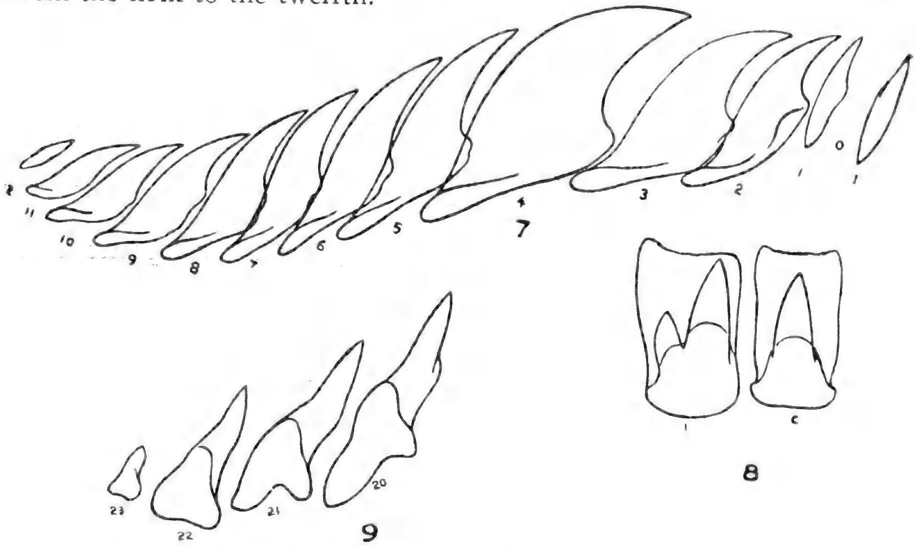

Fig. 7. *Delouagapia cordelia* (Hutton).
Figs. 8, 9. *Thalassohelix prousei* n. sp.

The animal of *cordelia* is slate-grey except for the sole, which is white. Surface reticulate veined, scarcely warty. Two deep parallel grooves on the dorsal area run back from between the superior tentacles, which are blunt, cylindrical and moderately long. Inferior tentacles short, genital orifice on right below mantle collar, proboscis capable of protrusion, foot narrow, transversely wrinkled and with a moderately long pointed tail.

Yoshio Kondo (1943, Occas. Pap. Bernice P. Bishop Mus., vol. 17, No. 19, p. 247) found close relationship between the anatomy of *Delos* and that of the smaller Melanesian-Polynesian species ascribed to *Ouagapia,* but since the anatomy of the large-size type species, *raynali,* is unknown, admitted the possibility of ultimate subgeneric division.

Although *cordelia* conforms with *Delos* in shell features, the *Ouagapia*-like colour pattern and in particular the disproportionately large fourth lateral tooth would seem to warrant the subgeneric status proposed above for this species.

The holotypes of the four species described in this paper are in the Auckland Museum.

New Zealand Molluscan Systematics, with Descriptions of New Species, Part 1.

By A. W. B. POWELL, Auckland Museum.

Family PECTINIDAE

Chlamys (Mimachlamys) taiaroa n. sp. Pl. 35, fig. 1.

Shell resembling *dichroa* in size, shape and coloration, but more inflated and with different sculptural detail. In *dichroa* the radials are strong, broad and flat-topped with channelled interspaces throughout. the concentric lamellae closely spaced, relatively strong but not spinose.

In *taiaroa* the radials are narrowly rounded and channelled only in the early growth stages. After about 25 mm. the radials spread to broadly triangular with the addition of a weak margining radial on each side and one or two secondary radials in each intercostal space. The concentric lamellae are weak, scarcely apparent in the interspaces but forming weak irregular scales on both primary and secondary radials. "*Camptonectes*" striations present but very weak compared with those in *dichroa*. The primary radials range between 15-20 in *taiaroa* and 18-21 in *dichroa*.

Holotype with 19 primary radials on the right valve and 18 on the left. Anterior lug of right valve with six scaly radiate ribs. Colour pink to orange-pink, alternating in intensity in the form of broad concentric zones corresponding with growth stages. Colour stronger and zones more clearly defined on the inside.

Height,	43.0 mm.	Length,	42.0 mm.	Thickness,	(2 valves)	16.0 mm.	(holotype)
,,	39.5 mm.	,,	40.0 mm.	,,	,,	16.0 mm.	(paratype)
,,	37.5 mm.	,,	36.0 mm.	,,	,,	15.0 mm.	,,
,,	41.5 mm.	,,	38.5 mm.	,,	,,	11.0 mm.	(*dichroa*)
,,	41.0 mm.	,,	39.0 mm.	,,	,,	10.0 mm.	,,
,,	31.0 mm.	,,	31.5 mm.	,,	,,	8.75 mm.	,,

Locality: Off eastern coast of Otago, 50-70 fathoms (trawled by Captain J. Black, Dunedin).

Holotype: Auckland Museum, presented by Mr. J. G. Smith, Dunedin. Paratype in collection of Mrs. N. Gardner, Auckland.

The Chatham Island shells figured by Finlay (1928, Trans. N.Z. Inst. 59, p. 269, Pl. 42, figs 45-48) do not represent typical *dichroa*, which is quite accurately portrayed in Suter's Atlas, Pl. 52, fig. 1. Finlay's material is finer and more delicately ribbed, but I have two strongly ribbed typical *dichroa* from Kaingaroa, Chatham Islands. There is insufficient material available to determine if there is more than one species of the *dichroa* group at the Chathams.

A series of ten topotypes of *dichroa* from the stomachs of cod taken at Port Pegasus, Stewart Island, are constant in their strong flat-topped radials with channelled interspaces and non-inflated valves.

Young examples of *Chlamys delicatula* Hutton, a species that occurs commonly on the continental shelf of Eastern Otago, somewhat resemble *taiaroa*, but are readily distinguished by their shape, higher than broad, more numerous radials and thicker, stronger shell.

Family MONTACUTIDAE

Genus TAHUNANUIA n. gen.

Type: *T. alata* n. sp.

The shell described below is closely allied to a Victorian species, *Saxicava subalata* Gatliff and Gabriel, 1910 (Proc. Roy. Soc. Vict. N.S. 23, p. 85). These shells, however, have nothing to do with *Saxicava* (= *Hiatella*), nor is Cotton and Godfrey's (1938) location of *subalata* in *Eximiothracia* any better (The Moll. S. Aust. 1, p. 136).

There is a pallial sinus in both *Saxicava* and *Eximiothracia* and it is especially deep in the latter, whereas the "*subalata*" group has an uninterrupted pallial line.

Other features of the "*subalata*" group are a single cardinal in each valve, a long external ligament and an oblique large and very distinct resilifer, seated on the nymphs. A character common to both the Victorian and New Zealand species is a slight radial ridge bordering the inner margin of both adductor scars. The genus seems to be nearest to *Scintillona* Finlay, 1926, but the hinge differs in the large oblique well-formed resilifer, that of *Scintillona* being weak, long, narrow and lying almost parallel to the dorsal edge. Further, the cardinal in the left valve is small, broadly triangular and located close to the dorsal margin. That of *Scintillona* is larger and projects below the hinge plate, but is not so prominent as in *Mysella*.

It may be noted that T. Soot-Ryen, 1951, Antarctic Pelecypods, Sci. Res. Norweg. Ant. Expeds., p. 33) has referred *Mysella* to the *Montacutidae* and that family location seems to be preferable for all three above-mentioned genera.

Tahunanuia alata n. sp. **Text fig. 1, 1a.**

Shell rather small, thin, dull-white, minutely granulated, ovate-trapezoidal, somewhat inflated arcuately from beaks to posterior-ventral extremity. Beaks nearer to anterior end, which is narrowly rounded and slightly gaping. Posterior end broadly winged with an oblique flattened posterior slope. Hinge-line long and relatively straight, the hinge plate weak anteriorly, deep over the cardinal area and moderate along the posterior dorsal slope. Hinge of right valve with a single deep strongly projecting and forwardly inclined narrow cardinal in front of the umbo, an obliquely triangular functionless space directly under the umbo followed by a conspicuous oblique divergent resilifer with clear cut edges, seated on and occupying most of the nymph. Left valve with a weak broadly triangular cardinal situated on the upper half of the hinge plate in front of the umbo. Ligament long, extending from the umbo to the posterior slope. Muscle scars deeply impressed, narrowly ovate, the anterior one with a radial ridge margining its inner face and a less distinct ridge margining the inner edge of the posterior scar.

Pallial line entire.

Height, 5.5 mm.; length, 10.0 mm.; inflation (both valves), 3.6 mm. (holotype).

Localities: Tahunanui Beach, Nelson (type); off White Rocks, Queen Charlotte Sound, 25 fathoms (Dominion Museum); off Hen and Chickens Islands, 26-30 fathoms (Dominion Museum); off Mayor Island, 45 fathoms, Bay of Plenty (C Williams).

Holotype: Auckland Museum.

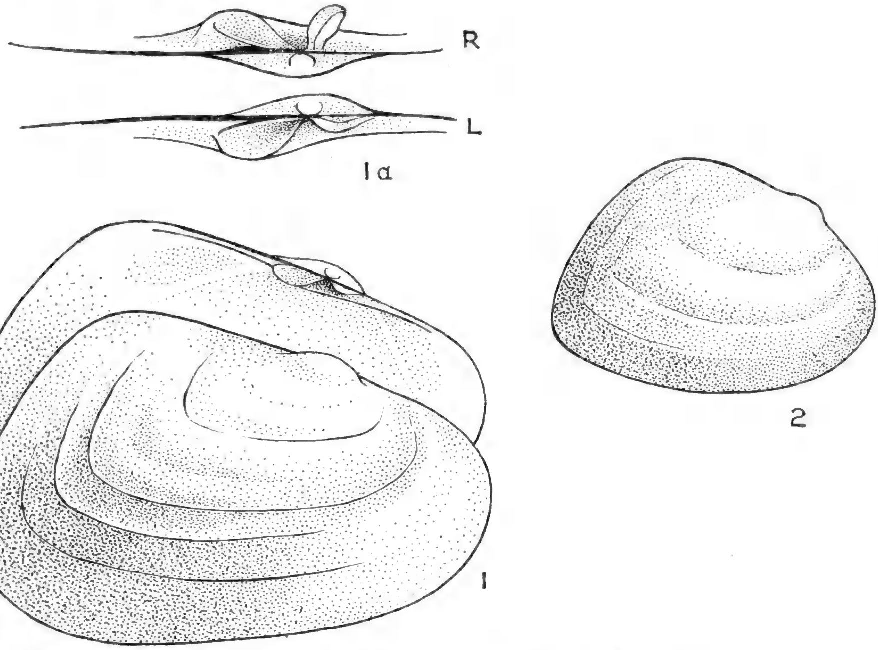

Fig. 1 and 1a. *Tahunanuia alata* n. sp. Holotype, 5.5 mm. x 10.0 mm.
Fig. 2. *Tahunanuia trigonia* n. sp. Holotype, 3.5 mm. x 4.75 mm.

Tahunanuia trigonia n. sp. Text fig. 2.

Shell rather small, thin, dull-white, minutely granulate, trigonal, narrowly rounded anteriorly and broadly winged posteriorly. Beaks at about the anterior third. Somewhat inflated posteriorly by a strong arcuate angulation running from the beaks to the posterior-ventral angle. Hinge plate long and relatively straight, narrow but deeper over the cardinal area. Right valve with a single, strongly projecting, narrow, forwardly inclined cardinal and a conspicuous oblique divergent resilifer, seated on and occupying most of the nymph. In this species the ligament is set in a long narrow groove posterior to the beaks. Muscle scars small, ovate, subequal, the anterior one bounded on the proximal edge by a slight radial ridge.

Height, 3.5 mm.; length, 4.75 mm.

Locality: Perseverance Harbour, Campbell Island, 18 fath. (Capt. J. Bollons).

Holotype: 1 right valve, Powell coll., Auckland.

The species is much shorter and more trigonal than *alata* and has the umbonal-ventral ridge stronger and distinctly angulate.

Family CUSPIDARIIDAE

Cuspidaria willetti Fleming, 1948.

The type locality for this species is Chalky Sound, 14 fathoms, Fiordland. It is now known to me from the following Aupourian localities: Two miles off N.W. end of Motiti Island, Bay of Plenty, from stomach of a tarakihi taken in 35 fathoms (Mr. Gordon Williams); off Opotiki, 20 fathoms (Mr. W. La Roche); trawled, Bay of Plenty (Mr. S. Voss).

Localities for both *trailli* and *fairchildi* are:—

trailli Hutton, 1873

Stewart Island, 14 fathoms (type); Foveaux Strait, 15 fathoms; 96 fathoms, 1½ miles N.N.E. of Mayor Island; off Opotiki, 20 fathoms; off Hen and Chickens Islands, 25 fathoms; off Little Barrier Island, 25-30 fathoms; 1½ miles off Leigh, Hauraki Gulf, 30 fathoms; between Spirits Bay and Three Kings Islands, 95 metres; off Great Island, Three Kings Islands, 98 fathoms.

fairchildi Suter, 1908

Off Flat Point, 75 fathoms (type); 96 fathoms, 1½ miles N.N.E. of Mayor Island; 84 fathoms, 1½ miles N.E. of Mayor Island.

Family HALIOTIDAE

Haliotis (Sulculus) virginea crispata Gould.

1847—*Haliotis crispata* Gould, Proc. Boston Soc. N.H., 2, p. 251.

1890—*Haliotis crispata*: Tyron and Pilsbry, Man. Conch. 12, p. 109, Pl. 16, figs. 87, 88 (copied, U.S. Expl. Exped. f. 248, 248a).

Locality: "Australia"? = New Zealand.

For many years I have recognised two forms of mainland *virginea*: (1) a large southern one, predominantly greenish, with deep spiral grooves and weak meandering radials, which become obsolete as the shell reaches maturity; (2) a small northern one, variously and brightly coloured, the dorsal surface often bright orange, or variegated red and green, with deep spiral grooves crossed throughout by prominent meandering radial folds.

The difficulty has been to decide which form is true *virginea*. Dr. C. A. Fleming during a recent visit to the Australian Museum, Sydney, kindly examined for me the original figures of *virginea* in Chemnitz (Conch. Cab. 10, pl. 166, figs. 1607 and 1608). He affirms that these figures are definitely of the southern form. Mr. Tom Iredale then suggested that Gould's *Haliotis crispata*, described with a query, as from Australia, really represented the northern New Zealand form of *virginea*. This undoubtedly seems to be the case and Gould's original description quoted below fits the northern shell exactly.

"Shell small, very thin and delicate, of an elongated oval and more than usually convex form, the surface marked with fine, regular, equal, revolving threads, and with very delicate, branching, oblique, zigzag ripples, which are almost equally conspicuous in the interior. The spire is prominent, of a little less than three whorls, the apex nearly on the median line. The perforations are small, rounded, slightly tubular, numerous and crowded, six or seven of them open; and external to the series is a deep canal. The colour is bright brick-red or red-lead colour, having between the canal and the margin a few narrow and distant yellowish-white stripes. The interior is brilliant silvery, and somewhat iridescent. Length an inch and three-eighths; breadth seven-eighths of an inch."

It is desirable to nominate type localities for both subspecies. Gmelin's material was from Cook's voyages and the sources of the collections were Bay of Islands, Queen Charlotte Sound and Dusky Sound. The United States Exploring Expedition visited Bay of Islands, Akaroa and Auckland Islands. I therefore nominate Queen Charlotte Sound as type locality for *virginea virginea* and Bay of Island for *virginea crispata*.

Localities and dimensions of specimens for both subspecies are as follows:—

virginea virginea Gmelin, 1790.

South Island of New Zealand, Stewart Island, Wellington and southern coast of the North Island.

75 mm. x 51 mm. near Dunedin.
75 mm. x 49 mm. Ocean Beach, Stewart Island.
56 mm. x 38.5 mm. Kartigi Beach, North Otago. Normal Otago adults.
55.5 mm. x 36 mm. Croixelle Islands, Nelson.
68 mm. x 44 mm. Lyall Bay, Wellington. (Extra large for Cook Strait.)
42 mm. x 28 mm. Island Bay, Wellington. (Normal Cook Strait adult.)

Other localities: Portobello, Dunedin; Oamaru; Timaru; 4 miles south of Clarence River, Marlborough; Cascade Point, Westland; Kahurangi Point, West Nelson.

virginea crispata Gould.

North Island, Bay of Plenty to North Cape.

40 mm. x 27 mm. Leigh, Hauraki Gulf.
40 mm. x 27.5 mm. Great Barrier Island.

Other localities: Whangarei Heads; Bay of Islands; Doubtless Bay; Waikuku Beach; Tom Bowling Bay; Cape Maria van Diemen.

Family CALLIOSTOMATIDAE

Venustas punctulata multigemmata n. subsp. Pl. 35, figs. 2, 3.

Shell large, thin, tall-spired, pale coloured, sculptured with fine, very numerous gemmulate spiral cords and intermediate threads. Whorls eleven, including a low, minute, smooth protoconch of 1½ smooth whorls. First post-nuclear whorl with two spiral cords, second and third whorls with three cords, fourth with four and increasing to sixteen primary gemmulate cords and about nine plain intermediate threads on the penultimate. Spire tall, almost one and two-thirds height of aperture. Whorl outlines strongly convex, not angled. Colour buff, speckled with light brown on the cords between the gemmules. Some examples with narrow irregular and intermittent light reddish-brown axial streaks.

Height, 54 mm.; diameter, 50 mm. (holotype).
Height, 48 mm.; diameter, 44 mm. (paratype).

Locality: 50 to 70 fathoms off Eastern Otago. Trawled by Mr. J. Black.

Holotype: Auckland Museum.

This is the largest of the *punctulata* series and the finest and most delicately sculptured. It seems to occur abundantly at the type locality and shows little variation. It stands nearest to *punctulata ampla* Powell, 1939, a stronger shell with fewer and coarser spirals, from shallow water, Stewart Island.

Family PLANAXIDAE

Hinea braziliana (Lamarck) 1822.

Suter (1913, Man. N.Z. Moll. p. 194) admitted this species to the New Zealand fauna, citing Bay of Islands but no authority, and Finlay, in his 1926 commentary (p. 376), rejected the record for lack of definite evidence of New Zealand occurrences. However, I can name two records: Great Barrier Island (Rev. W. H. Webster collection, Auckland Museum), a dead shell, and Whangaroa Harbour (collected W. E. La Roche, ca. 1924), one living example, now in my collection, Auckland.

The species is common in eastern Australia, Queensland to Victoria, Tasmania, Lord Howe Island and Kermadec Islands.

Family NATICIDAE

Two extra limital Naticoids and one beach specimen of a New Zealand upper Pliocene fossil deserve mention but, on the present evidence, not inclusion in the Recent faunal list.

Conuber conica (Lamarck), 1822.

Two half-grown, well preserved examples collected by Mrs. I. Worthy at Tauranga Bay, Whangaroa. This is a common East Australian species. At the same time and place a single well preserved example of the Mitrid genus *Arenimitra* was obtained. It resembles *exasperata* Reeve and *arenosa* Lamarck but is much more slender. This also should not be added to the fauna until more are found.

Propesinum umbilicatum (Quoy and Gaimard), 1833.

A single slightly damaged but comparatively fresh example from Stewart Island, collected by Mrs. W. H. Harrison. This is a common Tasmanian species. The Stewart Island shell has the typical colour pattern but a slightly shorter spire than any I have seen.

Eunaticina cincta (Hutton), 1885.

A stained and rather old shell of large size (20 mm. x 17 mm.) picked up in beach drift at Paihia, Bay of Islands, by Mr. L. W. Delph. The species is otherwise known only from Landguard Bluff and Te Piki, uppermost Castlecliffian (Pliocene) New Zealand. The Paihia specimen may have come from some raised beach deposit. The rusty brown staining of the specimen certainly suggests that source.

Family CYMATIIDAE

Charonia capax Finlay.

1913—*Septa rubicunda*: Suter (not of Perry), Man. N.Z. Moll., p. 303, Pl. 43, f. 1.

1926—*Charonia capax* Finlay, Trans. N.Z. Inst. 57, p. 397, Pl. 20, f. 67.

1926—*Charonia capax euclioides* Finlay, Trans. N.Z. Inst., 57, p. 398, Pl. 20, f. 68.

Type localities: Off Otago Heads, 20 fathoms (*capax*) and 40 fathoms (*euclioides*).

When Finlay described *capax* and *euclioides* he had only the holotype of each. Eight additional specimens from the vicinity of the type locality (60-70 fathoms off Eastern Otago) now before me, would on Finlay's criteria separate into seven *capax* and one *euclioides*. However, the slender shape and smaller aperture seem to be entirely resultant from adventitious whorl acceleration caused by injury or deflection to avoid adherent growth. Neither the stronger nodulation nor the narrower shoulder cords, features claimed by Finlay as characteristic of *euclioides*, are, in the present series, restricted to the alleged subspecies. In fact, they seem to represent but one species.

Northern shells tend to vary considerably, with strong rounded nodulation associated with a dark reddish-brown pattern for shallow-water shells. However, those from the deeper waters (continental shelf) from Bay of Plenty northward are pale in colour, like the Otago shells, but mostly strongly nodose.

There is, however, a second species of *Charonia* in northern waters which I previously misidentified as *capax*. This is:—

Charonia rubicunda (Perry).

1811—*Septa rubicunda* Perry, Conchology, London, Pl. 14, f. 4.

1924—*Septa rubicunda*: Bucknill, Sea Shells of New Zealand, Pl. 4, f. 3.

1933—*Charonia* cf. *capax*: Powell, Trans. N.Z. Inst. 63, p. 162.

1937—*Charonia capax*: Powell, The Shellfish of New Zealand, Pl. 14, f. 10.

Type locality: New Holland. Probably New South Wales.

A long series of New South Wales *rubicunda* now enables me to claim this species as an occasional occurrence in Northern New Zealand waters. It is broader than *capax*, has very few nodules on the spire and the whole of the shell is crossed by closely spaced spiral cords with deeply incised interspaces. These cords are somewhat variable in width on the body-whorl, but in all cases they are uninterrupted by nodulation. The coloration is characteristic, a rich pinkish brown with a bright reddish-brown maculated pattern. The outer lip is sharply ledged internally and chequered with clear cut dark reddish-brown rectangular patches alternating with white.

Height (actual), 139 mm. (estimated) 142 mm.; diameter, 84 mm. (1937 figured specimen).

Localities: Near old stone wharf, Pilot Bay, Tauranga, six living examples with eggs taken by Dr. C. E. R. Bucknill, July, 1922 (my figured example, 1937, is one of these); Tairua, near Mercury Bay (Mrs. Stocker).

Monoplex australasiae Perry.

1811—*Monoplex australasiae* Perry, Conch. or Nat. Hist. of Shells (London), Pl. 3, f. 3.

1873—*Triton (Simpulum) acclivis* Hutton, Cat. Mar. Moll. N.Z., p. 13.

1913—*Septa costata*: Suter (non Born, 1778), Man. N.Z. Moll. p. 305, Pl. 43, f. 2.

1915—*Monoplex parthenopeum*: Iredale (non von Salis, 1793), Trans. N.Z. Inst., vol. 47, p. 459.

1926—*Monoplex acclivis*: Finlay, Trans. N.Z. Inst., vol. 57, p. 398.

Finlay (l.c.) advocated the use of Hutton's *acclivis* for the New Zealand shells, stating that they differed from Australian examples in having a longer canal and a different outer lip. However, after examining long series of both New Zealand and East Australian shells I fail to find any constant points of difference. The name *parthenopeum* was given to a Mediterranean shell, but I have not seen specimens. Since both the South African and Japanese forms of *Monoplex* show obvious differences the best course seems to be the adoption of Perry's name, given to a New South Wales shell, for the Austro-neozelanic *Monoplex*.

Particymatium strangei (Adams and Angas).

1864—*Triton strangei* Adams and Angas, Proc. Zool. Soc., p. 73.

1933—*Cabestana*? *labiosa*: Powell, Trans. N.Z. Inst. 63, p. 159, Pl. 23, f. 9.

1936—*Particymatium strangei*: Iredale, Rec. Aust. Mus. 19 (5), p. 307.

The New Zealand record is based upon a single well preserved beach specimen from Takapaukura, Tom Bowling Bay. This specimen has suffered injury at two points and this has caused whorl acceleration resulting in an abnormally high spire. The varix on the body-whorl opposite the aperture is an unusual feature, but can be matched in at least one instance in a Kermadec series. These abnormalities undoubtedly influenced Iredale (1936) in doubting the identity of my New Zealand record. Iredale (l.c.) stated that he was misled in accepting the British Museum locality of West Indies for *labiosum* Wood, the locality being unknown and the figure very like the Sydney shell. He then suggested continuing the use of the name *strangei* for the New South Wales shells and noted that Kermadec shells showed no differences.

Mayena australasia vossi n. subsp. Pl. 35, fig. 4.

Shell of similar size to *australasia,* fusiform, sharply shouldered, with two nodulous spiral keels, the uppermost at shoulder the stronger and the lower one at the suture. The nodules are strong, pointed and fewer than in *australasia*, 4-6 between varices. Spire shorter than aperture plus canal, but the canal is almost twice as long as in *australasia*. Colour pale buff, weakly maculated, mostly on the nodules and as a narrow peripheral line. Interior of aperture and labial parietal callus, porcellaneous white. Epidermis buff, delicately and densely reticulated by axial and spiral threads with microscopic short bristles at all points of intersection. In *australasia* the reticulation is more dense, giving a velvety matted texture.

Height (actual) 81.5 mm. (estimated) 83.0 mm.; diameter 43.5 mm. (holotype).

Height (actual) 73.5 mm. (estimated) 77.0 mm.; diameter 43.0 mm. (paratype).

Locality: Eight miles east of Mayor Island, 70 fathoms, Bay of Plenty.

Holotype: Presented to the Auckland Museum by Mr. S. Voss, of Tauranga.

This proposed new subspecies seems to be nearest allied to *Mayena australasia benthicola* Iredale, 1929 (Rec. Aust. Mus. 17 (4), p. 174, Pl. 41, f. 4), from the continental shelf, New South Wales. Both have two rows of very strongly developed but sparsely spaced nodules. In *benthicola* the spire is described as being "longer than the aperture" (plus canal) and from the figured holotype there appear to be at least 6-7 nodules between varices. A deep water South Australian relative, *euclia* Cotton, 1945, is a narrower shell with an even higher spire and a longer canal. In *vossi* the spire is considerably shorter than the aperture plus canal, and the nodules are reduced to from 4-6 between varices.

Finlay (1926, Trans. N.Z. Inst. 57, p. 400) described the New Zealand littoral form as *Mayena zelandica*, type from Tauranga, said to differ from the Australian *australasia* in having a subobsolete lower keel and many nodules on the peripheral keel (about 9 between varices in the specimen figured).

In 1933 (Powell, Trans. N.Z. Inst. 63, p. 163) I pointed out that only a few of the New Zealand shells have as many as nine nodules between the varices, the average for eight New Zealand specimens taken at random being 6.875, and for the same number of New South Wales specimens 6.625; the difference is negligible. Further, the majority of New South Wales examples examined have the subobsolete lower keel.

There are two colour forms in *australasia*, one buff to light yellowish-brown indefinitely clouded or marbled with reddish-brown, and the other dark reddish to purplish-brown with conspicuous white patches where the main spirals cross the varices. These two colour forms seem to be distributed irrespective of locality, depth and sex. It may be noted that the dark-brown form tends to obsolescence of the nodular peripheral keel over the last whorl.

The new subspecies *vossi* is a buff form, but another benthic example from 45 fathoms off Mayor Island (S. Voss) is identical with the shallow-water dark brown form.

It appears that whereas the larvae of the littoral form is probably freely transported in surface plankton across the Tasman by means of the East Australian Current, the benthic occurrences are below the effective influence of the current and thus we get comparative isolation in the deeper waters of the continental shelves of the two countries, resulting in local benthic subspecies.

Family TONNIDAE

Tonna dolium (Linnaeus). Pl. 35, fig. 5.

1758—*Buccinum dolium* Linn. Syst. Nat. Ed. 10, p. 735.

1952—*Tonna dolium*: Tinker, Pacific Sea Shells, Honolulu, figures facing p 136.

Tropical Pacific and Indian Oceans.

I now have three New Zealand records of this handsome tropical shell. (1) Tokerau Beach, Doubtless Bay (Mrs. F. Bloomfield, 2/9/1950); (2) Off Whangaroa, in crayfish pots obtained by Mr. Eric

Sanderson, specimen now in collection of Mrs. I. Worthy, Patumahoe, Auckland; (3) Mount Maunganui Beach, obtained during winter of 1950 by a visiting American collector.

I have examined all three specimens, which are in a good state of preservation, especially the Whangaroa one, which was inhabited by a hermit crab. This shell has full colour and a high gloss with no signs of wear and evidently was living at the locality shortly before it was taken.

It is probable that these odd occurrences represent survivors from occasional drift from warmer areas of the South Pacific during abnormally prolonged spells of northerly winds. They possibly reach here in their early post-larval stages with planktonic drift, but occurrences are evidently too infrequent and too sparse for mating and permanent establishment of the species in New Zealand waters.

Two of the three records are from sparsely inhabited areas. The human factor is unlikely to have accounted for the presence of these shells, so the inference is that the species can reach here and survive in these waters.

It seems best to admit the species to the fauna, for its claim is equal to that of other "extra-limital" Northland inclusions in the faunal list: e.g., *Xenophalium royanum* Iredale, *Cymatilesta bolteniana* A. Adams, *Recluzia lutea* Bennett, *Hydatina physis* Linnaeus and a number of others.

Family CASSIDIDAE

Xenophalium (Xenogalea) matai n. sp. Pl. 35, fig. 6.

A member of the *pyrum* group but small, much more slender, minus nodules and with the columellar callus-plate less expanded, not dilated and restricting the false umbilicus to a very small opening.

Shell small, rather thin, narrowly ovate. Spire about one-third height of aperture. Whorls $6\frac{1}{2}$, including typical protoconch of $2\frac{1}{2}$ whorls. Labial varix recurved, smooth and slightly thickened behind. Pillar with seven distinct but weak oblique plications and the usual ridges bordering the base of the columellar-callus. Callus-plate thick but rather narrow, set tightly to the columellar, the free distal edge bluntly rounded and bridging a small rounded false umbilicus. Surface smooth except for a few spiral incised lines on the spire and on the base. There are about ten spiral lines on the early spire-whorls and four or five rather distantly spaced on the base. The only axial sculpture is in the form of weak irregular axial folds. Colour pale pinkish buff, with a very weak pattern of pale purplish-brown blotches, arranged on the body whorl in five spiral series, the uppermost at the suture.

Height, 45.5 mm.; diameter, 31.0 mm. (holotype).

Locality: Beach Harbour, Breaksea Sound, Fiordland, alive on intertidal mud-flat (A.W.B.P., Nov., 1934, on N.Z.G.S. Matai).

Holotype: Auckland Museum.

The species resembles *pyrum* in colour pattern, lack of labial denticles and in the presence of spiral sculpture, and *labiatum* in its narrow shape, small false umbilicus and thickened labial varix, but is quite distinct from either and cannot be considered hybrid.

Family MURICIDAE

Genus UTTLEYA Marwick, 1934.

Uttleya williamsi n. sp. Pl. 36, figs. 5, 5a.

Shell small, narrowly fusiform. Spire tall, acuminate, a little less than height of aperture. Protoconch high, narrowly conical, of three and a half smooth lightly convex whorls, with a small central nucleus. Post-nuclear whorls three, sculptured with regular, distinct, rounded spiral cords, with linear interspaces. There are 9 cords on the ante-penultimate and 11-12 on the penultimate. These cords become obsolescent on the upper and median portion of the last half-whorl, but those on the neck and fasciole, numbering about eight, are strong right to the outer lip. Aperture narrowly ovate, produced below into a short canal, with a broad shallow sinus. Fasciole not defined. Inner-lip smooth, rather wide, well defined and slightly excavated. Outer-lip evenly arcuate and in profile, sinuous, with a broad shallow concavity over the upper half. Colour deep buff, body-whorl broadly spirally banded, two bands with a subequal band of the ground colour occupying the upper half of the body-whorl followed by a second peripheral light band and a final broad band extending to but not over the fasciole.

Height, 10.75 mm.; diameter, 3.7 mm. (holotype).

Locality: 2½ miles north of Mount Maunganui, 18 fathoms, Bay of Plenty. Several from the stomach of a fish; Moki (*Latridopsis ciliaris* Forster), Mr. Gordon Williams.

Dentition: Pl. 36, fig. 5a.

The dried animal in the holotype was extracted with the aid of a wetting agent and a mount of the radula prepared. The dentition is Trophonoid. Central tooth with three long cusps of equal size and length and two half sized intermediates each placed nearer to the outer cusp than to the central tooth. The base of the central is wide and shallow with upcurved extremities.

Operculum horny, very thin, ovate, with subapical nucleus.

The species is nearest to *ahiparana* Powell, 1927, but that species is more slender with more narrowly convex whorls, weaker sculpture and more numerous (19-20) spiral cords on the penultimate.

Holotype: Presented to the Auckland Museum by Mr. Gordon Williams.

Uttleya marwicki n. sp. Pl. 36, fig. 6.

1934—*Uttleya* sp. Marwick. Proc. Malac. Soc. 21, p. 20. Pl. 2, fig. 13.

Shell ovate-fusiform, slender at first but suddenly inflated after the first post-nuclear whorl. Protoconch high, narrowly conical, of three and a half smooth, lightly convex whorls, with a small central nucleus. Protoconch followed by a brephic half-whorl, smooth, except for three distant thread-like varices. Post-nuclear whorls sculptured with distinct rounded spiral cords with subequal interspaces, 8 on spire whorls in holotype (increasing to about 14 obsolescent ones on the penultimate of the large Wellington example): colour buff with a broad white zone encircling the body-whorl at and below the top of the aperture. In the large Wellington specimen the spirals are obsolete on the body-whorl except for six linear spaced cords on the base just above the fasciole.

Height, 8.1 mm.; diameter, 3.6 mm. (juvenile Holotype).

Height, 20.0 mm.; diameter, 8.0 mm. (Hypotype of Marwick's *Uttleya* sp. 1934).

Localities: Tahunanui Beach, Tasman Bay, Nelson (type); Wellington Harbour, 5-6 fathoms (fragmentary specimen in New Zealand Geological Survey.

Holotype: Presented to the Auckland Museum by the writer.

This Cookian *Uttleya* is apparently very rare. I nominate the juvenile Nelson specimen as holotype since it exhibits the sculptural detail much better than in the large Wellington fragment.

A feature of the species is the sudden inflation after the first post-nuclear whorl and subsequent wide and strongly convex whorls.

Family COLUMBARIIDAE

Coluzea mariae n. sp. Pl. 35, fig. 8.

Shell fusiform, with broadly conic spire and long, straight, tapered canal. Whorls 8, including a smooth papillate typical protoconch of 2 whorls. Spire rather squat, less than half the height of the aperture plus canal; angle 55°, outline strongly keeled just below the middle of the whorls and excavated below at suture. Sculptured with distant sharply raised spiral cords, three above and two below the peripheral carina on spire whorls and about 24 on the base and neck; six of these are stronger than the rest and occupy the base from level with the top of the aperture to the commencement of the neck and canal. All post-nuclear whorls crossed by numerous weak axial folds which crenulate the peripheral carina, forming 23 to 24 blunt tubercles per whorl. The axials become rapidly obsolete over the base. Colour uniformly white.

Height, 81.0 mm.; diameter, 21.5 mm.

Locality: 60-70 fathoms off Eastern Otago (trawled by Captain J. Black, Dunedin).

Holotype: Auckland Museum.

The species is named in honour of Mrs. Black.

Mr. R. K. Dell, of the Dominion Museum, Wellington, informs me that there is more than one species of the *spiralis* group in New Zealand waters. The type of *spiralis* was neither figured nor adequately described. No dimensions were given and the location cited was simply "New Zealand. Mus. Cuming." However, Hutton 1880 (Man. N.Z. Moll., p. 50) synonymised his *Fusus pensum*, 1873 (Kapiti Island) with *spiralis* and Tryon, 1881 (Man. Conch. 3, pl. 85, fig. 593) figured Adams and Reeve's *Fusus spectrum* as a synonym of *spiralis*. The point is that all these references are to a narrow shell with a spire angle ranging between 32° for *pensum* to 42° for Northland "*spiralis*" = *Columbarium suteri* Smith, 1915.

The Otago shell represents a distinct species with a short broadly conic spire (55°) and very numerous peripheral crenulations.

Family COMINELLIDAE

Cominella virgata brookesi n. subsp. Pl. 35, fig. 7.

A geographic subspecies with a distinctive colour pattern, distributed from Whangaroa to Parengarenga Harbour. Suter (1913, Man. N.Z. Moll., p. 290) gives the range of *virgata* as Bay of Islands to East Cape, and the type locality is Bay of Islands.

Typical *virgata* has weak spiral lirae marked out as thin dark brown continuous lines, three on the spire-whorls and 6-7, rarely 8, on the body-whorl and base. In addition there is a weaker under pattern of flexuous axial flammules. Interspaces of both spirals and axials approximately equal, which results in a reticulated effect. The new subspecies has a dense pattern of flexuous, narrow, dark-brown axial lines on an olive-grey ground. The pattern has frequent meanders and interrupted lines, caused by damage to the outer lip during growth. This pattern is descriptive of well preserved examples. When erosion takes place, close spiral dark lines appear from underneath the surface pattern, but both are never visible on an uneroded surface. Worn shells exhibit approximately eight dark brown spirals on the spire-whorls and sixteen on the body-whorl and base, twice the number shown in the typical species. Columella and outer lip bright orange as in the typical species.

At Te Hapua, Parengarenga, a stunted form of *virgata brookesi* occurs. It has a tendency to develop stronger and more persistent axial costae, some extending on to the body-whorl, but this is probably only an ecological form.

Height, 32.5 mm.; diameter, 17.00 mm. (holotype).

Localities: Whangaroa Harbour (W. H. Webster Coll., Auckland Museum); Whatuwhiwhi, Rangiawhia Peninsula, Mangonui County (D. Forsyth) (type locality); Aurere, Doubtless Bay (A. E. Brookes); Te Hapua, Parengarenga Harbour (A.W.B.P.).

Holotype: Auckland Museum.

In the Auckland Museum collection typical *virgata* is represented from the following localities: Bay of Islands; Whangarei Harbour; Port Fitzroy, Great Barrier Island; Little Barrier Island; Alderman Islands; Big Mercury Island; Narrow Neck and Takapuna, Auckland; and Mount Maunganui, Bay of Plenty.

I am indebted to Mr. A. E. Brookes for first bringing this subspecies to my notice, to Mr. D. Forsyth for the Whatuwhiwhi material, and to Mr. V. W. Lindauer for a long series of topotypes of *virgata*.

Family NASSARIIDAE

When Finlay (1926) provided the new name *aoteanus* for "*Arcularia coronata* var." (Smith, 1915) from 11-20 fathoms near North Cape, New Zealand, he also remarked that "Powell and La Roche have collected one or two specimens and these prove to be of the '*glans*' type, not like *spiratus* but close to *particeps* Hedley."

One of the specimens, formerly in Mr. La Roche's collection, is definitely a *particeps*, but the other is a typical *spiratus*. No further New Zealand examples of *particeps* are known to me, but I have additional Northland records of *spiratus;* listed below.

Dredging operations on the continental shelf, Northland, have produced several *aoteanus* but no *spiratus*, which seems to occur only in shallow water. The specimen Suter listed from 38 fathoms near Cuvier Island as "*Nassa suturalis dunkeri* n. n." (1908, Trans. N.Z. Inst., 40, p. 350) was thus almost certain to have been an *aoteanus*. However, his subsequent description and figure (1913, Man. N.Z. Moll., p. 398 and 1915, Atlas, Pl. 45, f. 17) is of *particeps*, probably an Australian example, and not the Cuvier Island shell. As pointed out by Finlay (l.c.) the name *dunkeri* must be dropped, since it is merely a new name for *Nassa intermedia* Dunker, 1866, non Forbes, 1844.

Nassarius particeps (Hedley).

1915—*Arcularia particeps* Hedley, Proc. Linn. Soc. N.S.W. 39 (4), p. 738.
1926—*Nassarius* cf. *particeps*: Finlay, Trans. N.Z. Inst. 57, p. 419.

Localities: Cavalli Islands, Northland (W. La Roche ca. 1924), one example, Powell coll., Auckland). The type locality is Port Jackson, New South Wales.

The species is characterised by three narrow brown spiral lines on the spire-whorls and five or six on the body-whorl, in addition to a maculated pattern.

Nassarius spiratus (A. Adams).

1852—*Nassa spirata* A. Adams, Proc. Zool. Soc. London for 1851, p. 106.

Localities: Tom Bowling Bay, Whangaroa, Matauri Bay and Cavalli Islands, Northland; Kaitoke, Great Barrier Island (Powell coll., Auckland). The type is from Swan River, Western Australia.

The species occurs commonly in New South Wales, Norfolk Island and at Sunday Island, Kermadec Group. It has a maculated pattern but lacks the spiral lines of the *glans-particeps* group.

Nassarius aoteanus Finlay.

1915—*Arcularia coronata* var., Smith, Brit. Antarctic "Terra Nova" Exped. 1910, Moll. p. 85, Pl. 1, f. 28.
1926—*Nassarius aoteanus* Finlay, Trans. N.Z. Inst. 57, p. 419.

Localities: Near North Cape, New Zealand, 11-20 fathoms (type); half-way between Outer Chicken Island and Mokohinau Islands, 62 fathoms; off Cuvier Island ca. 40 fathoms; Tryphena and Kaitoke, Great Barrier Island, from crayfish pots (Powell coll., Auckland).

The species has a channelled suture, coronated by short stout axials, and is coloured uniformly pale yellowish-brown.

Family MITRIDAE

Austromitra planatella Finlay, 1930.

The holotype from off Cuvier Island in 38 fathoms is an immature shell measuring 10.8 mm. x 4.5 mm. Two adult specimens in my collection measure 13.6 mm. x 5.8 mm. and 13 mm. x 5.5 mm. respectively. The first is dull white and is from 30 fathoms off Mayor Island, Bay of Plenty, the second is light pinkish-brown and was found at Whangaroa. A feature of the species is the pinched or narrowly arched character of the axials.

Austromitra brunneacincta n. sp. Pl. 36, fig. 4.

Shell of moderate size for the genus, rather broadly fusiform, spire about equal to height of aperture plus canal, strongly axially costate, crossed by numerous clearly incised spiral lines. Colour buff, with a pattern of narrow light reddish-brown spiral bands, two on the spire whorls and five on the body-whorl. The first is subsutural and the fifth covers the fasciole. Four of the bands show strongly within the aperture. Whorls 6, including a smooth globular protoconch of $1\frac{1}{2}$ whorls. Axials moderately strong, rounded, regular, vertical, continuous from suture to suture and rapidly becoming obsolete on the base, 16 on the penultimate. The whole surface crossed by distinctly incised spiral lines, about 14 on the spire whorls and about 55 on the body-whorl, including the fasciole. Columellar plaits four, oblique, uppermost strong.

Height, 10.6 mm.; diameter, 4.9 mm.

Locality: Mayor Island, $\frac{1}{2}$ mile off west side, from stomach of a tarakihi, *Dactylopagrus macropterus* (Forster), taken in 18 fathoms (Mr. Gordon Williams, 12/12/1947).

Holotype: Presented to the Auckland Museum by Mr. Gordon Williams.

The species is nearest to *planatella* but in that species the shell is larger, the axials are pinched or narrowly arched, the spiral sculpture is much weaker and there is no colour pattern.

Austromitra zafra n. sp. Pl. 36, fig. 3.

Shell small, narrowly fusiform, uniformly dark reddish-brown, sculptured with numerous rather weak narrowly rounded axials crossed by closely spaced spiral cords with linear interspaces. Whorls 5, including a smooth pupoid protoconch of $1\frac{1}{2}$ whorls. Axials slender, vertical, about 25 on the penultimate. Spiral cords evenly developed over all post-nuclear whorls, including the fasciole, 16 on penultimate. Columellar plaits four, oblique, uppermost strongest.

Height, 5.25 mm.; diameter, 2.25 mm.

Locality: Mayor Island, 1 mile off south-west end, from stomach of a tarakihi, taken in 50 fathoms (Mr. Gordon Williams, 20/2/1949).

Holotype: Presented to the Auckland Museum by Mr. Gordon Williams.

The style of sculpture is reminiscent of that of the Pyrenid genus *Zafra*.

Microvoluta obconica n. sp. Pl. 36, fig. 2.

Shell small ovate-biconic, solid, sculptured with low distant axial folds, about ten per whorl and faint incised spiral lines. Whorls $4\frac{1}{2}$, including a smooth dome-shaped protoconch of $1\frac{1}{2}$ whorls. Spire less than height of aperture. Spire whorls with a subsutural fold and furrow and two median spiral incised lines. Body-whorl with an additional spiral line proceeding from the suture and four more on the upper part of the base. A rather closely spaced group of four rounded spiral cords on the neck separate the body-whorl from the smooth fasciole. Columellar plaits four, upper three strong, lower one weak and very oblique.

Colour buff, with three broad white spiral zones on the body-whorl, each with a colour pattern of yellowish-brown arcuate to chevron-shaped narrow axial lines.

Height, 5 mm.; diameter, 2.75 mm. (holotype).

Locality: Off Spirits Bay, Northland, 30 fathoms (type); Discovery II St. 933, off Three Kings Islands, 260 metres.

The species is more ovate and inflated and has much weaker axial sculpture than either *biconica* Murdoch and Suter, 1906, or *cuvierensis* Finlay, 1930.

Holotype presented to the Auckland Museum by the writer.

Family MARGINELLIDAE

Very few of the large number of species ascribed to this family are known anatomically. This fact, coupled with an almost general lack of sculptural features in the shell, has induced either a conventional lumping of species in the type genus or their assignment to a few genera or subgenera, often quite inappropriately.

Habe, 1951, in "Illustrated Catalogue of Japanese Shells" (No. 16, pp. 101-107), proposed three new generic names for Japanese groups and these seem to be represented in Australian and New Zealand waters. They are *Volvarinella* Habe, 1951, type. *V. makiyamai* Habe, *Kogomea* Habe, 1951, type. *Marginella novemprovincialis* (Yokoyama) and *Microvulina* Habe, 1951, type. *M. nipponica* Habe. Habe also used *Volvarina* generically. However, since most of the species are based solely on shell characters it would seem safer for the present to assign subgeneric rather than generic status to the groups.

The acceptance of Habe's new names would involve the following changes in the New Zealand Recent faunal list:

Subgenus *Volvarinella* for *amoena* Suter, 1908; *aoteana* Powell, 1932; *cairoma* Brookes, 1924; *fusula* Murdoch and Suter, 1906; *hebescens* Murdoch and Suter, 1906; *lurida* Suter, 1908; *stewartiana* Suter, 1908; *subfusula* Powell, 1932 and possibly *subamoena* Powell, 1937. Subgenus *Microvulina* for *angasi* Crosse, 1870. Subgenus *Kogomea* for *Gibberula ficula* (Murdoch and Suter, 1906).

Family CANCELLARIIDAE

Zeadmete barkeri n. sp. **Pl. 36, fig. 1.**

Shell nearer to the Castlecliffian (Upper Pliocene) *pliocenica* Finlay, 1930, than to *trailli* Hutton, 1873. It resembles *pliocenica* in being shouldered, in having the spiral cords of the spire-whorls stronger and more openly spaced and the pillar plaits much weaker and more oblique than in *trailli*. It differs from *pliocenica* in having only subobsolete axials, which render the upper spiral cords of the spire whorls weakly crenulate but not gemmate, in the narrower and less distinct shoulder and in the more broadly ovate outline to the whole shell.

In *trailli* the shell is more obese than either *pliocenica* or *barkeri*, not shouldered, the spiral cords are closer, linear spaced, the aperture wider and relatively shorter and the pillar plaits very strong.

Shell small, ovate, dull white, sculptured with revolving series of flat-topped cords, four primary ones on spire whorls increasing to six on the penultimate, three more on the upper part of the base followed by about eleven linear-spaced, rounded cords, on the lower half of the base. Spire about equal to height of aperture.

Height, 8.8 mm; diameter, 4.75 mm. (holotype).

Locality: Off Mayor Island, 35 fathoms.

Holotype: Presented to the Auckland Museum by Mr. G. W. Barker.

Family DIAPHANIDAE

Austrodiaphana maunganuica n. sp. Pl. 36, fig. 7.

Shell small, thin, squat, ovate-cylindrical with flat spire and sharply carinated shoulder having a weak concavity immediately below it. Whorls $3\frac{1}{2}$, the small, smooth, globular protoconch scarcely visible above the level of the shoulder. Aperture narrow above and expanded below. Columella thin, separated from body-whorl by a long, deep, crescentic umbilicus. Sculptured with about 18 subobsolete spiral lirae and more distinct but irregular axial growth lines. Colour pale yellowish-brown with two narrow colourless spiral zones, one immediately below the shoulder and the other about the middle of the body-whorl. The columella and umbilicus are colourless also. One specimen has the addition of a darker-brown line margining the lower side of each clear zone.

Height, 2.1 mm.; diameter, 1.45 mm.

Locality: $2\frac{1}{2}$ miles north of Mount Maunganui, Bay of Plenty, from stomach of a tarakihi, *Dactylopagrus macropterus* (Forster), taken in 18 fathoms (Mr. Gordon Williams, April, 1948) (type); off Hen and Chickens Islands, 25 fathoms (Finlay coll., Auckland Museum).

Holotype: Presented to the Auckland Museum by Mr. Gordon Williams.

The species is smaller and narrower than *colei* Fleming, 1948, from Fiordland, the only other New Zealand member of the genus so far described. A conspicuous difference is in the form of the umbilicus, which is short in *colei* but long in *maunganuica*. Also there is a weak shoulder constriction in *maunganuica*, but it is not nearly so pronounced as in the Australian genotype *brazieri* Angas.

The small paratype of *colei* is about the size of *maunganuica* but the differentiating characteristics are still apparent.

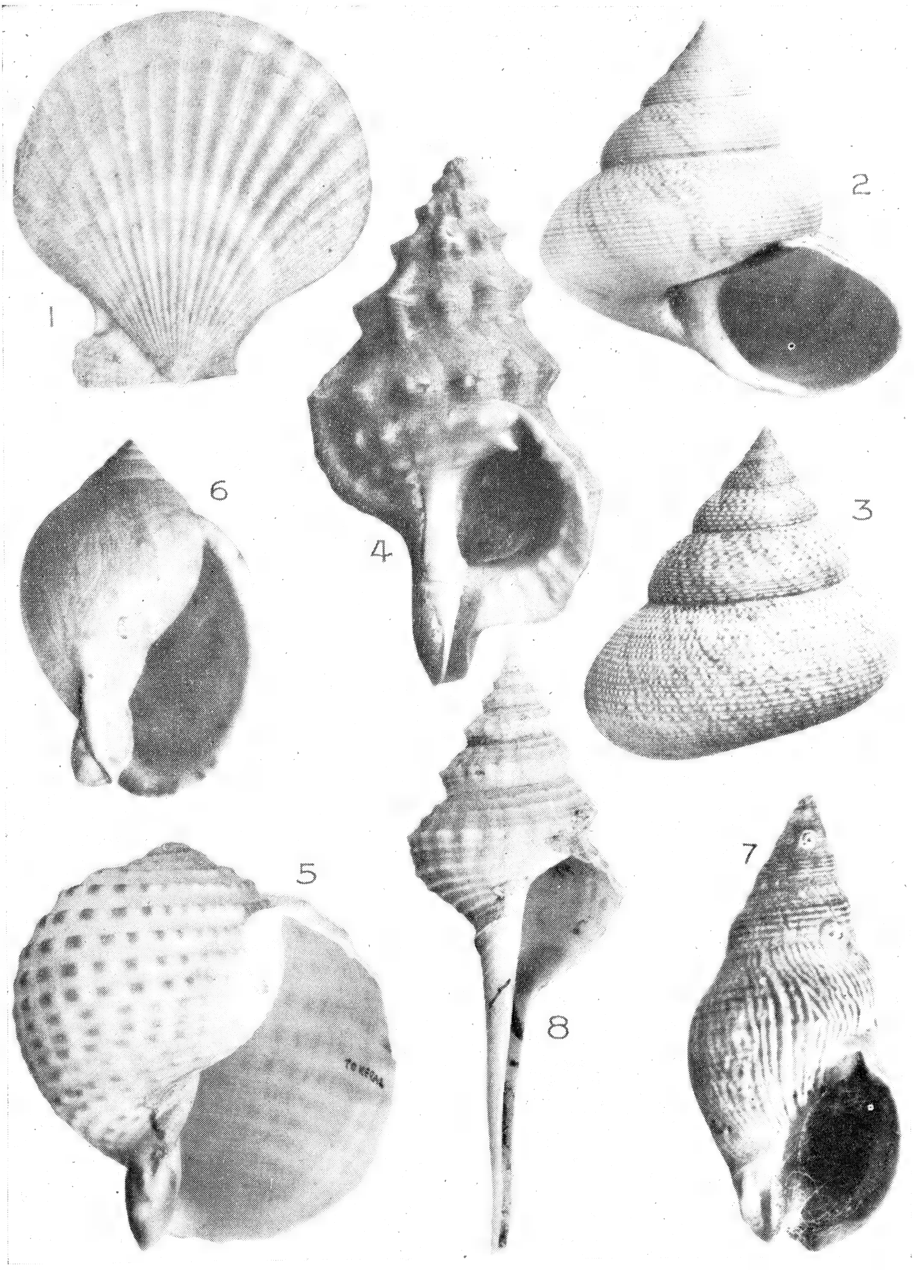

Fig. 1. *Chlamys (Mimachlamys) taiaroa* n. sp. Holotype 43 x 42 mm.

Figs. 2 and 3. *Venustas punctulata multigemmata* n. subsp. Holotype (Fig. 2), 54 x 50 mm.

Fig. 4. *Mayena australasia vossi* n. subsp. Holotype, 81.5 x 83 mm.

Fig. 5. *Tonna dolium Linnaeus*, 83 x 73 mm.

Fig. 6. *Xenophalium (Xenogalea) matai* n. sp. Holotype, 45.5 x 31 mm.

Fig. 7. *Cominella virgata brookesi* n. sp. Holotype, 32.5 x 17 mm.

Fig. 8. *Coluzea mariae* n. sp. Holotype, 81 x 21.5 mm.

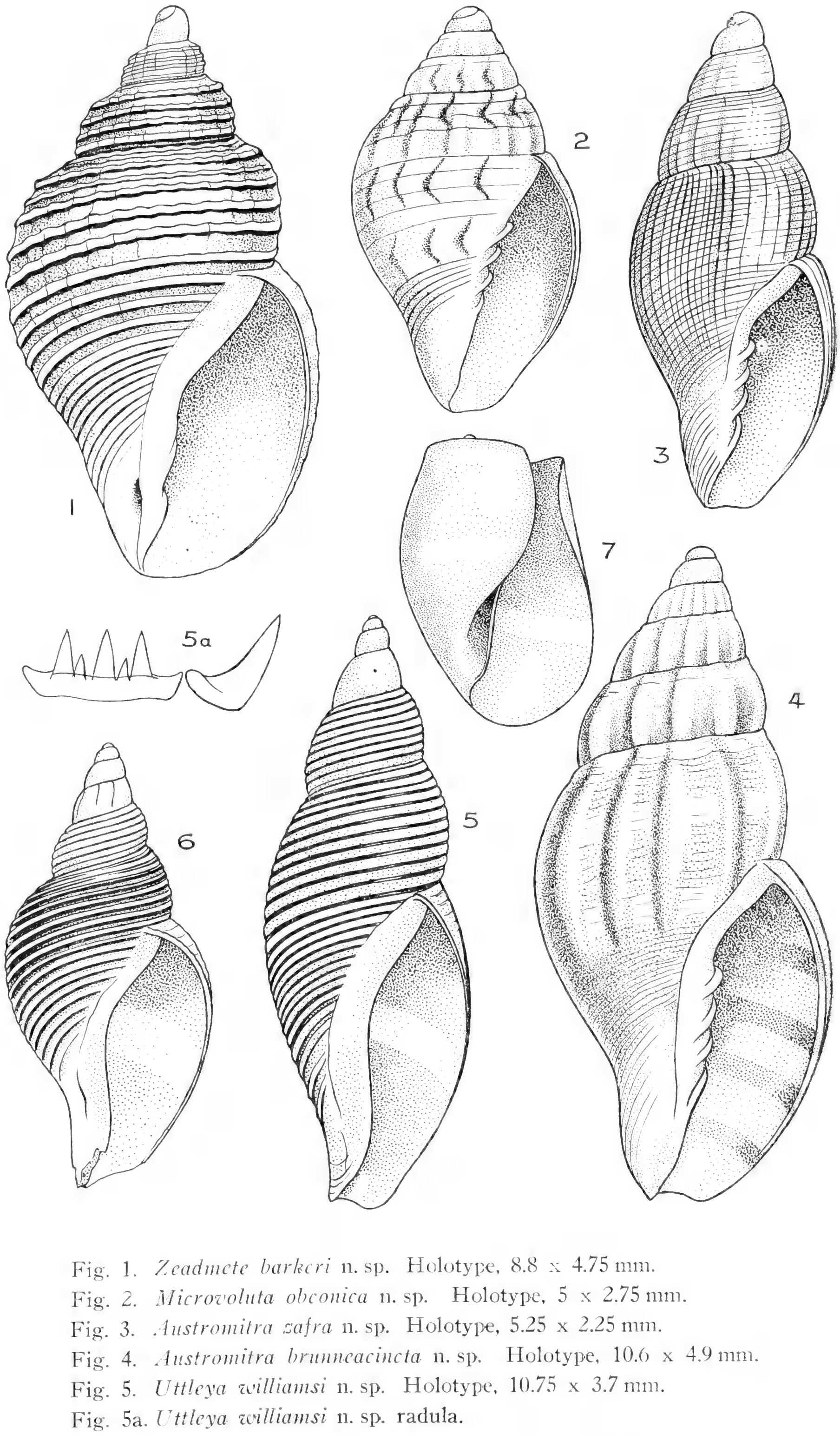

Fig. 1. *Zeadmete barkeri* n. sp. Holotype, 8.8 x 4.75 mm.
Fig. 2. *Microvoluta obconica* n. sp. Holotype, 5 x 2.75 mm.
Fig. 3. *Austromitra zafra* n. sp. Holotype, 5.25 x 2.25 mm.
Fig. 4. *Austromitra brunneacincta* n. sp. Holotype, 10.6 x 4.9 mm.
Fig. 5. *Uttleya williamsi* n. sp. Holotype, 10.75 x 3.7 mm.
Fig. 5a. *Uttleya williamsi* n. sp. radula.
Fig. 6. *Uttleya marwicki* n. sp. (Holotype) 8.1 x 3.6 mm.
Fig. 7. *Austrodiaphana maunganuica* n. sp. Holotype, 2.1 x 1.45 mm.

Some Stray Tropical and Sub-Tropical Sea Birds in New Zealand.

By E. G. TURBOTT, Auckland Museum.

Fregata minor (Gm.) (greater frigate bird).

The only New Zealand specimen in the Auckland Museum is one which was included amongst records of *Fregata ariel* by Oliver (1930), and had been incorrectly assigned to that species in the collection. It has the following data: A.M. 111.1, female, collected at Lake Kimihia (near Huntly, Waikato district), in 1911, by G. Clinch. The specimen was mounted in flight. It is in adult plumage with characteristic grey throat and foreneck. Dimensions are as follows: wing 583, tail 413, tarsus 20, middle toe 67, culmen 98 mm.

Fregata ariel (G. R. Gray) (lesser frigate bird).

One record only of a specimen of the lesser frigate bird from New Zealand in the Auckland Museum collections is given by Oliver (1930), that of an adult female obtained at Pahi, on the Kaipara Harbour, on 30th March, 1907. Cheeseman (1908) gives details of the capture of this specimen, which was found on the farm of Mr. G. V. New. It was apparently almost exhausted when captured and died a few days later. The locality is about half-way between the east and west coasts and the distance in a direct line from the sea (a little overestimated by Cheeseman) is 15-20 miles. In this specimen, as noted by Cheeseman, the collar on the hind neck is white, mottled with dark brown, without trace of rufous. A few scattered feathers form the only rufous coloration on the breast.

A second specimen was obtained in March, 1918, when it was blown ashore during a heavy gale. This was a female and the locality recorded was Auckland. It is in immature plumage, and the only rufous coloration on the white areas is a faint wash on the crown and nape. A mottling of dark brown appears on the forehead and crown. On the underparts, an irregular band of greyish brown extends across the belly from the flanks.

The third specimen obtained was an adult male, in brilliantly iridescent plumage, found dead at Panmure, near Auckland, on 7th June, 1922, by N. Freebairn. It was mounted, as in the case of the two specimens above, being shown with the bright throat sac partly inflated.

In March, 1936, the partial remains of another specimen were found at Te Kuiti, approximately 100 miles to the south of Auckland, and 25 miles inland. This was a female, and in immature plumage.

A recent example, and the fifth from New Zealand in the Auckland Museum, was received from the caretaker of Little Barrier Island, Mr. C. H. Parkin, who discovered the bird exhausted on the ground near the homestead on 4th March, 1951. Shortly afterwards Mr. Parkin disturbed a harrier in the act of carrying it off, but was able to save the specimen. It had apparently died before being attacked and was still undamaged. The specimen is an adult female. It is in process of moult, and numerous fresh feathers are to be seen coming out of the sheaths on neck, mantle and belly. Where the new plumage has already appeared it is iridescent, especially the lanceolate feathers of the head and back which have a strong greenish and purplish sheen; and wings and tail are distinctly iridescent. Compared with this specimen, the adult female from Pahi previously mentioned is in duller plumage; it is faintly iridescent on the lower back, wings, tail and head, and has a patch of worn brown feathers on the back immediately below the hind neck. There is a much greater amount of rufous coloration on the white areas in the present specimen, forming an irregular wash on the underparts; the collar round the hind neck is mottled white and dark brown mid-dorsally, and the feathers are chestnut at the tips. The wing spread of this specimen was approximately 5ft. 9in. (175 cm.).

The following are observations from several informants which record the movements apparently of the same bird during the previous day, 3rd March. The bird was seen at noon at Laingholm, on the north shore of the Manukau Harbour, near Auckland, by Mr. E. D. Willis. A sketch of the bird in flight made by Mr. Willis shows the forked tail, the distinctive shape of the bill and white ventral area. It was seen a second time at 4 p.m. near South Head, Kaipara Harbour, by Messrs. B. Roy and J. B. Herman, who noted the same distinguishing characters, and believed that it was a frigate bird. It flew in to rest on a tree, perching on a broken limb and remaining for three-quarters of an hour, and appeared to be weak or sick. The wing spread was estimated at 5-6 feet, and the reddish legs were noted. The distance from Laingholm to South Head, Kaipara Harbour, is approximately 45 miles in a N.W. direction, and Little Barrier Island, where it was found by Mr. Parkin, lies about 50 miles E.N.E. of South Head.

This frigate bird was undoubtedly brought to New Zealand by the particularly severe cyclonic storm experienced in the North Auckland and Auckland districts from 27th February-1st March, 1951. It is of interest that a similar occurrence was recorded in Australia, a frigate bird of unknown species being seen near Sydney on 13th March, 1951, shortly after a period of severe weather (Marshall, 1951). An account of some other occurrences of storm-driven sea birds in eastern Australia in relation to cyclones is given by Goddard and Hindwood (1951).

The following are the dimensions of the above specimens of *F. ariel*:—

A.M. 112.1: Pahi; wing 525, tail 315, tarsus 18, toe 57, culmen 92 mm.
A.M. 112.2: Auckland; wing 520, tail 315, tarsus 17, toe 58, culmen 86 mm.
A.M. 112.4: Panmure; wing 545, tail 343, tarsus 16, toe 61, culmen 85.5 mm.
A.M. 112.5: Te Kuiti; culmen 90 mm.
A.M. 112.6: Little Barrier I.; wing 525, tail 335, tarsus 17, toe 61.5, culmen 88.5 mm.

Observation of Fregata minor. The writer is indebted to Mr. H. R. McKenzie, of Clevedon, for information on a frigate bird observed at Kawakawa Bay, Clevedon, on 18th February, 1951. The observations were made by Mr. J. G. Moffat, who saw the bird from a boat offshore closely enough to give details of its plumage which suggest that it was an adult female *F. minor*. The underparts were white, and region of the throat and foreneck white or grey, but not black as in the adult female *F. ariel*. There had been strong winds from the N.E. for several days before the bird was observed. It forms an addition to several recent field records (from Masterton, August, 1949; Tauranga, May, 1950; Whangarei, June, 1950), all apparently having been adult females of *F. minor* (Stidolph; Davenport; Turbott: 1950).

Sterna bergii Licht. (crested tern).

A specimen in immature plumage from Sunday Island, Kermadecs, is listed by Oliver (1930). In addition, the Museum has the dried remains of an adult picked up by H. R. McKenzie on the beach at Kapo Wairua, at the eastern extremity of Spirits Bay, on 25th March, 1951 (McKenzie, 1952). Dimensions of the two specimens are:—

A.M. 138.1: Sunday Island; male; wing 320, tail 138, tarsus 27, toe 33, culmen 57 mm. (1st April, 1910.)

A.M. 138.9: Spirits Bay: tail (worn) 166 approx., tarsus 27, toe 32, culmen 61.5 mm. (25th March, 1951.)

Portions of the plumage of head, back, tail and the upper coverts of one wing are still attached to the specimen found at Spirits Bay, showing that it was in breeding plumage: the crown is black, lower back and wing coverts uniform dark grey and bill yellow with a dark area at the base. The flight feathers are missing from both wings. The coloration of the lower back and wing coverts is of a dark grey shade, corresponding closely to the only example of *Sterna bergii cristata* Stephens* in the Auckland Museum collection (A.M. 138.2: Cronulla Reef, Sydney). Unfortunately the wing length is not available, but it is close to this specimen in other dimensions. The distribution of *cristata* is from the Malay Peninsula and the Riu Kiu Islands to Australia and the central Pacific.

It is presumed that the immature specimen from Sunday Island also belongs to this subspecies: the head is dark brown mottled with white on the crown; back and median wing coverts pale grey, some feathers faintly washed with brown; lesser wing coverts darker grey; secondaries and scapulars, on outer webs, dark brown; outer tail feathers (old) dark brown, inner tail feathers (new) grey; four outer primaries (old) dark brown, inner primaries (new) silver-grey; outermost primary short; neck and underparts white.

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* cf. Peters, "Checklist of Birds of the World," II (1934); also Whittell and Serventy, "A Systematic List of the Birds of Western Australia" (1948), who consider that *S.b. gwendolenae* Mathews (Rockingham, Western Australia) is of unsatisfactory status.

Sterna fuscata L. (sooty tern).

A specimen from Waitomo Caves, near Te Kuiti, in the Auckland Museum is recorded by Oliver (1930). The following data on the specimen are available: A.M. 87.1, male, collected near the Waitomo Caves, after the cyclonic storm of March, 1918, by H. F. Smith. It is in adult plumage, measurements being: wing 298, tail 194, tarsus 23, toe 27, culmen 42.6 mm.

The three following specimens in immature plumage have also been obtained:—

A.M. 87.65: Tauranga, approximately 5th February, 1936. Measurements: wing 284, tail 117, tarsus 23, toe 27, culmen 38.7 mm. There are well marked pale tips on the feathers of the back and wing coverts, and the tail feathers.

A.M. 87.64: Manurewa, near Auckland, picked up after a northerly gale, on 26th March, 1936. Measurements: wing 280, tail 119, tarsus 23, toe 25, culmen 38.8 mm. Only a few white tips on the upper parts; tail much worn, new tail feathers and coverts appearing.

A.M. 87.66: New Plymouth, on the beach near the Waiwhakaiho River, 4th March, 1951. Only the tail and one foot of this specimen were saved, the remainder being destroyed subsequently by dogs. Dimensions are as follows: tail 115, tarsus 22, toe 30 mm.

Notes were made by the finder, Mr. M. J. S. Black, and include the following details: the whole upper surface blackish brown, with lighter flecking on mantle and wing coverts; primary feathers sooty black; foreneck and breast brown; abdomen and under tail coverts greyish white; length of bill approximately 47 mm., wing approximately 295 mm.

Information on another specimen, apparently in transitional plumage from juvenal (or post-juvenal) to adult, has been made available by Dr. C. A. Fleming, who found it on Muriwai Beach, west of Auckland, on 7th February, 1936.* The specimen was apparently placed in the Auckland Museum, but unfortunately cannot now be traced. Accordingly, the following detailed description is recorded (notes by C. A. Fleming): *S. fuscata;* young; much decayed and sex not determined; wing 290, tail 145, bill 41, tarsus 24.5 mm.; forehead white; head, crown black; hind neck and general upper surface sooty black,

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* This specimen, and the specimen from Tauranga (A.M. 87.65), were found after the cyclonic storm on 1st-2nd February, 1936. Two additional reports of birds blown ashore during the storm were received by R. A. Falla, who included all the records in nature notes in *The New Zealand Herald,* 7th March, 1936: they were a sooty tern, found at Te Awamutu (80 miles south of Auckland), and a red-tailed tropic bird (*Phaethon rubricauda* Bodd.) at Taupo. The storm was the most severe which had been experienced in New Zealand since March, 1918, when the specimens mentioned above of the lesser frigate bird and sooty tern were obtained.

with most feathers margined with white; wings sooty black above, marginal coverts, primaries and secondaries sooty black, grey beneath, white quills, under coverts white; tail coverts black above, grey beneath, white quills; streamers white-quilled above, inner margin whitish becoming sooty towards tips, outer margins grey and sooty, darker at extremity; bill and feet black. Notes.—Differs from juvenal plumage in that the white parts of the adult are present; dark parts sooty black like the adult. Differs from adult (breeding) in having white tips to body feathers, and grey streamers.

Procelsterna cerulea albivitta Bonap.* (grey noddy).

Buller (1888) in recording the specimen which he obtained in the early months of 1882 from Cape Maria van Diemen gives notes from the collector, C. H. Robson. The specimen was found exhausted on shore after a heavy S.W. gale; and the same informant stated that another was "observed on the wing, one very calm day."

It has been observed to the west of New Zealand by Cunningham (1950). Two birds were seen at sea about 300 miles from North Cape en route from Sydney to Auckland on 16th October, 1949.

On 16th January, 1951, on the return voyage from the Three Kings Islands, the writer closely observed a flock of four grey noddies. This was close inshore off Cape Karikari, to the north of Doubtless Bay, North Auckland. The birds remained near the vessel for half an hour, either flying overhead or circling widely at no great distance, once coming down to rest on the sea. The white under wing coverts were clearly seen. The weather was calm, with settled conditions for some time previously.

Some further observations of interest were made to the south of the Kermadec Islands when the writer accompanied the Danish "Galathea" Deep Sea Expedition in February, 1952. A single grey noddy was first seen on 13th February, and two on the following day at a distance of approximately 350 miles south of Sunday Island, Kermadecs, and 340 miles E.N.E. of Auckland. (The position was roughly 35° 20′ S, 178° 50′ W.) A single bird was again seen on both 19th and 20th February, when the "Galathea" was again in nearly the same position. The weather during this and the preceding period was almost continuously settled.

There is some indication in these observations that this non-migratory species wanders fairly widely, on occasions at least, away from the immediate neighbourhood of the breeding stations, and possibly also is a fairly regular visitor to northern New Zealand.

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* Trinomial follows Peters, "Checklist of Birds of the World," II (1934). The birds observed were identified as "grey" and not "blue-grey" noddies, and are presumed to belong to this subspecies (distribution, Friendly and Kermadec Islands, Lord Howe Island, Norfolk Island). It is unlikely that the Easter I. or St. Ambrose I. (Chile) subspecies would reach this area.

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The Torehine Beds of Coromandel Peninsula

By R. N. BROTHERS, Auckland University College, and
A. P. MASON, Auckland Museum.

Abstract.

Microfaunal evidence indicates that the Torehine Beds of Coromandel Peninsula are Waitakian-Duntroonian in age. This determination assists in limiting the age of the First Period Volcanics of the area.

INTRODUCTION.

Because of the economic importance of its goldfields, Coromandel Peninsula was the subject of many geological reports in the period 1870-1910. The scattered outcrops of Tertiary sediments in the northern portion of the peninsula were first examined in detail by McKay (1886), and his report formed the basis of later accounts given by Park (1897) and McKay (1897). Fraser and Adams (1907) gave a detailed description of the beds, grouping them as the Torehine Series which, on the basis of earlier accounts by Park (1897) and MacLaren (1900), they regarded as Lower Eocene in age. Since the publication of Fraser and Adams' account the Torehine Beds have received no attention in geological literature.

One of the present authors visited several of the outcrops in 1946 in the company of Dr. B. H. Mason and it was then thought worthwhile to examine the beds in the light of the modern standard Tertiary subdivision. A further visit was made by the writers in 1951 and the opportunity was taken to collect systematically from the several beds. It is apparent from the accounts given by previous workers that the beds were formerly far better exposed than they are today and, in common with most of the later authors, the writers can add little to McKay's original (1886) description.

In the course of the present survey the following localities were visited:—

(a) Torehina (= Torehine of earlier writers) 1 mile north of Amodeo Bay.

(b) Cutting on main road 300 yards south of Tawhetarangi Creek, Amodeo Bay.

(c) Valley of Umangawha Stream, $1\frac{3}{4}$ miles east of Torehina (= "west branch of the Umangawha River" of McKay, 1886, and "Branch Creek" of Fraser and Adams, 1907).

(d) Coast $1\frac{1}{4}$ miles east of Cape Colville.

In addition, samples for microfaunal study were collected from a cutting on the main road 1 mile east of Torehina.

STRATIGRAPHY.

The basal beds are "coal measures" which are best exposed in a cutting on the main road 300 yards south of Tawhetarangi Creek. Here the succession in descending sequence is as follows:—

(6) Dark sulphurous mudstone (at least 10 feet thick).

(5) Coarse sandstone with impure coaly bands (5 feet).

(4) Light-coloured sandy shales with plant remains (5 feet).

(3) Greywacke conglomerate (5 feet).

(2) Light-coloured shales similar to (4).

(1) Pre-Tertiary basement (Manaia Hill Series).

At this locality the beds are intersected by an andesite dyke and also by a minor fault.

The most nearly complete section of the beds is that exposed at Torehina. The succession, as given by Fraser and Adams (1907, p. 55), is:—

Coralline limestone with foraminifera (top).

Calcareous sandstone.

Marly sandstone.

Sandy shales with carbonaceous material.

Conglomerates.

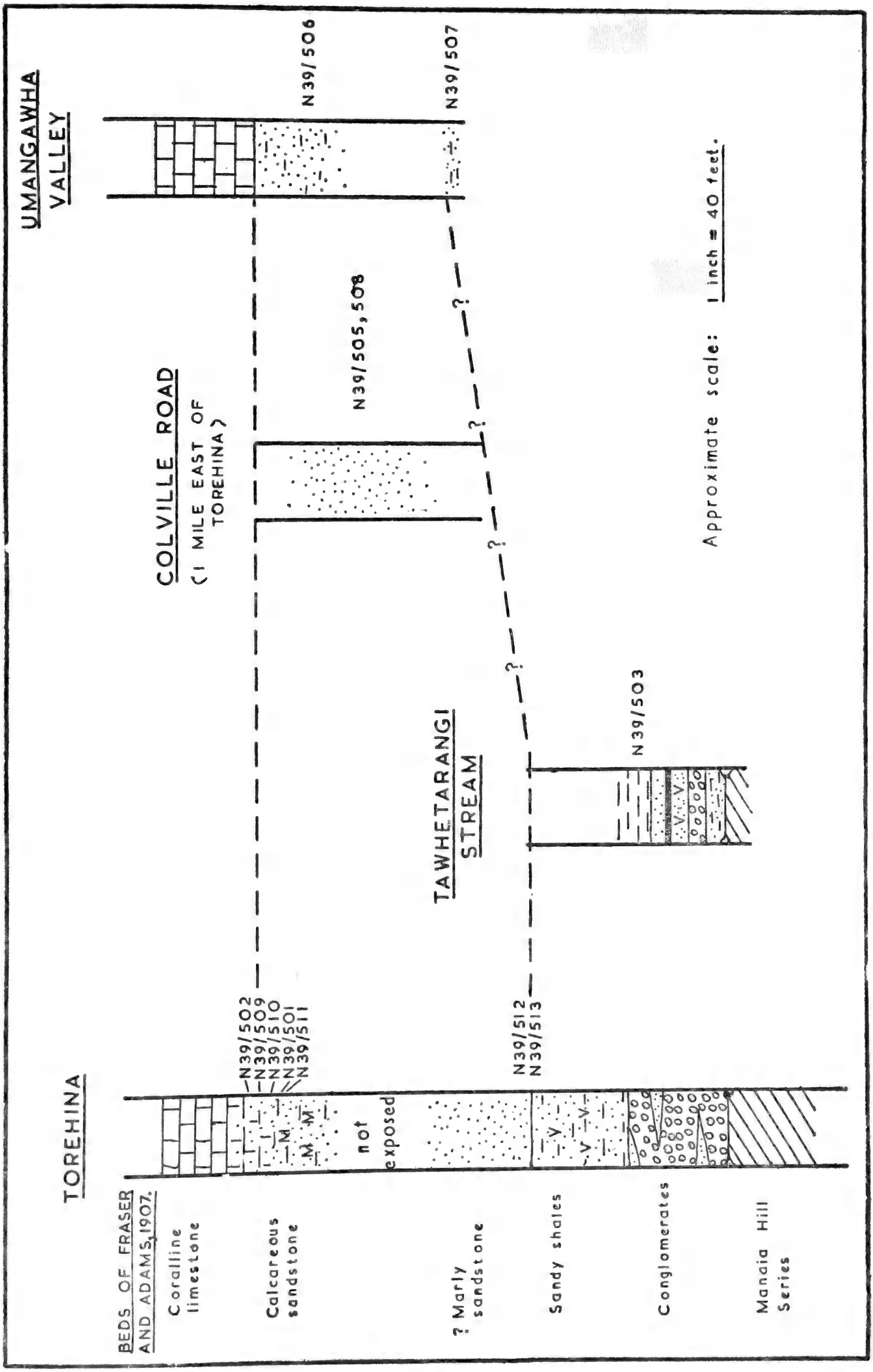
(Readers are referred to Fraser and Adams, *loc. cit.*, for a more detailed account of the succession.)

The conglomerates are intraformational and consist mainly of fragments of the sandy shales, although greywacke pebbles are more abundant towards the upper limit. They rest unconformably on the upturned beds of the Manaia Hill Series (Fig. 1), and together with the sandy shales are equivalent to the beds exposed south of Tawhetarangi Creek. The marly sandstone is now poorly exposed, being represented only by weathered outcrops at the back of Torehina Beach. The next point north of Torehina consists of a glauconitic shelly limestone ("coralline limestone") which grades downwards into a fossiliferous calcareous sandstone.

At Torehina the main road to Colville turns inland and climbs over the divide into the valley of Umangawha Stream. Towards the summit of the road a blue-grey medium sandstone which is probably equivalent to the fossiliferous calcareous sandstone at Torehina is exposed in the road cuttings.

The section in the valley of Umangawha Stream is obscure, but both the limestone and the calcareous sandstone can be recognised. Some distance below these is a dark, carbonaceous mudstone which possibly represents the basal beds of the coastal section.

The outcrop near Cape Colville is restricted to a cliff face approximately 50 yards in width. Fraser and Adams (1907, p. 58) give the following succession:—



Text—fig. 1. Stratigraphic columns of outcrops of Torehine Beds.

Sandstones and mudstones (top).

Shelly conglomerate (2 feet to 3 feet), marly sandstone (10 feet), shelly conglomerate (1 foot).

Marly sandstone (15 feet to 20 feet).

Shelly conglomerate (20 feet), (highly fossiliferous).

The authors were unable to distinguish all the beds mentioned by Fraser and Adams and it appears that the vigorous wave erosion at this locality has greatly altered the exposure during the last 40 years. There was no trace of the basal "highly fossiliferous" conglomerate and the two samples collected for microfaunal study proved barren. The beds are lithologically dissimilar to those at Torehina.

AGE AND CORRELATION.

Both in 1946 and 1951 samples were collected for foraminiferal study. The stratigraphic positions of the samples collected are shown in Text—fig. 1, and the writers are indebted to the late Dr. H. J. Finlay and Mr. N. de B. Hornibrook, of the New Zealand Geological Survey, for the following age determinations:—

Locality.	Sheet Sample No.	Grid Reference.	Age.
Torehina	N39/f501	946834	Waitakian-Duntroonian
,,	N39/f502	,,	No fauna
,,	N39/f509	,,	? Duntroonian
,,	N39/f510	,,	Waitakian-Duntroonian
,,	N39/f511	,,	,, ,,
,,	N39/f512	946833	,, ,,
,,	N39/f513	,,	,, ,,
Tawhetarangi Creek	N39/f503	943823	No fauna
Colville Road	N39/f505	964832	Waitakian-Duntroonian
,, ,,	N39/f508	,,	No fauna
Umangawha Valley	N39/f506	976830	Duntroonian
,, ,,	N39/f507	976829	? Duntroonian

Thus the foraminiferal faunas indicate a Waitakian-Duntroonian age for the Torehine Beds at and near Torehina. The lithologically distinct beds at Cape Colville could well be of different age.

The Torehine Beds may be correlated with the younger members of the Whangarei Group of North Auckland. Marshall (1916, pp. 89 and 93) remarked on the lithological resemblance between the Whangarei Limestone and the crystalline limestone of the Torehine Beds.

MINERALOGICAL ASPECTS OF THE TOREHINE BEDS.

A qualitative check was made on the non-opaque, heavy mineral content of sandstone samples from localities (a), (c), and (d) above. In all samples the heavy mineral suites were limited in their content, the few species present being the more stable ones that are typical of the greywacke undermass. These are apatite, brown biotite, garnet, titanite, green tourmaline and zircon. One grain of common augite was located, but a source for this may be found in tuffaceous facies of the greywacke. The general absence of ortho- and clino-pyroxene confirms the position of the Torehine Beds as antedating the main effusion of andesite.

Following a discussion of the evidence available, Fraser and Adams (1907, p. 89) assign a pre-Jurassic age to the diorite that intrudes the Moehau Series (pre-Jurassic) on the west flank of Moehau Range. The lack of hornblende in the Torehine sediments suggests that this diorite was not exposed to erosion in Waitakian-Duntroonian times but was still contained by the pre-Tertiary country rock. This view is strengthened by the fact that diorite pebbles are absent from the basal conglomerate.

DISCUSSION.

In Coromandel Subdivision, the First Period Volcanics rest unconformably on the Torehine Beds, which are now known to be of Landon age and are, in turn, covered unconformably by volcanic rocks of the Second Period. Plant microfossils from Second Period rocks of Great Barrier Island indicate an Upper Taranakian or Lower Wanganuian age (Couper, 1953). The First Period Volcanics, therefore, are either Pareoran or Southlandian.

ACKNOWLEDGMENTS.

The writers desire to thank Dr. B. H. Mason for permission to use information obtained during the 1946 visit to the beds. They are also indebted to the late Dr. H. J. Finlay and Mr. N. de B. Hornibrook, of the New Zealand Geological Survey, for examination of microfaunal samples.

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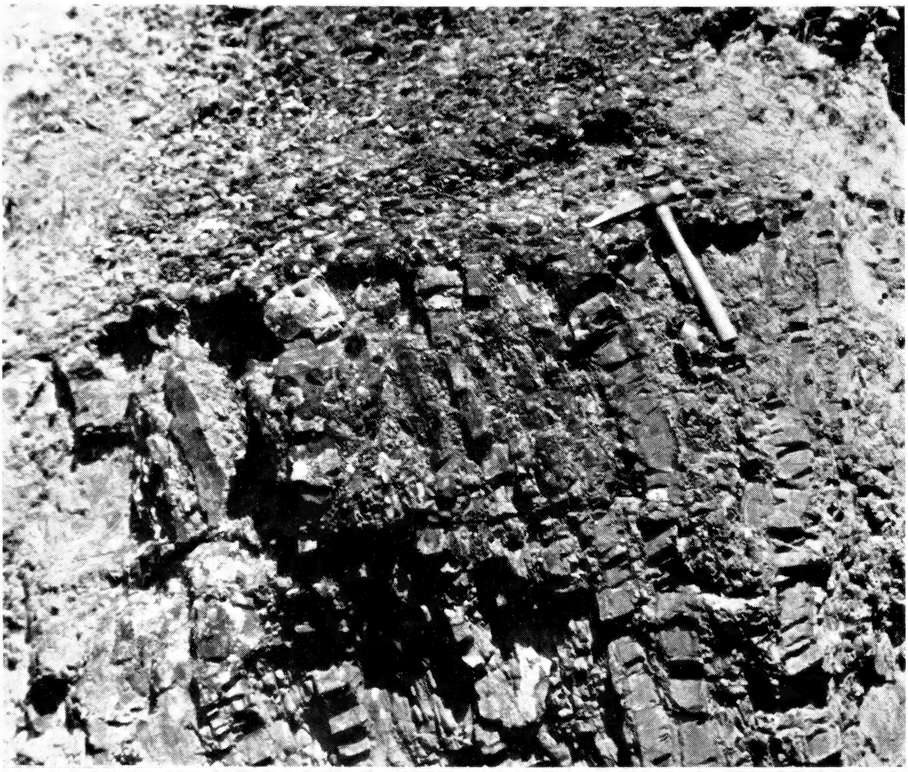

Fig. 1. Angular unconformity between Manaia Hill Series (Jurassic) and Torehine Beds (mid-Tertiary); coast at Torehina.

Fig. 2. Crystalline limestone; valley of Umangawha Stream.

Algae of The Three Kings Islands, New Zealand

By V. J. CHAPMAN, Auckland University College.

At the end of 1952 and the beginning of 1953 an expedition from the Auckland Museum visited the Three Kings group of Islands. Mr. J. Edwards, a member of the expedition, collected algae from various places, and these were handed to the present author for identification. The marine algae were generally those that are to be found on rocky coasts elsewhere in the Auckland Province (Chapman, 1950; Chapman and Beveridge, 1950; Dellow, 1950; Carnahan, 1952). There were, however, two outstanding items in the collection. The first was a new species of brown alga allied to *Sporochnus* with unusual features intermediate between typical *Sporochnus* species and the genus *Bellotia*. The other was a new species of the genus *Grateloupia*, which will be described in a separate communication by Miss J. Trevarthen. The new records suggest that a more detailed study of the north coast of the North Island should be very profitable.

General collection, S.E. Bay, Great Island, 8th January, 1953:

Chlorophyceae

Ulva sp. (sporelings only).

Cladophoropsis herpestica (Mont.) Kuetz.

Caulerpa sedoides (R. Br.) C. Ag.

Phaeophyceae

Ecklonia radiata (C. Ag.) J. Ag.

Xiphophora chondrophylla (R. Br.) Mont. var. *minus* J. Ag.

Halopteris hordacea (Harv.) Sauv.

Perithalia capillaris J. Ag.

Sargassum verruculosum (Mert.) J. Ag.

Sargassum sp. (material not sufficient for identification. Mr. Lindauer has had the same material from the north but never in a state to permit of identification—personal communication).

Rhodophyceae

Caulacanthus spinellus (Hook. f. et Harv.) Kuetz.

Gelidium caulacantheum J. Ag.

Pterocladia lucida (R. Br.) J. Ag.

Vidalia colensoi (Hook. f. et Harv.).

Rec. Auck. Inst. Mus. Vol. 4, No. 4, pp. 199-204, 12th February, 1954

Phacelocarpus labillardieri (Mert.) J. Ag.
Melanthalia abscissa (Turn.) Hook. f. et Harv.
Corallina gracilis Lam. var. *lycopodioides* Taylor.
Lithothamnion sp. (not fruiting).
Bostrychia arbuscula Hook. f. et Harv.
Ballia callitricha (C. Ag.) Mont.
Laurencia sp. (very young, possibly *L. thrysifera*).
Lophosiphonia macra (Hook. f. et Harv.) Fkbg.
Polysiphonia sp. (*corymbifera?*) 12-14 siphons.

Our knowledge of the New Zealand species of Polysiphonia is not sufficient for accurate identification. *P. corymbifera* C. Ag. is the only species recorded for New Zealand with this number of siphons.

General collection, N.W. Bay, Great Island, 8th January, 1953:

Chlorophyceae

Caulerpa sedoides (R. Br.) C. Ag.

Phaeophyceae

Perisporochnus regalis n. sp.
Carpophyllum plumosum (A. Rich.) J. Ag.
Carpophyllum maschalocarpum (Turn.) Grev.
Xiphophora chondrophylla (R. Br.) Mont. var. *minus* J. Ag.
Sargassum sinclairii Hook. f. et Harv.
Sargassum undulatum J. Ag.
Sargassum verruculosum (Mert.) J. Ag.
Landsburgia quercifolia Hook f. et Harv.

Rhodophyceae

Porphyra columbina Mont.
Nemastoma oligarthra (J. Ag.) Kylin.
Grateloupia sp. nov*
Grateloupia fastigiata J. Ag.
Corallina gracilis Lamour.
Calophyllis hombroniana (Mont.) Kuetz.
Gigartina circumcincta J. Ag.
Gymnogongrus nodiferus (C. Ag.) J. Ag.
Laurencia sp. (young).

South East Bay, Great Island, 7th January, 1953. (Two collections.):

Chlorophyceae

Ulva sp. (sporelings).

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* To be described separately.

Rhodophyceae

Gelidium pusillum (Stackl.) Le Jol.
Gelidium pseudointricatum Skottsb. et Leur.
Catenella fusiformis J. Ag.
Laurencia thrysifera? J. Ag. (denuded).
Bostrychia arbuscula Hook. f. et Harv.

North West Bay, Great Island, *Corallina* zone, 5th January, 1953:

Chlorophyceae

Ulva sp. (sporelings).

Rhodophyceae

Corallina gracilis Lamour.
Nemastoma oligarthra J. Ag.
Grateloupia sp. nov.
Laurencia thrysifera J. Ag. (?) denuded.

South East Bay, Great Island, 7th January, 1953:

Myxophyceae

Calothrix confervicola (Roth.) Ag.

Chlorophyceae

Rama longiarticulata (J. Ag.) Chapman (see Chapman, 1951).

Rhodophyceae

Gelidium pusillum (Stackl.) Le Jol.
Catenella nipae Zanard.
Bostrychia arbuscula Hook f. et Harv.

Tasman Stream (fresh water), Great Island. Collections 30th December, 1952, and 5th January, 1953:

**Oedogonium* sp. (not fruiting).
Spirogyra sp. (not fruiting).
**Vaucheria* sp. (not fruiting).
Ulothrix tenerrima Kuetz.
**Microspora* sp.
**Rhizoclonium riparium* Harv.
Scytonema cincinnatum (Thur.).

The species marked * were also collected from a pool at the edge of the Tasman Stream.

Perisporochnus n. gen.

Plantis ex haustorio coniformi orientibus, axe primario ramis et ramulis vestito, ramis ramulos spiraliter ferentibus; axe et ramis uniformiter constantibus e parvis cellulis, cum singula serie epidermali cellularum magnarum; sporangiis unilocularibus lateraliter natis in paranematis dichotomose ramosis.

Plants arising from a conical holdfast, main axis clothed with branches and branchlets, branches bearing branchlets in whorls; axis and branches uniformly composed of small cells with a single epidermal layer of large cells; unilocular sporangia borne laterally on dichotomously branched paranemata.

Type: *Perisoprochnus regalis* n. sp.

Perisporochnus regalis n. sp. Pl. 1; figs 1, 2.

Plantis ad 24 cm longis orientibus ex haustorio coniformi rhizoidibus septatis operto, axe primario per totam longitudinem multis ramis et ramulis dense vestito; axe et ramis constantibus e parvis cellulis cum singula serie magnarum cellularum epidermalium, parietibus crassatis sed per foveas tenuiparietales distinctis; ramis ramulos spiraliter ferentibus; ramulis plerumque simplicibus, raro cum laterali brevi, per receptaculum tumescens et cristam capillorum terminatis; pedicello 2-5-ies longiore quam crista apicali; capillis simplicibus, 40-70u diametro in regione basali meristematica, apud apicem ad 140u expansioribus; sporangiis unilocularibus 30-34u longis, 11-11.5u latis, lateraliter natis in paranematis dichotomose ramosis.

Plant up to 24 cm. long, arising from a conical holdfast covered with septate rhizoids, main axis densely clothed throughout its length with numerous branches and branchlets; axis and branches composed of small cells with one row of large epidermal cells, walls thickened but studded with thin walled pits; branches bearing branchlets in whorls; branchlets usually simple, rarely with a short lateral, terminating in swollen receptacle and tuft of hairs; pedicel 2-5 times longer than the apical tuft; hairs simple, 40-70 u diameter in basal meristematic region, expanding to 140 u at apex; unilocular sporangia 30-34 u long x 11-11.5 u wide, borne laterally on dichotomously branched paranemata.

Type specimen in herb. Auckland Inst. and Museum.

The whole plant is much coarser than are species of *Sporochnus* and it also differs from *Sporochnus* in the whorled arrangement of branchlets on the branches. In this latter respect it is more like *Bellotia*, but it differs from that genus in having the sporangia concentrated terminally instead of medially, and the paranemata are typically Sporochnalean in being dichotomously branched. Anatomically it differs from *Sporochnus* and *Encyothalia* in that there is no evidence of any larger central cells, the entire main axis and branch axes being composed of a mass of uniform thick-walled small cells, perforated here and there, especially towards the periphery, with thin-walled pores, though these are not true sieve plates. The outermost layer is composed of large cells also with thin-walled pores, restricted to the inner wall and the inner half of the lateral walls. Anatomically it appears to have affinities with *Perithalia*, which also has a similar structure and lacks the characteristic large central cells. The new genus therefore lies intermediately between *Sporochnus, Bellotia* and *Perithalia*.

I wish to express my thanks to Mr. W. A. Crawley, of Auckland University College, for the latin diagnoses. Dr. Drouet of the Chicago Natural History Museum, identified the *Scytonema cincinnatum*.

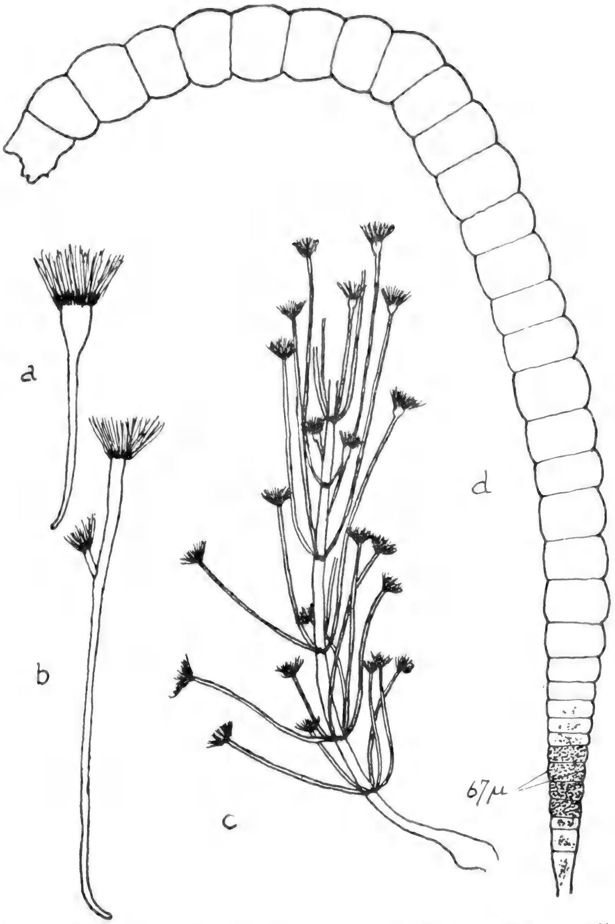

Fig. 1. *Perisporochnus regalis*, n. sp. (a) Branchlet with swollen receptacle; (b) branchlet with branch; (c) main branch showing whorled lateral branchlets; (d) single paranemata (a-b x 2; c x 1).

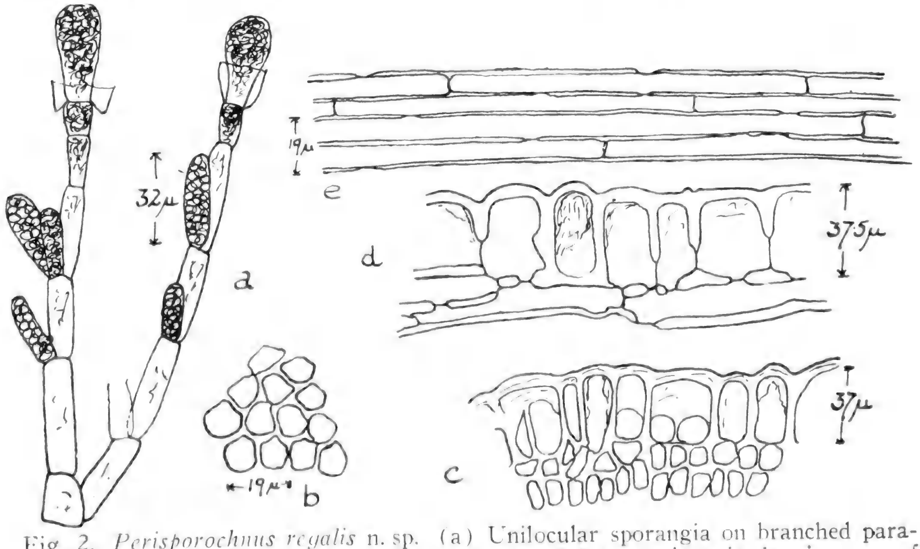

Fig. 2. *Perisporochnus regalis* n. sp. (a) Unilocular sporangia on branched paranemata; (b) central cells of main axis; (c) t.s. main axis showing row of large epidermal cells and small cells within; (d) l.s. epidermal cells enlarged to show pits; (e) l.s. central cells showing pits.

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Perisporochnus regalis n. sp. type specimen (x .8).

POHUTUKAWA x RATA

Variation in Metrosideros (MYRTACEAE) on Rangitoto Island, New Zealand

By R. C. COOPER, Auckland Museum.

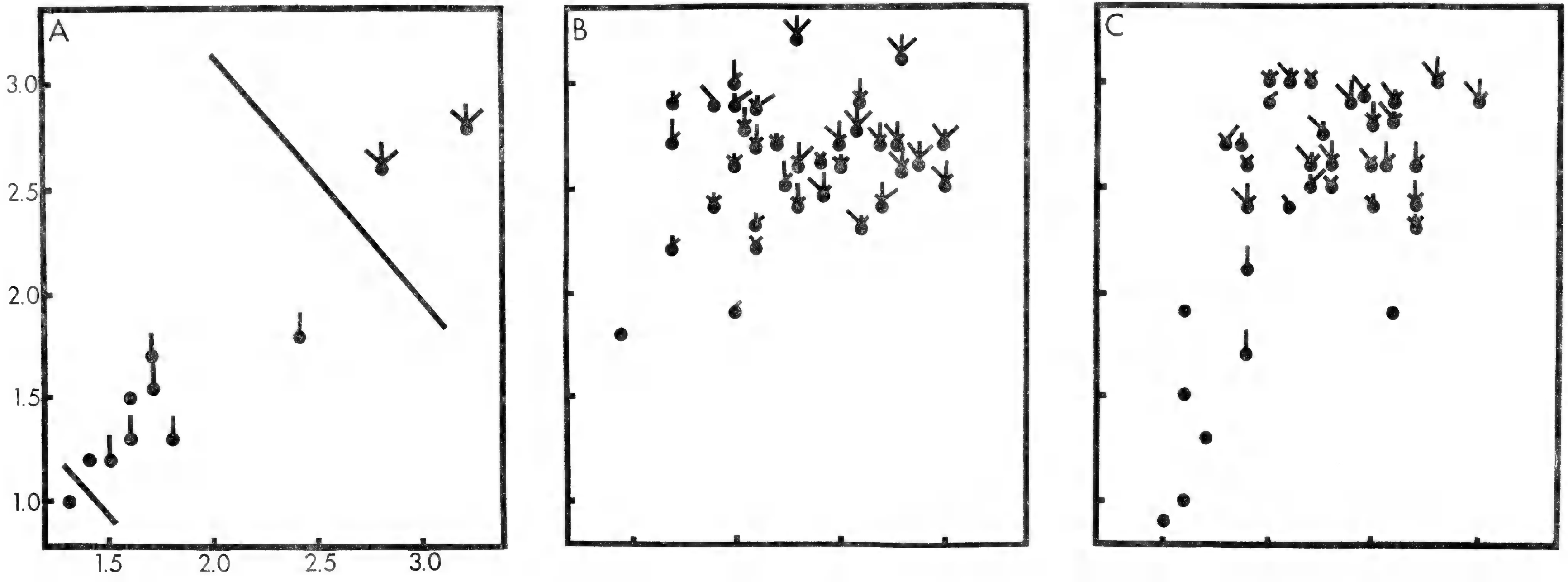
Abstract.

Attention is drawn to certain recent papers describing new techniques for the study of variation in plants. One of these techniques, the pictorialized scatter diagram is illustrated, using specimens of *Metrosideros spp.* from a known hybrid swarm on Rangitoto Island, and the results from an ordinary herbarium collection and two mass collections are contrasted.

The method by which a pictorialized scatter diagram is developed is explained in Anderson (1949 and 1952) and Anderson and Gage (1952). Anderson (1949 and in press) has also explained the ecological, genetical and mathematical criteria upon which scatter diagrams are based. Stebbins (1953) pointed out that the method is "by far the best yet devised for making the observer aware of a pattern of variation in respect of three or more characters which are varying simultaneously." He added, "to be sure the selection of characters to study and of their arrangement on the diagram are based on just as strictly subjective judgment as are the descriptions of the traditional systematist. But once the method is learned it is, like every other scientific method, a valuable tool for making complex natural phenomena relatively clear to the human mind without seriously distorting them." The same author also remarked that the method "has the advantage of being repeatable."

The figures listed in the three tables below are the measurements of certain characters of specimens of *Metrosideros spp.* (Myrtaceae) gathered on Rangitoto Island, a circular volcanic cone situated in Hauraki Gulf at the entrance to Auckland Harbour. The measurements in the first table were made on specimens collected by various botanists over the last eighty years and preserved in the Cheeseman Herbarium at the Auckland Museum. The measurements in the second and third tables were made on specimens gathered as "mass collections" by the writer immediately prior to the preparation of this paper. These collections are also preserved at the Auckland Museum.

Measurements of leaf width and stamen length were chosen as abscissa and ordinate respectively because they varied consistently and could be measured accurately. The other three characters, leaf length, internode length and calyx length, were indicated by rays from each dot on the scatter diagram. Limits of the three grades of each of these characters were chosen so that extremes associated with higher values for leaf width and stamen length are indicated by long rays and extremes associated with lower values for leaf width and stamen length are represented by no rays.



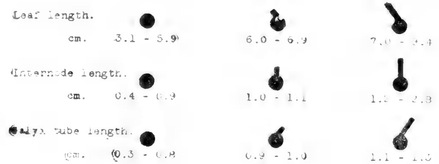
Pictorialized scatter diagrams of three samples of a hybrid swarm between *Metrosideros excelsa* (Pohutukawa) and *M. robusta* (Rata) on Rangitoto Island, New Zealand.

a. Ordinary herbarium specimens in the Auckland Museum.

b. Mass collection from the southern side of the island.

c. Mass collection from the eastern side.

Horizontal axis, leaf width; vertical axis, stamen length; three other characters are indicated by rays:—



At one extreme, the upper right-hand corner of each diagram, are the specimens with leaves which are markedly long and broad, and with stamens, internodes and calyx tubes which are markedly long. On the diagram of herbarium specimens (diagram A) the two dots enclosed by a line in the upper right-hand corner are specimens belonging to the species formerly known as *Metrosideros tomentosa* Rich. but now known as *M. excelsa* Sol. ex Gaertn. and commonly called pohutukawa or Christmas tree. One of these specimens was collected by Kirk on the Waitemata in December, 1874, and the other was gathered by the writer in a remnant of coastal scrub on his property at Blockhouse Bay this year. Both are similar to specimens collected on the southern slope of Rangitoto Island and shown in the extreme upper right-hand corner of diagram B.

At the other extreme, the lower left-hand corner of each diagram, are the individuals with leaves which are markedly short and narrow, and with stamens, internodes and caylx tubes which are markedly short. On the diagram of herbarium specimens (diagram A) the dot enclosed by a line in the lower left-hand corner is a specimen belonging to the species known as *M. robusta* A. Cunn. and commonly called rata. This specimen was collected by Kirk at Mahurangi about 1870 and is similar to specimens collected on the eastern slope of Rangitoto Island and shown in the extreme lower left-hand corner of diagram C.

Metrosideros excelsa and *M. robusta* are distinguished readily by the leaves of the former being tomentose beneath and the leaves of the latter being glabrous, by the stamens of the former being crimson and the stamens of the latter being dark scarlet, and so on. The characters used in the diagrams, however, were those which could be measured most easily in the field.

Individuals which connect *M. excelsa* and *M. robusta* were described by Kirk (1899) as *M. robusta* var. *intermedia* from specimens collected at Rangitoto Island. Carse (1927) described plants intermediate between *M. excelsa* and *M. robusta* from Lake Taupo, Bank of Whau and Titirangi as x *M. sub-tomentosa* nov. hyb., and Oliver (1928) adopted this name instead of *intermedia* "under the authority of a rule which states that the first name used in a specific sense must stand." In terms of Article H. 1 of Appendix II of the 1952 Code of Nomenclature the intermediates will be known in future as *Metrosideros* x *sub-tomentosa* Carse (= *Metrosideros excelsa* x *M. robusta*), if a name is required for them.

The significance of the three scatter diagrams is clear.

1. They show a high degree of correlation among the characters employed, and support the existing taxonomic arrangement.

2. They show the superiority of mass collections over ordinary herbarium collections. On this subject I cannot do better than quote Anderson (1941). "The information derived from a study of mass collections is useful in two ways. It will, in the first place, aid the systematist in cataloguing the various entities involved, species, varieties, forms, etc. While it may raise more new questions than it may solve old ones, it will aid in the production of monographs whose categories are more accurately adjusted to the variation patterns of their particular genera. Mass collections have for some time been customary in avian

taxonomy (see, for instance, Mayr[3]), and Kinsey, in a series of brilliant monographs[4], has shown their superiority in insect systematics. If taxonomy were to be nothing more than cataloguing, and if taxonomists were to confine themselves to the problems raised by their herbaria, mass collections would still be a useful adjunct to herbarium technique and in many critical groups would provide more efficient working material, even when their special difficulties of collecting and filing are considered.

There is no reason, however, why taxonomy should be content to cultivate such a narrow field. If collectors and herbarium administrators could be persuaded to encourage mass collections, critically made and carefully assembled, a second kind of problem could be investigated in herbarium material. The description and analysis of geographical trends in variation, the delimitation and interpretation of centres of variation, the establishment and analysis of variation patterns in different genera and families, are only a few of the problems that might well be investigated. It is already possible to correlate information from the field of taxonomy with that from cytogenetics. The time is not far distant when the biochemist of the germplasm will also turn to the taxonomist for morphological evidence derived from studying the products of the germplasms. To speak with authority on such questions taxonomists will need to refine their biological as well as their bibliographical techniques."

In this very minor example of the technique, diagrams B and C show that the prevalence of individuals closely resembling Kirk's specimen of *M. excelsa* from the Waitemata and my collection from Blockhouse Bay is greater in the sample from the southern side of Rangitoto Island (diagram B) than it is in the sample from the eastern side (diagram C). In the sample from the eastern side of the island none of the specimens is identical with Kirk's specimen of *M. excelsa* from the Waitemata or my collection from Blockhouse Bay, but there are several individuals which closely resemble Kirk's specimen of *M. robusta* from Mahurangi. Further fieldwork, using ecological techniques, would be required to verify these distribution patterns.

General: Cockayne and Allan (1927) recognized ten classes and grades of individual polymorphy and seven classes and grades of polymorphy in groups of related individuals. The two authors considered hybridism to be the most prolific source of diversity, however, and emphasized that in the majority of cases there occur amongst hybridising species not a few intermediate individuals but a multitude of forms producing a motley "swarm." In 1934 they published an annotated list of 491 groups of wild hybrids in the New Zealand flora and expressed the opinion that of these 396 were established beyond reasonable doubt. They recognized the hybrids as such by field studies, supplemented by observations of cultivated specimens, and in several instances Allan bred plants similar to suspected wild hybrids by controlled crossings of the putative parents.

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[3]Mayr, Ernst. Speciation phenomena in birds. Amer. Nat. 74: 249-278. 1940.

[4]Kinsey, Alfred C. The gall wasp genus *Cynips*. A study in the origin of species. Indiana Univ. Studies, 84-86: 1-577, 1930; The origin of higher categories in Cynips. Indiana Univ. Publ. Sci. Ser. 4: 1-334, 1936.

Evidence relating to only some of the 491 groups has been published, however, and in herbaria other than that of the Botany Division, D.S.I.R., Wellington, where most of the collections of Cockayne and Allan are preserved, there are few representative collections of the hybrid swarms. In other words, much work remains to be done, on the foundations provided by Cockayne and Allan, especially as Anderson (1949) has emphasized that the almost imperceptible introgression of one species into another, by repeated back crossing of the hybrids to one or both parents, may be of far greater biological significance than hybridisation which leads to "bizarre hybrid swarms, apparent even to the casual passer-by." Valuable new techniques for this work, the study of introgression and the further analysis of variation in the New Zealand flora, are mass collecting (Anderson, 1941 and 1943), inclusive herbarium sheets (Anderson, 1951 and 1952), and pictorialized scatter diagrams and similar methods of polygraphic analysis (Anderson, 1949 and 1952). The value of these methods in the study of cultivated plants (Anderson, 1952; Stebbins, 1953) and the possible use of the pictorialized scatter diagram in other fields of research (e.g., archaeology) must also be mentioned.

ACKNOWLEDGMENTS.

I am indebted to Dr. Edgar Anderson, Assistant Director, Missouri Botanical Garden and Engelmann Professor of Botany, Washington University, St. Louis, Missouri, and to Dr. Norton H. Nickerson, of the University of Massachusetts, for much stimulating advice regarding introgression and the techniques for its study. Mr. H. Grimson, Assistant Education Officer of the Auckland Museum, gave much appreciated help with the mass collections on Rangitoto Island.

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TABLE 1.

Specimens in the Cheeseman Herbarium, Auckland Museum.

No.	Leaf length.	Leaf width.	Internode length.	Stamen length.	Calyx length.
Kirk, 1874	7.7	2.8	2.5	2.6	1.1
Kirk, c. 1870	3.5	1.3	0.8	1.0	0.7
Kirk, 5593	4.2	1.6	0.6	1.5	0.7
Cheeseman, 5574	3.4	1.6	1.8	1.3	0.7
Cheeseman, 5575	3.2	1.5	2.4	1.2	0.8
Cheeseman, 5576	3.4	1.4	0.7	1.2	0.7
Cranwell, a	5.2	1.8	1.5	1.3	0.7
Cranwell, b	3.6	1.7	1.2	1.6	0.7
Cranwell, c	5.2	2.4	2.4	1.8	0.6
Cranwell, d	4.5	1.7	1.3	1.7	0.7
Cooper, 36092	8.3	3.2	1.8	2.8	1.1

TABLE 2.

Mass collection from the southern slope of Rangitoto Island between reference points 377666 and 375674 on the N.Z. Lands and Survey Motutapu map of 1943 (1 : 25,000 series).

	Leaf length.	Leaf width.	Internode length.	Stamen length.	Calyx length.
1	6.7	2.2	1.1	2.7	1.0
2	6.5	2.7	1.3	2.4	1.1
3	5.1	2.0	1.6	3.0	0.9
4	6.1	2.0	1.0	2.6	1.0
5	6.7	2.1	1.3	2.7	0.9
6	6.4	2.3	1.5	2.4	0.9
7	6.8	2.3	1.4	2.6	1.1
8	6.9	1.9	1.1	2.4	1.0
9	3.7	1.4	0.4	1.8	0.7
10	5.5	1.7	1.2	2.7	1.0
11	6.2	2.1	1.2	2.8	1.0
12	5.5	1.7	1.1	2.9	1.0
13	8.1	2.3	1.2	3.2	1.3
14	5.9	2.0	1.1	2.9	1.1
15	7.5	2.5	1.4	2.7	1.0
16	9.1	2.8	1.5	3.1	1.1
17	7.7	2.7	1.2	2.7	1.0
18	7.4	2.8	1.3	2.6	1.0
19	7.0	2.6	1.6	2.8	1.2
20	6.3	2.6	1.2	2.9	1.0
21	7.4	2.6	1.0	2.3	1.0
22	7.0	1.9	0.9	2.9	0.8
23	6.2	2.0	1.1	2.9	1.1
24	7.7	3.0	1.3	2.5	1.0
25	6.9	2.5	1.1	2.7	1.0
26	7.5	3.0	1.1	2.7	1.1
27	6.9	2.4	0.9	2.6	1.0
28	6.1	2.1	0.9	2.2	0.9
29	5.8	2.1	1.1	2.3	1.0
30	5.6	2.3	1.3	2.5	0.9
31	7.0	2.7	1.5	2.7	1.0
32	4.4	2.0	0.6	1.9	0.9
33	7.3	2.4	1.2	2.5	1.0
34	4.9	1.7	1.0	2.2	1.0
35	7.3	2.8	1.5	2.6	1.1

TABLE 3.

Mass collection from the eastern slope of Rangitoto Island between reference points 382688 and 394692 on the N.Z. Lands and Survey Motutapu map of 1943 (1: 25,000 series).

	Leaf length.	Leaf width.	Internode length.	Stamen length.	Calyx length.
41	6.7	2.5	1.2	2.8	1.0
42	3.1	1.5	0.6	0.9	0.5
43	6.8	1.8	0.9	2.7	1.1
44	4.5	1.7	0.8	1.3	0.6
45	5.9	2.6	0.8	1.9	0.8
46	5.7	2.0	0.8	2.9	0.9
47	7.6	2.5	0.9	2.6	0.9
48	7.3	1.9	1.3	2.4	0.9
49	3.8	1.6	0.7	1.5	0.8
50	6.4	2.7	1.0	2.3	0.9
51	6.1	2.1	0.9	2.4	0.7
52	7.2	2.2	1.1	2.6	1.0
53	6.6	2.3	0.8	2.5	1.0
54	7.9	2.8	1.9	3.0	0.9
55	7.0	2.4	1.2	2.9	0.8
56	3.4	1.6	0.6	1.0	0.6
57	4.9	2.5	1.6	2.6	0.9
58	6.3	2.7	1.3	2.4	0.9
59	8.2	2.6	1.1	2.9	0.9
60	9.4	2.5	1.1	2.8	1.0
61	5.5	2.7	1.2	2.6	0.9
62	4.7	1.9	1.4	1.7	0.7
63	4.8	1.6	0.7	1.9	0.5
64	5.5	2.2	1.1	2.5	1.1
65	8.6	3.0	1.3	2.9	1.0
66	6.9	2.0	1.1	3.0	0.9
67	7.5	2.4	0.9	2.9	1.0
68	7.0	2.1	1.1	3.0	0.9
69	7.2	2.3	1.3	2.6	1.0
70	7.6	2.3	1.0	2.7	0.8
71	6.2	2.2	0.9	3.0	1.0
72	4.0	1.8	1.0	2.7	0.7
73	6.3	1.9	0.8	2.6	1.0
74	6.3	2.5	1.1	2.4	0.8
75	5.3	1.9	1.3	2.1	0.8

Notes—

1. All measurements are in cm.
2. Nos. 36-40 were not used in the numbering of mass collections.
3. "Leaf length" and "leaf width" were measured on leaves at the second node beneath the apex of a mature woody branchlet bearing the flowering shoot.
4. "Internode length" refers to the third internode from the apex of the mature woody branchlet bearing the flowering shoot.
5. "Calyx tube length" refers to the calyx of a fully-open flower in the centre of a cyme.

A Note on the Occurrence of Chelisoches morio (Fabricius) on Pitcairn Island, South East Pacific Ocean (Dermaptera : Labiduridae.)

By E. T. GILES, Auckland.

Abstract.

An adult ♀ *Chelisoches morio* (Fabricius) is recorded from Pitcairn Island, S.E. Pacific Ocean. This is a new locality for the species and the first earwig record from the island.

Through the courtesy of Dr. G. Archey, Director, and Mr. E. G. Turbott, Ornithologist and Entomologist, Auckland Institute and Museum, this earwig came to the writer's attention. Data supplied with it read: "Found in bath, alive, within abdomen of second. Pitcairn Island. Coll: A. W. Moverley, 26. viii. 1952."

The specimen is an adult ♀ *Chelisoches morio* (Fabricius) with its head firmly held inside the posterior six segments of another earwig, almost certainly of the same species. A summary of the carnivorous habits of the species is given by Hincks (1948). It could easily develop cannibalistic traits and doubtless the one was feeding on the remains of the other.

Both are of a dark reddish-brown colour, but usually this earwig is black. Specimens of a similar light colour are rare in the Burr Collection in the British Museum (Natural History), which was examined through the courtesy of Mr. D. R. Ragge. It would be interesting to find the proportion of light-coloured individuals in the population of the species on Pitcairn Island. The effect of "drift" (Wright, 1940) could offer an explanation if it were found to be high.

This is the first record of a dermapteran from Pitcairn Island; Hincks (1938) gives none. *C. morio* is of world-wide distribution and it is not surprising that it should turn up on the island, although it is isolated and of volcanic origin. Specimens of such a hardy, active insect could be easily transported there on rafts of vegetation carried by ocean currents or among the plants and possessions of early native voyagers. Instances of this species being introduced are given by Burr (1910)—to the East Coast of Africa; by Lucas (1920)—to Kew Gardens, London; and by Hebard (1933)—to the coast of California. In Auckland on 7.iii.1950 the writer took a nymph among bananas shipped from Western Samoa.

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New Records and Descriptions of Hemiptera-Heteroptera from the Three Kings Islands.

By T. E. WOODWARD,

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Abstract.

Twenty-five species of Heteroptera are now known to occur on the Three Kings. Species found also both on the mainland of New Zealand and overseas are —Pentatomidae: *Cuspicona simplex* Walker; Cydnidae: *Philapodemus australis* (Erichson); Lygaeidae: *Pachybrachius nigriceps* (Dallas); Reduviidae: *Empicoris rubromaculatus* (Blackburn); Nabidae: *Nabis capsiformis* Germar; Miridae: *Megalocerоea reuteriana* Buch. White, *Eurystylus australis* Poppius, *Coridromius variegatus* (Montrouzier); Veliidae: *Microvelia halei* Esaki. Species known only from New Zealand (Maorian sub-region)—Lygaeidae: *Nysius huttoni* Buch. White, *Rhypodes clavicornis* (F.) (showing some local variation), *Targarema staali* Buch. White, *Taphropeltus putoni* (Buch. White), *Cymus novaezelandiae* sp. nov.; Nabidae: *Nabis maoricus* Walker; Miridae: *Calocoris laticinctus* (Walker); *Sthenarus myersi* Woodward. Forms not recorded outside the Three Kings—Pentatomidae: *Cermatulus nasalis turbotti* Woodward; Lygaeidae: *Tomocoris insularis* Woodward. In addition, one species of Anthocorid and one Aradid have been sent to specialists for determination, and there have been noted one apparently endemic species of *Sthenarus* and three species of *Lygus*, of which one is not known from the mainland.

Cymus novaezelandiae sp. nov. and the nymphs of *Cermatulus nasalis turbotti* are described. Information is given on local variation in rostral length of *Rhypodes clavicornis.*

ACKNOWLEDGMENTS.

I am much indebted to the authorities of the Auckland Institute and Museum, and particularly Dr. G. Archey and Mr. E. G. Turbott, for the opportunity of visiting the Three Kings on one of the expeditions, and of examining much material, to Mr. Turbott for specimens of *Cermatulus,* to Mr. J. S. Edwards for the collection of a large series of Hemipterous material and for locality and habitat information, and to Dr. W. E. China for kindly checking some of the species against British Museum material and for the determinations acknowledged in the text. The author's expenses in participating in the 1951 expedition were defrayed from a Hutton Research Grant of the Royal Society of New Zealand.

INTRODUCTION.

The types of *Cermatulus nasalis turbotti* were collected by Mr. E. G. Turbott during the autumn, 1946, expedition of the Wild Life Branch of the Department of Internal Affairs and described by the author in

1950. The rest of the material was collected by Mr. Turbott and the author on the Auckland Museum expedition of summer, 1951, and by Mr. J. S. Edwards on the Museum's expedition of 1952-53.

While a survey so restricted in time and season cannot, of course, be regarded as all-inclusive, nevertheless collecting has been fairly intensive and carried out at probably the optimum season for insect activity. Many mainland species which were especially sought for in appropriate localities were not found in these islands. The time available for collecting on the smaller islands of the group has been extremely limited, so that our present conception of the Three Kings Heteropteran fauna is based almost entirely on that of Great Island, which has suffered the most floristic alteration in recent times (Baylis, 1948; Turbott, 1948).

The general conclusion must be that the Heteropteran fauna of the Three Kings is a restricted sample of the mainland fauna, together with a few interesting endemic species and subspecies which have apparently developed there in isolation. The total number of discovered species of Heteroptera in the group is twenty-five. Three species, *Tomocoris insularis* Woodward, *Lygus* sp., and *Sthenarus* sp., and one subspecies, *Cermatulus nasalis turbotti* Woodward, have not been recorded from the mainland or seen by the author in mainland collections, and are apparently not represented elsewhere. The first is undoubtedly a relict species of a genus once more widely distributed in New Zealand (Woodward, 1953, p. 213). In addition, the Great Island population of *Rhypodes clavicornis* (Fab.) shows a constant structural difference from all mainland specimens examined in the strikingly longer rostrum (p. 222), and thus might be regarded as constituting an insular subspecies or incipient subspecies. The S.W. Island population of this species is intermediate as regards this character between the Great Island and the mainland forms.

It is hoped later to present a more detailed comparison of the Hemipteran faunas of the mainland and the Three Kings when the Homoptera of the latter have been worked out.

The relative sparsity of the present bug fauna seems attributable to four main causes:

(1) Non-representation of mainland species in the Three Kings area when this was connected to the mainland (due to restrictions of geography, small area, and less variety of plant cover).

(2) The emergence of species and subspecies on the mainland since the separation of the Three Kings. This probably applies to many of the mainland forms with restricted distribution and of apparently recent origin, such as the brachypterous Rhyparochrominae inhabiting leaf-mould. The converse of this is the development of species and subspecies on the Three Kings.

(3) The introduction of species into the mainland but not to the Three Kings, due to the relative inaccessibility and the much smaller area of the latter. Such recently introduced Pentatomids as *Nezara viridula* (Linn.) and *Antestia orbona* Kirkaldy are examples. The former, although apparently it has not yet invaded the Three Kings, has recently spread to the far northern coast of the North Island of New

Zealand. On the other hand, *Cuspicona simplex* Walker, which has recently been introduced into the mainland, has also found its way to at least one island of the Three Kings group.

(4) The elimination of host plants and habitat niches, firstly by Maori occupation and secondly by goats since their introduction last century until their destruction in 1946 (Baylis, 1948; Turbott, 1948). The effects would presumably have been greatest on tree and forest dwelling insects. On the other hand, survival of species frequenting kanuka (*Leptospermum ericoides*), at least some grasses and sedges, and the more inaccessible cliff and rock plants, has been relatively favoured. This is seen by the collection data below and accords with the effects of Maori occupancy and of goats as detailed by Baylis and Turbott. It is of interest that both on the Three Kings and on the mainland kanuka has been found by the writer to suport a much richer bug fauna than manuka (*L. scoparium*), and, but for the survival of the former as a dominant element of the flora, probably the Hemiptera would have been even more depleted. On the Three Kings, only three Heteropteran specimens were taken from manuka, a fifth instar nymph of the predacious Pentatomid *Cermatulus nasalis turbotti,* and one male and one nymph of the Lygaeid *Pachybrachius nigriceps* (Dallas).

It is, of course, at present difficult to distinguish the effects of (1) and (4), but additional information would no doubt be obtained by intensive collecting from South-West Island and the other smaller islands of the group, which probably support a virtually primitive plant community, though more restricted than that formerly covering Great Island (Baylis, 1948).

The positions of the quadrats and other localities noted in the following records are shown by Turbott (1948; pl. 41), Baylis (1948; p. 242), and Battey (1951).

The bulk of the material recorded is to be deposited in the Auckland Museum.

FAMILY PENTATOMIDAE.

SUB-FAMILY PENTATOMINAE.

Cuspicona simplex Walker.

1867—*Cuspicona simplex* F. Walker, *Cat. Spec. Het. Hem. Coll. Brit. Mus.*, pt. 2: 388.

One ♀, S.W. Island, 13/1/51, sweeping a mixed growth of *Solanum nigrum* L. and *Solanum aviculare* Forst. (poroporo). After the capture of this specimen, stands of *Solanum* on both S.W. and Great Island were vigorously swept, but no further specimens were found. This Australian species was recorded from the mainland of New Zealand by Spiller and Turbott (1944; pp. 79-80), where it is apparently a recent introduction. Its incursion into the Three Kings is also apparently recent, and perhaps it has not yet had time to become fully established or to spread to Great Island. Spiller and Turbott record it from North Auckland (Hokianga), Auckland (widely distributed, including Waiheke Island), and Taranaki (New Plymouth). Besides Auckland itself, the writer has taken it in various parts of North Auckland (Paihia

(13/2/49) and Russell (14/2/49), Bay of Islands, and Manganuka Gorge (17/2/51)), Little Barrier Island (11/12/50), and Wellington (Otaki R. (S. of Levin) and Point Howard (31/1/51)). All captures were on solanaceous plants.

SUB-FAMILY ASOPINAE (AMYOTINAE).

Cermatulus nasalis (Westwood) subsp. **turbotti** Woodward.

1950—*Cermatulus turbotti* Woodward, *Rec. Auck. Inst. Mus.* 4 (1): pp. 24-30; figs. 1-2.

1953—*Cermatulus nasalis turbotti* Woodward, *Trans. R. Soc. N.Z.* 80 (3 and 4): pp. 299, 308-310, 312, 318; figs 9, 34.

Type ♀♀ collected by E. G. Turbott, Great I.: 1 ♀, Tasman Valley, 6/5/46; 2 ♀♀, near depot, 5 and 10/5/46; all on kanuka (*Leptospermum ericoides* A. Rich.).

On the 1951 expedition, the following specimens were collected, all from Great Island: 2 adults from near depot (1 ♂, 12/1/51, E. G. Turbott; 1 ♂, 14/1/51, T.E.W.); 4 last (fifth) instar nymphs (2 from the eastern slopes of Tasman Valley, 12/1/51; 2 from the East Point, 14 and 15/1/51, T.E.W.); 3 young nymphs from eastern slopes of Tasman Valley, 12/1/51 (1 second instar, 2 third instar, T.E.W.). All except one of the specimens were taken on kanuka (*L. ericoides*); one of the fifth instar nymphs from East Point was on *L. scoparium* Forst. (manuka).

The two last instar nymphs caught on 12/1/51 emerged in captivity, one (♂) on the day of capture, while the other (♀) was found to have emerged by the return to Auckland (18/1/51). The former was seen, at emergence, to be bright red, but by the next day had darkened to the normal adult coloration, the hemelytra being the last to change colour.

Adult Male

The males of this subspecies show the same tendency as the females to a greater body size than in *nasalis*. Length (3 ♂♂), 12.0-12.5 mm. Width across pronotal shoulders, 6.25-6.5 mm. Head as in ♀, except that apical margin of tylus is more broadly convex and disc of juga has dark ochreous mottlings. As in ♀, eye only $\frac{1}{3}$ as wide as interocular space. Head above, pronotum and scutellum in all three specimens with metallic bronzy and greenish reflections. Antennal segment III $\frac{2}{3}$-$\frac{3}{4}$ as long as II; IV 1/5th-$\frac{3}{8}$ III, and V subequal to or rather shorter than IV. Pronotum across shoulders 2.20 times median length. Membrane of hemelytra infuscated, particularly near anal angle of corium, appearing bronzy-brown in closed position; veins darker brown. Hind wings with green reflections. Black sternal spots of abdomen smaller than in ♀. Other features as described for ♀ (Woodward, 1950, *op. cit.*).

Nymphs

Fifth (last) Instar:

Ovoid, about $\frac{1}{2}$ as long again as wide across abdomen (9.5 mm.: 6 mm.). Width of head across eyes, 2.26 mm. Dorsal surface of head, pronotum, scutellum, and wing pads shining bronzy-black with metallic green reflections, except for the eyes, which are brownish black, and a broad, orange-brown marginal band on each side of pronotum, narrowing at posterior shoulders, and along anterior half of each wing pad. Dorsal surface of abdomen with five median bands of similar metallic colour to above, the first transversely linear, very short antero-posteriorly, the second wider and several times longer, and flanked on each side by a small patch of similar colour, the third the widest and more than twice as long as second, the fourth the longest, the fifth the narrowest and nearly rectangular. Dorsum with five large lateral patches of similar metallic colour on either side, each invaded at margin by an orange-brown semicircular area. Connexivum below with similar, though smaller, dark metallic patches, the invading semicircles proportionately larger. A sixth, smaller, anterior patch on each side of dorsum may be reduced to a transverse bar. Last three (reduced) terga, including that of anal tube, completely dark metallic, except for small, lateral, orange-brown patch on each side of antepenultimate (eighth). All metallic areas rugose and, especially on thorax and wing pads, strongly punctate; spaces between them on abdomen orange-brown mottled with purplish brown, without rugae and not or scarcely punctate; an unmottled yellowish brown area inside mesial margin of each wing pad. Antennae orange-brown; first segment with external dorso-lateral aspect black; second black on apical $\frac{1}{4}$; third and fourth black except at base. Rostrum reaching hind coxae; infuscated ochreous, last segment blackish brown. Ventral surface of body yellowish to pinkish ochreous, with dark spots and bands. Ventro-lateral regions of head and thorax shining dark metallic. Legs yellowish ochreous with reddish and black mottlings; femora at apex, tibae at base and apex, and whole of tarsi shining black. Ventral black spine of fore tibiae pronounced. Wing pads reaching half-way along third abdominal tergum (level with posterior margin of second median metallic bar). Scutellum well defined as a bluntly rounded triangle between them.

A general darkening of the pale areas may occur after death in dried specimens.

Sides of tylus parallel throughout; shape of tylus and juga as described for adult ♂. Eye only 0.29 times as wide as interocular space (7.5: 26). First antennal segment very short, not reaching to apex of head; proportions of segments II-IV, 45: 23: 23. Pronotum subtrapeziform; anterior margin widely and rather shallowly concave; posterior margin nearly straight, with the backward triangular projections smaller and more rounded than in adult, base outside them slightly sinuate; sides gently sinuate, slightly concave just behind middle; median length nearly equal to length of head, and about $\frac{1}{3}$ posterior width and $\frac{3}{4}$ anterior width of pronotum (32: 34: 90: 42). Pronotum, and scutellum except at apex, with a well defined impressed median line (ecdysial cleavage line). Mesosternum on each side of low carina transversely striate, but ochreous, not metallic as in adult. Anterior abdominal spine rounded, very short, scarcely reaching anterior margin of hind trochanters.

Ecdysis: At the last ecdysis the nota of the ♀ split in the median longitudinal line from the anterior margin of the pronotum through the length of the scutellum and metanotum, which is very short in the mid-line. Cleavage thus occurs along and for a short distance behind the median line visible in the fifth instar nymph. In this respect the last ecdysis resembles that described by Myers (1926; p. 497) for *Glaucias amyoti* (A. White) rather than in *Cermatulus nasalis nasalis* as described by the same author (p. 493). However, the process is subject to a certain amount of individual variation. The last ecdysis in the latter subspecies was observed by Myers in only one specimen. In the only other instance so far observed in *turbotti* the two halves of the thoracic plates have closed back, one over the other, so firmly that it is impossible to delimit the ecdysial line in this region. In both specimens of *turbotti* a transverse split occurred along the whole dorsal width of the base of the head, in the membranous posterior border of the occipital region which in life is covered by the anterior part of the pronotum. From this, on each side, a split extended forward along the inner dorsal margin of the eye to its anterior end. Thus the entire sclerotised dorsal plate of the head between and before the eyes remained intact and was levered up from behind and pushed forward while the adult head and its appendages were being withdrawn; the rest of the body was drawn forward through the median gap in the thoracic plates.

The fifth instar nymph of *nasalis* differs from that of *turbotti* mainly in the evenly convex margins of the pronotum, which lack any concavity or sinuation, and in the absence of the marginal orange-brown areas in the dark connexival patches. Other colour differences may well be subject to individual variation in both species. For a description and illustration of the fifth instar nymph of *C. nasalis nasalis,* see Myers, 1926, pp. 491-492, fig. 12, where these differences from *turbotti* are well shown.

Third Instar:

Ovoid. Length about 4 mm. and width about 2.75 mm., but the comparative softness of the integument makes for variation in size in life and for considerable shrinkage and distortion after death. Width of head across eyes, 1.27-1.32 mm. (Head capsule width is a better criterion for differentiating instars.) Distribution of light and dark areas as for fifth instar, except in the following respects: dorsal surface of head and thorax shining black with greenish reflections, but without the pronounced metallic bronzy sheen; sides of pronotum and, more obscurely, of mesonotum, yellow-brown; lateral black areas of abdomen with the marginal orange-brown invasions less clearly defined; a pair of conspicuous yellow triangular areas, one on each side of dorsum of abdomen at its anterior end; a pair of smaller yellow spots towards posterior end of dorsum. To the naked eye, apart from these patches, the dorsum appears completely black, the median black patches forming a more or less continuous block, especially after death. Venter of abdomen reddish brown. Legs, rostrum (last segment paler), and ventral surface of head and thorax shining blackish brown; tarsi black. First and second segments of antennae blackish brown, third and fourth black, with base of third orange-brown. Dorsal black areas only very obscurely rugulose and shallowly and sparsely punctate.

Wing pads not evident. Scutellum indicated only by the obtuse backward angulation of the mesonotum, not covering the metanotum. Fore tibiae with ventral spine small and easily overlooked. Rostrum well surpassing hind coxae. Abdominal spine, ventral thoracic carina and striate areas not developed. Thoracic cleavage line as in last instar. Pronotum proportionately much shorter than in last instar; anterior margin concave, posterior convex, the two nearly parallel; sides nearly straight; median length just over ½ length of head and about 2/7th posterior width and rather less than ½ anterior width of pronotum (12: 20: 41: 26). Eye 0.3 times as wide as interocular space (4.5: 15). Proportions of antennal segments II-IV, 23: 13: 16.

Second Instar:

Ovoid. Length about 3 mm. Width about 2.25 mm. Width of head across eyes, 1.05 mm. Colour pattern as for third instar, except that yellow-brown on margins of pronotum is less pronounced, and is absent from mesonotum; legs, rostrum, ventral surface of head and thorax, antennae except for extreme base of third segment, all black; first median black bar of abdominal dorsum scarcely apparent, second bar without the lateral spots; lateral black patches of dorsum without any signs of marginal orange-brown invasions.

Rostrum passing hind coxae. Proportions of antennal segments II-IV, 14: 9: 12. Pronotum shaped as in third instar; median length ½ length of head and about ¼ posterior width and just over ⅓ anterior width of pronotum (7.5: 15: 29: 21). Eye ⅓ as wide as interocular space (3.75: 11.5).

(Proportionate measurements to the scale 18 units = 1 mm.)

The paucity of Pentatomids as represented in these collections is outstanding, and particularly the absence of the common and widely distributed mainland species *Dictyotus caenosus* (Westwood). Its habits as a frequenter of the ground and of low-growing plants may tend to restrict its dispersal, though it also occurs in Australia; it is, however, a form that could easily have been transported by the early ships. It is quite possible, of course, that there occur on the Three Kings some species of this family, particularly the less common ones, which have been missed in collecting. However, there is undoubtedly a strong element of chance as to which species happen to reach such an area, and the results of these collections tend to emphasise this.

FAMILY CYDNIDAE.

Philapodemus australis (Erichson).

1842—*Cydnus australis* Erichson, *Arch. für Naturg.* 8: 275, 276.

One nymph, East Point, Great I., 15/1/51, under *Disphyma australe* (A. Cunn.); at cliff-top (T.E.W.).

Occurs in the Oriental and Australian regions, including New Zealand.

FAMILY LYGAEIDAE.
SUB-FAMILY LYGAEINAE.

Nysius huttoni Buch. White.

1878—*Nysius huttoni* Buch. White, *Ent. mon. Mag.* 15: 32.

Collected by author: 1 ♀, Tasman Valley, Great I., 12/1/51, sweeping sedges, grasses and rushes; 1 ♀, Great I., foot of cliff below depot, 14/1/51, on prostrate ngaio (*Myoporum laetum* Forst. f.); 2 ♂ ♂, 2 ♀ ♀, Great I., below cliffs near depot, 14/1/51, *Chenopodium triandrum* Forst.; 3 ♂ ♂, 2 ♀ ♀, East Point, Great I., 15/1/51, under *Disphyma australe* (A. Cunn.) Black.

Collected by J. S. Edwards: 1 ♂, Quadrat II, Great I., 1/1/53, on puka (*Meryta sinclairii* (Hook.) Sum.; 1 ♂, cliff vegetation, Great I., 4/1/53, on flowering kanuka (*Leptospermum ericoides*); 3 ♂ ♂, cliff edge above Castaway Valley, Great I., 4/1/53, dry grass.

Restricted to New Zealand.

Rhypodes clavicornis (Fab.).

1794—*Lygaeus clavicornis* Fabricius, *Ent. Syst.* 4: 169.

Collected by author: 2 ♂ ♂, 6 ♀ ♀, 4 nymphs, Tasman Valley, Great I., 11-12/1/51, sweeping sedges, grasses and rushes; 1 ♀, Great I., depot, 12/1/51, kanuka (*Leptospermum ericoides*); 4 ♂ ♂, 3 ♀ ♀, 9 nymphs, Great I., foot of cliffs below depot, on prostrate ngaio (*Myoporum laetum*); 7 ♂ ♂, 4 ♀ ♀, East Point, Great I., on and under *Poa anceps* Forst., on cliff slopes; 1 ♀, 2 nymphs, Great I., below cliff near depot, 14/1/51, on *Hebe insularis* (Cheeseman) Ckne and Allan; 3 ♂ ♂, 2 nymphs, Great I., below cliffs near depot, 14/1/51, *Chenopodium triandrum;* 2 ♀ ♀, East Point, Great I., 15/1/51, on *L. ericoides;* 3 ♂ ♂, 5 ♀ ♀, East Point, 15/1/51, sweeping sedges and rushes; 14 ♂ ♂, 6 ♀ ♀, S.W. Island, 13/1/51, sweeping grassy slopes.

Collected by J. S. Edwards: 1 ♀, Tasman Valley, Great I., 31/12/52, sweeping from *Leptospermum;* 2 ♂ ♂, 1 ♀, cliffs below Tasman Valley, Great I., 31/12/52, swept from *Haloragis erecta* (Murr.) Schindler; 1 ♂, 1 ♀, 1 nymph, cliffs at end Tasman Valley, Great I., 31/12/52, sweeping grasses and *Scirpus;* 1 ♀, Saddle, Great I., 2/1/53, tussock (*Scirpus* and *Carex*); 1 ♂, cliff edge above Castaway Valley, Great I., 4/1/53, dry grass; 1 ♀, cliffs near Castaway Valley, Great I., 4/1/53, on *Tetragonia.*

The Great Island population of *R. clavicornis* differs from all specimens examined from a wide range of localities in both North and South Islands and smaller islands near the mainland coast, in the considerably longer rostrum. No other constant differences are apparent and I have not separated this form taxonomically, although in view of the wide use of rostral length as a systematic character in the Heteroptera, one might perhaps feel justified in regarding this form as a subspecies. However, it seems sufficient, at least at present, to draw attention to it as an example of early intraspecific divergence of a population in isolation. It is a geographic form distinguished by only one visible structure from the general population, and as such is perhaps best considered an incipient subspecies; with continued isolation it might be expected eventually to develop other correlated differences. The real interest of the form, whatever it be called, is as an example of evolution in progress. In most cases the difference in rostral length from that of mainland specimens is so considerable as to be immediately obvious, while there is no overlap in the ranges of relative rostral length in the material examined of the two populations. The proportionate rostral length of the S.W. Island material is intermediate between that of the Three Kings and mainland specimens, and the range overlaps that of both. The ratio, length of rostrum: width of pronotum (across humeral angles) is as follows:—

	Mainland.	S.W. Island.	Great Island.
♂	1.18-1.40	1.35-1.48	1.45-1.53
♀	1.07-1.32	1.30-1.41	1.40-1.49

In the Great I. specimens the rostrum reaches as far as the middle of to just beyond the posterior coxae, often reaching or extending on to the first visible abdominal sternum; segment I usually surpassing base of head, II surpassing fore coxae and extending on to mesosternum, III reaching middle or hind end of middle coxae. In the mainland specimens the rostrum usually reaches middle coxae, but does not extend as far as their middle, never reaching first visible abdominal sternum; segment I not or barely passing base of head, II not or barely passing fore coxae, III not or barely reaching middle coxae, not reaching to their middle. The positions given apply when, as is usually the case, the head is retracted to or near the maximum extent within the prothorax, so that the eyes touch the latter.

As Usinger (1942; pp. 42, 45-46) has pointed out, *Rhypodes clavicornis* varies considerably in the degree of development of the sublateral processes of the posterior pronotal margin; in some specimens they are well developed triangular projections, in others they are absent or scarcely discernible. Usinger found the absence of these lobes commoner in the South Island specimens. They are well developed in all the Three Kings specimens. An examination of mainland material has indicated a probable tendency to local geographic variation in respect of body colour and of size of the pronotal processes, but as yet insufficient material has been available to give a clear picture of the distribution of the forms involved and to determine whether any of them warrant taxonomic separation. This is a problem which should be considered together with the Three Kings material, and it is hoped later to continue these studies in greater detail, as they provide examples of the ways in which speciation might begin.

SUB-FAMILY RHYPAROCHROMINAE.

Targarema staali Buch. White.

1878—*Targarema staali* Buch. White, *Ent. mon. Mag.* 15 (1): 34.

Collected by author: 12 ♂♂, 13 ♀♀, Tasman Valley, Great I., 11-12/1/51, kanuka (*Leptospermum ericoides*); 1 ♂, 1 ♀, Tasman Valley, Great I., sweeping sedges, grasses and rushes; 1 ♂, 3 ♀♀, depot, Great I., 12/1/51, on *L. ericoides;* 2 ♀♀, Bald Hill, Great I., 12/1/51, sweeping grasses and rushes; 2 ♂♂, East Point, Great I., 14/1/51, under *Poa anceps* Forst. on cliff slopes; East Point, Great I., 15/1/51, 3 ♂♂, 2 ♀♀, on *L. ericoides*, 1 ♀ sweeping sedges and rushes.

Collected by J. S. Edwards: 6 ♂♂, 4 ♀♀, Castaway Valley, Great I., 30/12/52, kanuka about camp site (*L. ericoides*); 7 ♂♂, 3 ♀♀, Tasman Valley, Great I., 31/12/52, sweeping from *Leptospermum;* 1 ♂, 1 ♀, Eastern Arm, Great I., 1/1/53, sweepings from ground vegetation (*Carex*, mosses, etc); 2 ♂♂, kanuka canopy near Quadrat II, Great I., 2/1/53 (*L. ericoides*); 15 ♂♂, 2 ♀♀, The Saddle, Great I., 2/1/53, *L. ericoides*; 1 ♂, near summit on N.W. cliffs, Great I., 3/1/53, kanuka canopy (*L. ericoides*); 1 ♂, 1 ♀, cliff vegetation, Great I., 4/1/53, on flowering kanuka (*L. ericoides*); 1 ♂, 1 ♀, Tasman Valley, Great I., 5/1/53, *Colensoa physaloides* (A. Cunn.) Hook.

Restricted to New Zealand.

Pachybrachius nigriceps (Dallas).

1852—*Rhyparochromus nigriceps* Dallas, *Cat. Hem. Brit. Mus.* 2: 577.

Collected by author: 6 ♂♂, 9 ♀♀, 17 nymphs, Tasman Valley, Great I., 11-12/1/51, sweeping grasses, sedges and rushes; 6 ♀♀, 11 nymphs, Bald Hill, Great I., 12/1/51, sweeping grasses and rushes; 2 ♂♂, East Point, Great I., 15/1/51, sweeping sedges and rushes.

Collected by J. S. Edwards: 2 nymphs, cliffs at end of Tasman Valley, Great I., 31/12/52, sweeping grasses and *Scirpus*; 1 ♂, Eastern Arm, Great I., 1/1/53, sweepings from ground vegetation (*Carex*, mosses, etc.); 8 nymphs, N.W. cliffs, Great I., 4/1/53, sweeping *Carex* and *Scirpus*; 1 ♂, 1 nymph, Bare Saddle, S.E. Bay, Great I., 5/1/53, low manuka (*Leptospermum scoparium*); 1 ♂, The Saddle, Great I., 2/1/53, tussock (*Scirpus* and *Carex*); 38 ♂♂, 42 ♀♀, 20 nymphs, cliff brow, S.W. Cove, Great I., 5/1/53, on *Scirpus nodosus* Rottb.

Widespread in the Pacific area, including New Zealand.

Taphropeltus putoni (Buch. White).

1878—*Scolopostethus putoni* Buch. White, *Ent. mon. Mag.* 15: 75.

1 ♀, Tasman Valley, Great I., 11/1/51, sweeping sedges, grasses, and rushes (T.E.W.).

Known only from New Zealand.

Tomocoris insularis Woodward.

1953—*Tomocoris insularis* Woodward, *Rec. Cant. Mus.* 6 (3): 213.

1 ♀, Castaway Valley, Great I., 15/1/51, *ex* leaf mould under sedges beside stream (T.E.W.).

Known only from the Three Kings.

SUB-FAMILY CYMINAE.

Genus CYMUS Hahn, 1832.

Cymus novaezelandiae sp. nov., figs.1-2.

This species occurs in two forms, macropterous and sub-brachypterous, of which the latter appears to be by far the more common.

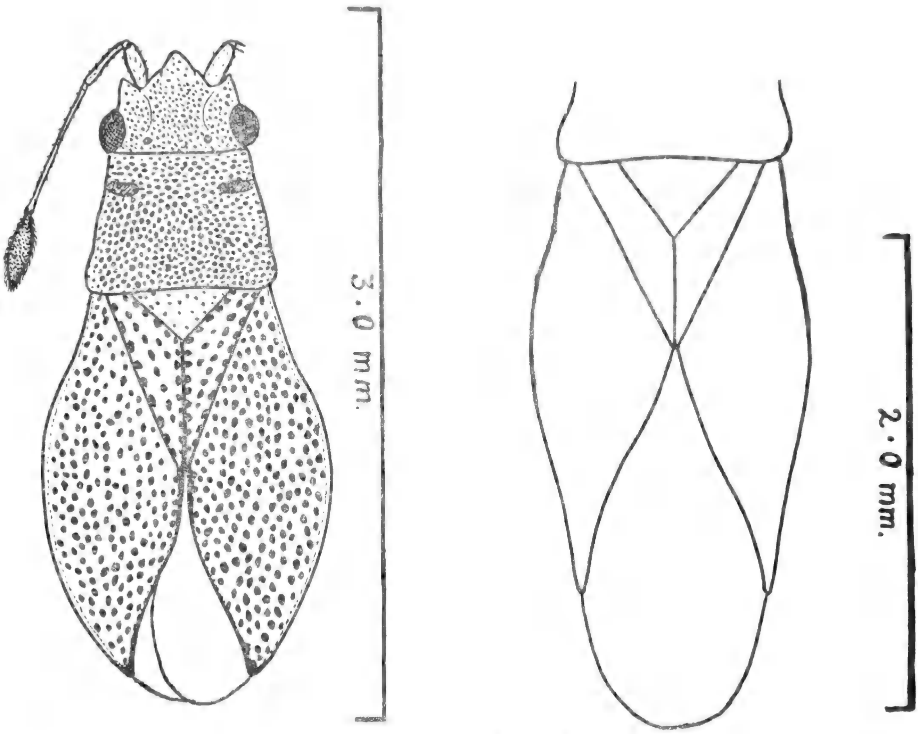
Diagnosis: Colour brown; stramineous or ochreous, sometimes infuscated or ferruginous. Second antennal segment short, subequal in length to first and about 2/5th as long as third; fourth segment and dilated apex of third black; fourth segment very strongly swollen, in middle about $\frac{1}{3}$ as wide as long and rather thicker than first segment, about $\frac{2}{3}$ as long as third segment. Head rather wider across eyes than long. Under-surface of head and thorax with golden, deciduous, scale-like hairs. Bucculae half or very nearly half as long as first rostral segment, which does not quite reach base of head. Pronotum rather longer than head and $\frac{2}{3}$-$\frac{3}{4}$ as long as wide at basal angles, length equal to anterior width. Pronotum raised between calli but with median carina obsolete; scutellum convexly raised behind the depressed base, without true carina. Metathoracic scent-gland spouts very small, ventrally truncate. Costal margins of coria strongly convex, sinuately incurved at about 1/5th from base, whence nearly straightly converging to base; in macropterous, but not in sub-brachypterous form, also sinuately incurved towards apex. In sub-brachypterous form, membrane short and narrow, $\frac{2}{3}$ as long as and narrower than corium, and extending for only about $\frac{1}{8}$ of its length beyond apex of coria; in macropterous form, slightly to considerably wider than corium and $\frac{3}{4}$ or more as long, extending for $\frac{1}{4}$ or more of its length beyond apex of coria. Length: sub-brachypterous 2.4-3.2 mm.; macropterous about 3.5 mm. Width: sub-brachypterous 1.0-1.3 mm.; macropterous (two specimens), ♂ 1.15 mm.; ♀ 1.4 mm.

Sub-brachypterous form, fig. 1.

Colour: Ochreous; head ferruginous, usually darker; eyes brownish black; ocelli reddish; antennae with fourth segment and usually extreme apex of third black; fourth rostral segment, the claws and the apex of third segment of tarsi black; venter of thorax black in middle between coxae, the rest ochreous to dark brown; pronotum and scutellum ochreous, usually darker than hemelytra and more or less infuscated; calli brown; hemelytra pale stramineous to ochreous, sometimes more or less infuscated in streaks and around punctures; inner margin of corium, bordering membrane, narrowly infuscated, more conspicuously black at base behind apex of clavus and at apex; whole dorsal suface occasionally with reddish tinge; membrane colourless and transparent towards apex, infuscated towards base; venter of abdomen ochreous or ferruginous, sometimes nearly black towards base.

Head: From above about $\frac{1}{3}$ as wide again across eyes as long (52: 38). Each eye about $\frac{1}{4}$ as wide as interocular space (9: 34); distance between ocelli twice that between each ocellus and the level of the innermost margin of the eye (taken transversely) (15: 7). Head above with close punctation, giving a granularly roughened appearance, punctures more remote on tylus and antenniferous tubercles; below finely and more remotely punctate; above and below with a covering of deciduous, golden, scale-like hairs, most of those of upper surface usually rubbed off, those of under surface usually concealing the punctures.

Antennae 1/6th-$\frac{1}{4}$ as long again as head and pronotum together; segment I short, stout, equal or subequal in length to distance between ocelli, subcylindrical, narrowing slightly towards apex; segment II short, equal or subequal in length to I and only $\frac{1}{3}$-$\frac{3}{8}$ as long as III, slightly and gradually thickened on apical half; III the longest and most slender, swollen at extreme apex; IV fusiform, subacute apically,



Figs. 1-2. *Cymus novaezelandiae* sp. nov. 1, sub-brachypterous ♂; 2, macropterous ♂, outline to show form of hemelytra.

strongly swollen, width near middle about $\frac{1}{3}$ length and rather wider than I; relative length of segments I-IV, 15: 15: 42: 30 (III and IV may vary even between the antennae of the one individual); relative width, I 7; II 2.5 at base, 4 at apex; III 3 at base, 4.5 at apex; IV 9.5 in middle; all segments with minute, setiferous tubercles, the hairs of segments I-III very short, pale, inconspicuous, semi-recumbent, rather sparse; IV with a close covering of very much longer black hairs. *Rostrum* reaching to posterior end of middle coxae, sometimes as far as anterior margin of hind coxae; segment I not quite reaching base of head; II reaching or almost reaching front coxae; III passing front coxae but not reaching middle coxae; segment I the longest, then in order, IV, II, III, but II sometimes equal to III, and sometimes nearly as long as IV; relative length of segments I-IV, 24: 16: 16: 21. Bucculae half as long as first rostral segment or nearly so, pale ochreous, with three or four punctures.

Thorax: Pronotum trapeziform; anterior and posterior margin nearly straight, the latter very broadly and shallowly emarginate; sides nearly straight, very feebly sinuate; rather longer than head (43: 38) and 1/6th-$\frac{1}{4}$ as wide again across posterior angles as head across eyes (62: 52); median length $\frac{2}{3}$-$\frac{3}{4}$ posterior width (43: 62) and equal to or only slightly greater than anterior width; anterior collar $\frac{1}{4}$ as long as whole pronotum, demarcated laterally, in front of calli, by more or less distinct transverse impressions; central part of disc, between calli, rather convexly raised but only obsoletely carinate; posterior half of disc scarcely raised, nearly flat, not markedly declivous at basal margin;

whole surface of pronotum, except the well defined calli, with large punctures mostly less than one puncture-width apart. Under-side of all thoracic segments, to bases of legs, similarly though rather more obscurely punctate, with a covering of deciduous hairs similar to those of the head (pronotum apparently originally with similar hairs, one to each puncture, but these have been worn down to their extreme bases, except where protected in the depressions between anterior collar and calli). Median part of thoracic venter, between bases of legs, with fine punctures several puncture-widths apart. Metathoracic scent-gland spout very small, tubercle-like, ventrally truncate. Scutellum with fine, rather obscure punctures, disc convexly raised towards median line, but without a distinct carina; base strongly depressed; $1\frac{3}{4}$ to twice as wide at base as long (31: 17). Legs short, with a covering of very short, pale, inconspicuous hairs, longest on hind tibiae and tarsi; relative length, femur: tibia: tarsus (excluding claws), as 32: 33: 18 (front leg); 50: 47: 20 (hind leg).

Hemelytra: Costal margins of corium strongly and evenly convex until about 1/5th from base, where sinuately incurved, thence nearly straightly converging to base; costal border above only narrowly flattened; corium twice to $2\frac{1}{4}$ times as long as outer margin and 3-4 times inner margin (behind scutellum) of clavus (116: 55: 35). Clavus with three rows of deep punctures larger than those of pronotum, those of each row nearly contiguous: a row closely parallel to claval suture, a V-shaped row parallelling the inner and the scutellar margins, and a straight row between them; in addition, usually one or two punctures between the two last-mentioned rows near the inner end; whole of corium covered with similar punctures. Membranes relatively short and narrow, each about $\frac{2}{3}$ as long as corium (75: 116) and with greatest width less than (0.55-0.88) greatest width of corium (25:40); extending beyond apex of coria for only 1/10th-1/6th of their own length (12: 75) and for a distance equal to only 1/17th-1/9th of the corium length.

Abdomen with venter very finely pubescent at base, except at sides, remainder shining, nearly glabrous, with extremely short, sparse, pale hairs.

The actual measurements are those of the holotype ♂; the ranges of proportions are from the whole available series of both sexes. There are no constant sexual differences in any of the proportionate dimensions, except as detailed below.

Length: ♂ 2.4 mm.-2.7 mm.; ♀ 2.9 mm-3.2 mm.

Width: ♂ 1.0 mm.-1.13 mm.; ♀ 1.20 mm.-1.27 mm.

Ratio of length to width: ♂ 2.2-2.5; ♀ 2.4-2.5.

Macropterous form, fig. 2.

This differs from the sub-brachypterous in the following respects: Hemelytra longer, with costal margin of corium sinuately incurved at apex as well as base. Membrane much longer and wider, in the two specimens to hand 0.84 (♂) and 0.75 (♀) times as long as corium; wider than corium (♂ 60: 42; ♀ 54: 50); extending beyond apex of corium for about $\frac{1}{3}$ of its own length in ♂ (43: 112) and about $\frac{1}{4}$ in

♀ (31 : 112) and for nearly $\frac{1}{3}$ of corium length in ♂ (43 : 133) and about 1/5th in ♀ (31 : 150). Pronotum proportionately rather larger, about $\frac{1}{4}$ as long again as head (51 : 41 in ♂, 50 : 44 in ♀). Size greater and form more elongate. Length: ♂, ♀ 3.5 mm. Width: ♂ 1.15 mm.; ♀ 1.4 mm. Ratio of length to width: ♂ 3.0; ♀ 2.5.

Both these macropterous specimens are dark; the pronotum, clavi and coria similarly infuscated ochreous; calli brownish black in ♂; venter of abdomen ferruginous, infuscated on basal half, where nearly black in ♂.

Sub-brachypterous form:

Types: Holotype ♂, Paiaka, Manawatu, North I., 9/1/50, T.E.W. Allotype ♀, Otautu area, Cape Colville, Coromandel Pen., North I., 16/1/52, sweeping grasses, T.E.W. In Auckland Museum.

Other specimens examined (including paratypes). *Mainland and nearby islands:* 1 ♂, 1 ♀, Kaitaia, N. Auckland, N.I., 13/5/23, J. G. Myers (Dom. Mus.); 2 ♂, 2 ♀, Auckland, 20/3/49, T.E.W.; 1 ♂, Auckland, 8/49, T.E.W.; 1 ♀, Paiaka, Manawatu, 2/2/51, T.E.W.; 1 ♂, Kawau I., Auckland, 5/1/51, T.E.W.

Three Kings Is.: 1 ♂, N.W. cliffs, Great I., 4/1/53, sweeping *Carex* and *Scirpus,* J. S. Edwards; 1 ♂, cliff brow, S.W. Cove, Great I., 5/1/53, on *Scirpus nodosus,* J. S. Edwards.

Macropterous form:

One ♀, Dyer's Pass, Christchurch, S.I., 9/1/25, C. E. Clarke, coll (Auck. Mus.); 1 ♂, Remuera, Auckland, 1/2/52, E. T. Giles.

This is in all probability the species referred to by Myers (1926; pp. 457, 462, 485) as *Cymodema* sp., of which he notes: "Adults have been taken in August, December, and February in the sweeping-net, and in May and July in winter quarters at the bases of rush-clumps, where they were most abundant in the later month." Of host plants, he says, "Meadow-grasses, especially *Bromus unioloides* K.B.K., are favoured. In winter the bases of *Juncus effusus* L. afford them shelter. . . ." He records the species as having been collected in North Auckland (Kaitaia), Wanganui, Levin (Weraroa), and Waikanae, all in the North Island.

Abnormalities:

In one ♀ (Otautu) the punctation of the right clavus is much reduced. The inner row has only 5 punctures behind scutellar apex (instead of about 8) and 2 near base; the outer row has only 2 punctures in apical half and 3 near base. The middle row is lacking. The basal half of the clavus is thus impunctate except at the extreme base. Those punctures present are of normal form. The punctation of the left clavus is normal.

Two specimens show antennal oligomery, a common malformation in the Lygaeidae. In 1 ♂ (Auckland, 8/49), the left antenna shows no division between segments III and IV, and the resultant fused segment is considerably shortened (ratio to III + IV on right antenna, 40: 64) and apically dilated as a black club, smaller and blunter at base and apex than the normal segment IV. The appearance is of regeneration following loss of the two apical segments in a nymphal instar. In 1 ♀ (Kaitaia), the left antenna shows no obvious segmentation after segment I and the unsegmented region is shortened as in the ♂ (ratio to II + III + IV of right antenna, 56: 87). There is also a curious malformation of the unsegmented region, which is clavately swollen and black at about half-way, then twisted, the apical half coming off from one side of the club, and narrowed; at the extreme apex the antenna is swollen again as an ovoid, stouter, and much shorter black club. The impression given is of an initial break at the extreme base of segment II of the nymphal antenna, followed by a second, apical break and/or damage after the regeneration of the first club.

(All the proportionate measurements given for the species are to the scale 75 units = 1 mm.)

Dr. W. E. China has determined the present species as belonging to *Cymus*. The short second antennal segment, subequal to the first, is not usual in the genus, but there is another instance in the North American species *Cymus breviceps* Stal.

FAMILY REDUVIIDAE.

SUB-FAMILY EMESINAE.

Empicoris rubromaculatus (Blackburn).

1889—*Ploiariodes rubromaculatus* Blackburn, *Proc. Linn. Soc. N.S.W.* 3 (1): 349.

One ♂, 1 ♀, Tasman Valley, Great I., 31/12/52, sweeping from *Leptospermum*, J. S. Edwards.

A widely distributed species, occurring in the Americas, the Pacific, Australia and New Zealand.

FAMILY NABIDAE.

Nabis maoricus F. Walker.

1873—*Nabis maoricus* F. Walker, *Cat. Hem. Het. Brit. Mus.* 7: 145.

1878—*Nabis saundersi* Buch. White, *Ent. mon. Mag.* 15: 159.

The Saddle, Great I., 2/1/53, 1 ♀ on kanuka (*Leptospermum ericoides*), 1 ♀ on ngaio (*Myoporum lactum*), J. S. Edwards. 1 ♀, E. block, Great I., 15/1/51, T. E. Woodward.

Endemic to New Zealand, where common and widespread. Dr. W. E. China has compared New Zealand specimens of both this species and the following with material in the British Museum, and gives the above new synonymy as probably correct. Previously, *N. saundersi* has been synonymised by some authors with *N. capsiformis*.

Nabis capsiformis Germar.

1837—*Nabis capsiformis* Germar, *Silbermann Rev. Ent.* 5: 132.

One ♂, 2 nymphs, Castaway Valley, Great I., 12/1/51, T. E. Woodward.

This species is widespread in the Pacific and is now nearly cosmopolitan.

FAMILY ANTHOCORIDAE.

Specimens of apparently a single species of Anthocorid were taken by J. S. Edwards and the author from Great I. (on *Chenopodium triandrum* and *Leptospermum* and from leaf mould, and by the author from S.W. Island (sweeping *Myoporum lactum* and *Muehlenbeckia complexa*). As the Anthocoridae of the Australian region are in process of revision by Mr. G. F. Gross, of the South Australian Museum, specimens have been forwarded to him, and it has seemed desirable to await his determination on the basis of this wider study.

Mr. Gross has identified these specimens as belonging to a new species of *Lasiochilus* Reuter, which he is describing, and which is also widespread on the mainland of New Zealand.

FAMILY ARADIDAE.

A single specimen was extracted from leaf mould collected by the author under ngaio (*Myoporum lactum*) on S.W. Island, 13/1/51. Together with other New Zealand material, this has been forwarded to Prof. R. L. Usinger, of the University of California, who is engaged in a revision of the Aradidae of the world.

FAMILY MIRIDAE.
SUB-FAMILY MIRINAE.

Megaloceroea reuteriana Buch. White.

1878—*Megaloceroea (Megaloceroea) reuteriana* Buch. White, *Ent. mon. Mag.* 15: 130.

Collected by author: 4 ♂♂, 10 ♀♀, 5 nymphs, Tasman Valley (east side), Great I., 12/1/51, sweeping grasses and sedges; 2 ♂♂, 3 ♀♀, 7 nymphs, near depot, Great I., 12/1/51, sweeping grasses and sedges; East Point, Great I., 17 ♂♂, 5 ♀♀, 5 nymphs, 14/1/51, on and under *Poa anceps* Forst. on cliff slopes, 1 ♂, 1 ♀, 15/1/51, sweeping sedges and rushes.

Collected by J. S. Edwards: 1 ♀, Tasman Valley, Great I., 30/12/52, on *Ipomoea;* 5 ♂♂, 1 nymph, cliffs at end Tasman Valley, Great I., 31/12/52, sweeping grasses and *Scirpus;* 2 ♀♀, Eastern arm, Great I., 1/1/53, sweepings from ground vegetation (*Carex*, mosses, etc.); 1 nymph, kanuka canopy near Quadrat II, Great I., 2/1/53 (*Leptospermum ericoides*); 2 ♂♂, the Saddle, Great I., 2/1/53, on ngaio (*Myoporum lactum* Forst.); 1 nymph, N.W. cliffs, Great I., 4/1/53, 480ft., sweeping *Carex* and *Scirpus*; 1 ♂, 1 ♀, cliff brow, S.W. Cove, Great I., 5/1/53, on *Scirpus nodosus* Rottb.

This species is widespread in Australia and New Zealand and is common on grasses, sedges and rushes.

Calocoris laticinctus (Walker).

1873—*Capsus laticinctus* F. Walker, *Cat. Hem.-Het. Brit. Mus.* 6: 128.

Tasman Valley, Great I.; 2 ♂♂, 1 ♀, 11/1/51, sweeping *Blechnum;* 1 ♂, 1 ♀, 12/1/51, sweeping grasses and sedges, T.E.W.

This species, which has long been synonymised with *Capsus ustulatus* F. Walker, *loc. cit.*, was placed by Distant in the genus *Calocoris*, but, as Dr. China has pointed out (*in litt.*), it differs from other species of *Calocoris* in having the head completely transversely carinate behind. Eventually it will most probably have to be removed from this genus. The species is known only from New Zealand.

Eurystylus australis Poppius.

1911—*Eurystylus australis* Poppius, *Ofvers. Finsk. Vet. Soc.* 53 A (4): 15.

One ♀, cliffs below Tasman Valley, Great I., 31/12/52, swept from *Haloragis erecta* (Murr.) Schind.; coll. J. S. Edwards.

This species occurs in both Australia and New Zealand, having apparently been introduced from the former to the latter.

Genus **LYGUS** Hahn, 1833.

Three species of *Lygus* were taken, but as this genus is a very large and cosmopolitan one, and most of the New Zealand and Australasian species are either undescribed or inadequately described, the naming of isolated new species is highly undesirable. The *Lygus* fauna of these regions needs revision as a whole and the author hopes to attempt this before long.

Sp. 1. Numerous specimens (several hundred) were collected by J. S. Edwards and the author from *Leptospermum ericoides* (kanuka) on Great I. The same species is also extremely abundant on kanuka on the mainland of New Zealand.

Sp. 2. Specimens were collected by J. S. Edwards and the author from *Myoporum laetum* (ngaio) on Great I. This species also occurs on the mainland.

Sp. 3. Taken by the author from shrubs on both Great I. and S.W. Island. Not known from the mainland.

SUB-FAMILY ORTHOTYLINAE (CYLLECORINAE).

Coridromius variegatus (Montrouzier).

1861—*Ocypus variegatus* Montrouzier, *Ann. Soc. ent. Fr.* (sér. 4) 1: 67.

Eight ♂♂, 9 ♀♀, 21 nymphs, S.W. Island, 13/1/51, on and under *Salicornia australis* Forst.; 14 ♂♂, 17 ♀♀, 28 nymphs, East Point, Great I., 14/1/51, *Chenopodium triandrum* Forst., on rocks at foot of cliffs; 1 ♂, 3 ♀♀, near depot below cliffs, Great I., *Chenopodium triandrum;* coll. T. E. Woodward.

This species was kindly determined by Dr. W. E. China, British Museum (Nat. Hist.). This is the first record of the species from New Zealand, and I have subsequently taken it from the Wellington district, North I. (1/2/51, Day's Bay, on *Lepidium oleraceum* Forst., and Titahi Bay, on and beneath *Salicornia australis, Lepidium oleraceum* and *Chenopodium triandrum*). All the plants on which it has been found in New Zealand are coastal succulents. This small, mottled species occurs also in Australia and New Caledonia. The hind femora are incrassate and the insect is capable of jumping some distance into the air when disturbed.

SUB-FAMILY PHYLINAE (PLAGIOGNATHINAE).

Sthenarus myersi Woodward.

1950—*Sthenarus myersi* Woodward, *Rec. Auck. Inst. Mus.* 4 (1); 22-23; figs. 12-15.

Collected by author: 22 ♂ ♂, 18 ♀ ♀, 2 nymphs, Tasman Valley, Great I., 11-12/1/51; 2 ♀ ♀, 1 nymph, near depot, Great I., 12/1/51; 3 ♂ ♂, 7 ♀ ♀, 2 nymphs, East Point, Great I., 15/1/51:

Collected by J. S. Edwards: 1 ♀, near depot, Great I., 30/12/52; 1 ♂, Tasman Valley, Great I., 31/12/52; 1 ♀, on cliffs, Great I., 4/1/53; 1 ♀, Bare Saddle, S.E. Bay, Great I., 5/1/53.

All the specimens were collected on kanuka (*Leptospermum ericoides* A. Rich.).

This species is known only from New Zealand, where it has a wide range at least in the North Island.

With the larger series now available, additional information can be given on variations in colour. The males tend to be darker than the females, but both sexes may be more or less rufescent, either above or both above and below, the cuneus sometimes entirely red or reddish brown, and some males, though in smaller proportion than the females, have the basal two-thirds of the second antennal segment ochreous. All specimens are of the larger type, as described by the author (1950) from Manawatu.

Sthenarus sp.

This species, which so far as can be determined at present is new, and is not known to the author from the mainland, was taken on pohutukawa (*Metrosideros excelsa* Gaertn.), 12-15/1/51 (T.E.W.). Unfortunately, the specimens are damaged, and description has been deferred until a better series can be obtained.

FAMILY VELIIDAE.

SUB-FAMILY MICROVELIINAE.

Microvelia halei Esaki.

1926—*Microvelia oceanica* Hale, *Rec. S. Austr. Mus.* 3: 208; *nec* Distant 1914, *in* Sarasin and Roux, *Nova Caledonia, Zool.* 1: 383.

1928—*Microvelia halei* Esaki, *Ins. of Samoa* 2 (3): 69; new name for *M. oceanica* Hale.

Thirty-six apterous ♂ ♂, 33 apterous ♀ ♀, 1 macropterous ♀, 40 nymphs, Tasman Stream, Great I., 11/1/51, T.E.W.

Occurs in Australia, New Zealand, and Lord Howe I.

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New Zealand Molluscan Systematics, with Descriptions of New Species, Part 2.

By A. W. B. POWELL, Auckland Museum.

Genus SEPTIFER Recluz, 1848.

Septifer cf. bilocularis Linn.

1758—*Mytilus bilocularis* Linn. Syst. Nat. 10th ed., p. 705 Indian Ocean.

A juvenile valve in fresh condition was obtained by Mr. Gordon Williams from the stomach contents of fish taken in 45 fathoms off Mayor Island, Bay of Plenty. It is 3.5 mm. in length and 3.2 mm. in height. The fish was a tarakihi (*Dactylopagrus macropterus* Forster).

The occurrence of this widespread Indo-West Pacific coral dwelling mussel in New Zealand waters is surprising, but small valves similar to the New Zealand example are not uncommon in a dredging from 10-30 metres off Sunday Island, Kermadecs.

Although the New Zealand specimen is very small it shows the unmistakable characteristics of the genus; i.e., variegated blue, green and reddish brown coloration, crenulated internal edge of the shell, short hinge on an internal ledge, muscle shelf behind the hinge and external sculpture of radiating closely-packed flattened ridges.

The muscle shelf is only half developed in this juvenile shell. It extends as a triangular plate from the ventral margin, but in some slightly larger Kermadec specimens the shelf extends two-thirds of the way across.

The excellent condition of the Mayor Island valve indicates that it could not have been long in the fish's stomach and must have been taken in the vicinity, thus ruling out the possibility of the fish having migrated from warmer seas with the shell in its stomach.

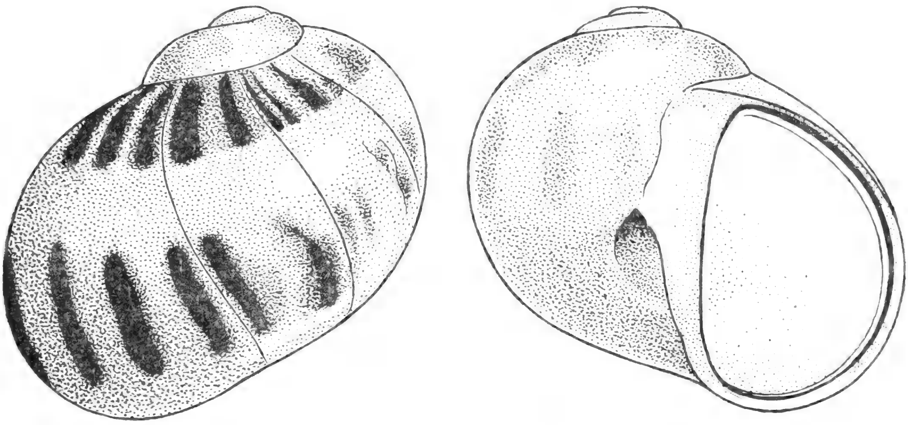
Proxiuber hulmei n. sp.

Shell of similar size to *australis* but proportionately broader, not so globose, with a distinctive colour pattern of two broad spiral zones of rectangular axial dark reddish-brown markings on a white ground covered by a very thin buff epidermis. Umbilicus a more convex crescent than in *maoria,* widely open, although half filled by the funicle and columellar callus. The two colour zones are both broad, the first subsutural and the second peripheral. They are separated by a clear space equal to half the width of a colour zone and the lower part of the base, almost equal to the width of a colour zone, is clear also. The surface is smooth and glossy, with faint, closely-spaced axial growth lines. The operculum is calcareous, smooth, white, paucispiral with two faint grooves margining the outer edge.

Height, 4.2 mm.; diameter, 4.5 mm. (Holotype).

Locality: Obtained from an Auckland trawler, exact locality and station not known.

Holotype: Presented to the Auckland Museum by Master S. G. Hulme.



Proxiuber hulmei n. sp. 4.2 mm. x 4.5 mm.

Genus **MYSTICONCHA** Allan, 1936.

Mysticoncha harrisonae Powell.

1946—*Mysticoncha harrisonae* Powell. *Rec. Auck. Inst. Mus.* 3 (2) p. 144.

Holotype: Lowrie's Beach, The Neck, Stewart Island. Powell collection, Auckland.

Two further examples of this species are now know. (1) 60 fathoms east of Stewart Island in stomach of blue cod (Mr. T. E. Jensen), (2) Pohara Beach, near Takaka, Nelson (the late Mr. W. V. Hadfield).

Cabestana (Cymatilesta) otagoensis n. sp. Pl. 39, fig. 1.

Shell large for the *waterhousei* group, slender, solid. Protoconch missing. Early whorls with two bifid, beaded prominent spiral keels, uppermost medial and four secondary beaded spiral cords, two above the medial keel, one between the keels and one below. On the antepenultimate the secondary spirals increase to four above the medial keel and two below the lower keel. On the body-whorl there are about 13 primary bifid spirals and a single cord in each interspace. Varices prominent, flange-like, spaced at two-thirds of a whorl intervals. Intervariceal axials weak, six to seven in number, unequally spaced, always bunched over two-thirds of the distance, leaving a clear space before the next varix commences. Height of spire about four-fifths height of aperture plus canal. Colour buff, intercostal spaces on the varices banded with pale reddish brown. Operculum ovate-pyriform with a terminal nucleus. Epidermis completely worn off.

Height (actual), 93.0 mm. (estimated), 94.0 mm.; diameter, 46.0 mm.

Locality: 10 miles north of Moeraki, Otago, 45 fathoms.

Holotype: Auckland Museum. Presented by Captain J. Black.

This species belongs to the *debilior* line rather than to the *waterhousei* line. The characteristic features are (a) the varices curving upwards and clasping the preceding whorl almost to the height of the lower keel and (b) the curious bunching of the axials in the intervariceal spaces.

In the Castlecliffian *debilior* Finlay, 1930, there are four bunched axials per intervariceal space compared with six or seven in *otagoensis*.

A shell washed up at Hokeo Beach, Levin, has the characteristic four bunched axials of *debilior*. Shells of a number of species judged to be derived from Pliocene beds are not uncommon on the Manawatu beaches. *Cabestana manawatuna* Fleming, 1943, from Locality 2492, Tahoraiti (S.W.) S.D., Lower Nukumaruan, seems to be ancestral to *debilior* rather than to *waterhousei*.

Mayena australasia blacki n. subsp. Pl. 39, fig. 2.

Shell larger than the typical species, prominently shouldered. Whorls angled medially, scarcely keeled and bearing bluntly rounded nodules, seven or eight between varices. There is no second or sutural angulation. Surface sculpture of dense spiral lirations and weak low primary spirals, two or three on the shoulder and about five on the body-whorl and base. Spire taller than aperture plus canal. Aperture strengthened with a heavy varix, strongly dentate within and with a massive parietal tubercle. Canal short, slightly oblique but little recurved. Colour pinkish buff obscurely maculated with pale reddish-brown. Varices banded with light purplish brown, and white where crossed by the weak primary spirals. Labial callus and interior of aperture porcellanous white. Epidermis yellowish-brown, densely axially lamellated, the lamellae crowded with short bristles.

Height (actual), 121.0 mm. (estimated), 124 mm.; diameter, 62.5 mm. (holotype).

Height (actual), 118.5 mm.; diameter, 59.5 mm.

Locality: Off Eastern Otago in 60-70 fathoms.

Holotype: Auckland Museum. Presented by Captain J. Black.

Two large examples of a *Mayena* from Bluff oyster boats, taken in 10 to 15 fathoms Foveaux Strait, resemble Northland shallow water *australasia* except for a relatively taller spire and weak numerous nodules (10-14 between varices) confined to the single peripheral angulation. When more material is available the Foveaux Strait form may be separable from typical *australasia*.

The relationship of *blacki* appears to be with this shallow-water Forsterian form of *australasia* rather than with subspecies *vossi* Powell, 1952, from 70 fathoms off Mayor Island, Bay of Plenty.

Other interesting records of warm-water *Cymatiidae* in the Forsterian are:—

Ranella multinodosa (Bucknill), off Eastern Otago, 60-70 fathoms.

Cabestana (Cymatilesta) spengleri (Perry), Foveaux Strait, oyster dredge (Mrs. R. H. Harrison) and (Mrs. E. Smith).

Cabestana (Cymatilesta) otagoensis n. sp., 45 fathoms, 10 miles north of Moeraki.

Genus **EMOZAMIA** Iredale, 1929.

Type (o.d.): *Murex licinus* Hedley and Petterd, 1906.

Emozamia licina (Hedley and Petterd). Pl. 39, figs. 5-7.

1906—*Murex licinus* Hedley and Petterd, Rec. Austr. Mus. 6 (3), p. 219, Pl. 37, fig. 6.

1929—*Emozamia licina*: Iredale, Rec. Austr. Mus. 17 (4), p. 185.

Holotype: Off Sydney, New South Wales, 250 fathoms.

The New Zealand specimen described below and figured (Plate 39, fig. 7) is probably identical with the New South Wales species. It is a rare shell in New South Wales collections, but through the courtesy of Miss Gertrude Thornley and Mr. C. F. Laseron, both of Sydney, I have two specimens on loan for comparison with the New Zealand shell. One of these is from Bateman's Bay, 60 fathoms, and the other Port Stephens, 30-40 fathoms.

The secondary or intermediate spirals are absent in Hedley's drawing of the holotype, weak in the Bateman's Bay and New Zealand specimens and strongly developed in the Port Stephens example. There is insufficient material to evaluate these differences, so, for the present, only one species is admitted. Following is a description of the New Zealand shell:—

Shell small, lightly built, broadly rounded, with a low spire and sculptured with vertical, low, rather narrow fluted varices, eight per whorl. On the spire-whorls there is a single rounded spiral cord and on the body-whorl the addition of five similar cords. There is a weak secondary spiral thread between the suture and the peripheral cord and one between each pair on the body-whorl. The cords do not cross the varices but form into a weak recurved spinose process at the crest of each varix. The surface of the shell is otherwise smooth and the colour uniformly pale pinkish-buff. Aperture relatively large, broadly-ovate. Anterior canal, partially closed, broad at the base but rapidly tapered, recurved and about one-third the height of the aperture in length. Fasciole narrowly arched, strongly imbricated and with a narrow false umbilicus partially bridged by the almost free parietal callus.

Height, 16.0 mm.; diameter, 12.0 mm.

Locality: 46-82 fathoms N.N.E. of Mayor Island, Bay of Plenty (S. M. Hovell); obtained from an Auckland trawler, exact locality and station not known (S. G. Hulme).

Genus **IREDALINA** Finlay, 1926.

The holotype of *Iredalina mirabilis* Finlay is a large, slender shell with a narrowly angled attenuated spire. It remained unique for over twenty-five years, but dead encrusted shells of *Iredalina* have been taken recently in some quantity by Captain J. Black, of the Dunedin trawler "Taiaroa."

In 1950 (Rec. Auck. Inst. Mus. 4 (1), p. 81) I recorded four specimens from the above source and noted that these had a shorter spire and a more inflated body-whorl. Dell (1951, Rec. Cant. Mus. 6 (1), p. 57) also recorded a similar squat inflated example from 80 fathoms off Banks Peninsula.

The considerable number of Eastern Otago shells I have now examined show that there are two forms or species of *Iredalina* on the eastern Otago shelf and that the genotype, *mirabilis* is much the rarer of the two.

At first I was inclined to consider the holotype to be an abnormality exhibiting elongation resultant from some early injury, but further examples of the slender typical *mirabilis* show that there is a constant difference between the slender and squat shells that is not related to shape.

All five typical *mirabilis* I have examined are lacking in sculpture on the pillar and all of the thirty or more examples of the squat species have about ten slightly raised spiral threads running around the pillar and terminating at the broad shallow oblique anterior notch. This pillar sculpture was noted by Dell (l.c.) also in his Banks Peninsula shell.

Iredalina mirabilis Finlay. Pl. 39, fig. 3.

1926—*Iredalina mirabilis* Finlay, Proc. Mal. Soc. 17, pp. 59-62.

Localities: 40 fathoms off Otago Heads (Holotype); 58 fathoms off Waitaki River (Captain J. Black).

Holotype: Finlay collection, Auckland Museum.

Shell large, always slender with a spire angle of 32-33° and no spiral threads on the pillar. The colour is indicated as uniformly salmon-pink without colour pattern and with a high glaze in life. No living examples have been taken.

Height.	Diameter	Ht. ÷ Diam.	Ht. ÷ Ht. Aperture.	Spire Angle.
140.0 mm.	48.0 mm.	2.91	1.97	32° *
147.0 mm.	48.0 mm.	3.06	1.98	33°
120.0 mm.	40.5 mm.	2.96	1.93	32°
112.0 mm.	39.5 mm.	2.83	1.89	32°

* = Holotype.

Iredalina aurantia n. sp. Pl. 39, fig. 4.

1950—*Iredalina mirabilis:* Powell, Rec. Auck. Inst. Mus. 4 (1), p. 81.

1951—*Iredalina mirabilis:* Dell, Rec. Cant. Mus. 6 (1), p. 57.

Localities: 50-60 fathoms off Cape Saunders; off eastern Otago, 60-70 fathoms (Holotype) (Captain J. Black); 80 fathoms off Banks Peninsula.

Shell smaller than *mirabilis,* more inflated with a spire angle of 44-52° and about ten slightly raised spiral threads running round the pillar. The colour, indicated by one very well preserved example from 55 fathoms off Cape Saunders, is uniformly salmon-pink with a high glaze. It is a very similar colour to that of the well known Fijian orange cowry, *Cypraea aurantium* Linn.

The station of *Iredalina* is still problematical. They must occur adjacent to the 60-70 fathoms hard bottom where the shells are trawled. The 55 fathoms Cape Saunders shell is the best preserved one so far taken, and this shell was not long dead, having full colour, original glaze, and was neither worm eaten nor encrusted.

Height.	Diameter	Ht. ÷ Diam.	Ht. ÷ Ht. Aperture.	Spire Angle.
77.0 mm.	35.0 mm.	2.17	1.68	52° (A)
87.0 mm.	38.5 mm.	2.26	1.58	50° (B)
109.0 mm.	49.0 mm.	2.22	1.60	51° (B)*
116.0 mm.	46.0 mm.	2.52	1.75	50° (B)
116.0 mm.	50.0 mm.	2.30	1.61	46° (B)
116.0 mm.	52.0 mm.	2.23	1.61	51° (B)
117.0 mm.	50.0 mm.	2.34	1.54	58° (B)
119.0 mm.	49.0 mm.	2.42	1.70	44° (C)

A = 80 fathoms off Banks Peninsula, B = 60-70 fathoms off Eastern Otago, C = 50-60 fathoms off Cape Saunders. * = Holotype.

Pachymelon (Palomelon) smithi Powell.

1950—*Pachymelon (Palomelon) smithi* Powell. Rec. Auck. Inst. Mus. 4 (1), p. 81.

Holotype: Off Eastern Otago ca. 70 fathoms. Auckland Museum.

A living specimen was trawled by Captain Black in 55-60 fathoms south of Timaru. The ground colour is pale orange with a conspicuous stain of bright purple around the fasciole and the suture at the termination of the last whorl. Most shells are devoid of other markings, but some have a sparse pattern of narrow angular streaks in dark reddish-brown arranged in three bands, one subsutural, one medial, and the third just above the fasciole.

Height.	Diameter.
118.0 mm.	45.5 mm. (Holotype)
113.0 mm.	44.0 mm.
73.0 mm.	29.0 mm.

The third specimen is one of several that have a well callused outer lip and are obviously adult. The axial sculpture is more pronounced and extends on to the body-whorl but otherwise there are no differences. The phenomenon of nanism is not uncommon among the deep water volutes of both New Zealand and Australia.

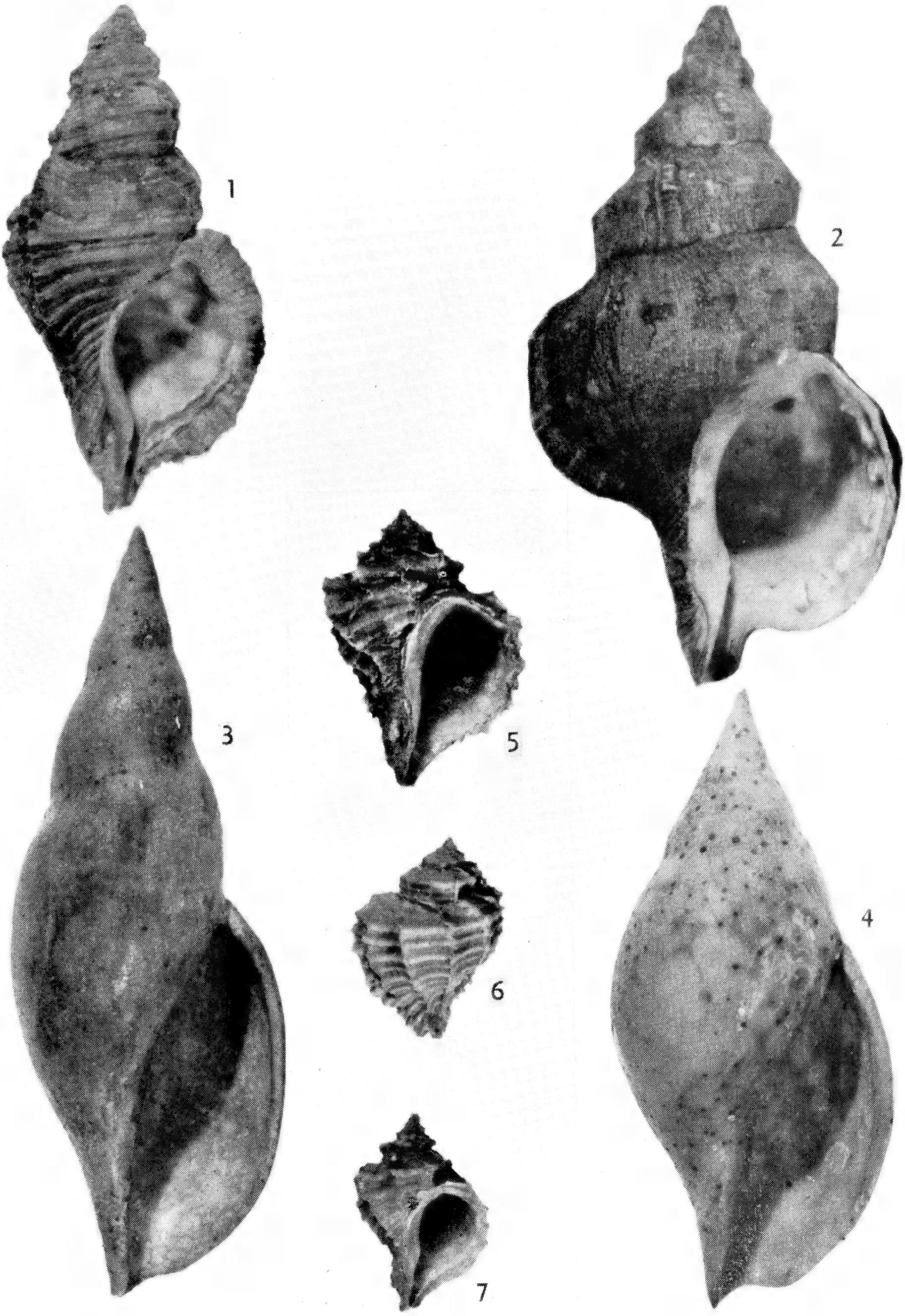


Fig. 1. *Cabestana (Cymatilesta) otagoensis* n. sp. Holotype 93 x 46 mm.
Fig. 2. *Mayena australasia blacki* n. subsp. Holotype 121 x 62.5 mm.
Fig. 3. *Iredalina mirabilis* Finlay. Holotype 140 x 48 mm.
Fig. 4. *Iredalina aurantia* n. sp. Holotype 109 x 49 mm.
Fig. 5. *Emozamia licina* (Hedley and Petterd), Bateman's Bay, 60 fathoms, New South Wales; Fig. 6. Port Stephens, 30-40 fathoms, New South Wales; Fig. 7. 46-82 fathoms N.N.E. of Mayor Island, Bay of Plenty, New Zealand, 16 x 12 mm. (All three figures uniform magnification).

A New Rail From Cave Deposits in the North Island of New Zealand.

By R. A. FALLA, Dominion Museum, Wellington.

Bird bones from a limestone cave about 13 miles from Hamilton, North Island, N.Z., discovered in 1948 by a party of the New Zealand Speleological Society led by Mr. H. G. Lambert and presented by the Society to the Auckland Museum, have been sent to me for examination, and I am grateful to the Director of the Auckland Museum, Dr. G. Archey, and to Mr. E. G. Turbott, ornithologist, for the opportunity to describe them.

The circumstances of the discovery have been described in a narrative account by P. Chester (*Newsview*, Auckland, May, 1953) and from it the following extracts are quoted: "High spot of the society's activity is the Karamu Cave, the most extensive one so far discovered in New Zealand. . . . Passages run through it for eight miles . . ." The article continues that: "The Bird Cave got its name from the skeleton of an extinct bird which Lambert and a party found on their second survey of the cave," and gives Lambert's own description as follows: "For four hours we'd lugged photographic equipment through the cave, hoping to find something worth photographing. Eventually we came to a spot below a gallery which we decided to explore. It took us another hour to find a way up. Then we spied the bird skeleton on the floor."

When finally extracted from the limestone matrix of the cave floor the bones were in fragmentary condition, but fortunately an excellent flashlight photograph (Plate 40) was taken by Mr. Lambert before they were disturbed, and this has saved much conjecture as to the probable proportions of the bird. It is a small rail, resembling in general proportions *Cabalus modestus* Hutton, but larger. Pectoral girdle, sternum, and wing-bones are missing, so that its flight potential remains unknown and can only be guessed at. From the fact that the legs have the proportional stoutness found in known flightless rails (*Gallirallus, Cabalus*) a similar condition might be inferred. The bones available may from their position *in situ* be referred to one individual. They are:—

Skull: Right half cranium with occipital foramen intact; premaxilla and mandibles complete but now in fragments tending to crumble because of their original light cancellated structure.

Vertebrae: Axis, atlas, ten other cervicals, and the last three free dorsals.

Pelvis: Almost complete.

Hind limbs: Right femur complete; left tibia, proximal end only; right tibia, distal end only; right tarsometatarsus complete.

Dimensions of these bones are included in the following description.

Rec. Auck. Inst. Mus. Vol. 4, No. 4, pp. 241-244, 12th February, 1954

Capellirallus, new genus.

Generic characters: Bill long (ratio of premaxilla to length of rest of skull, 2:1) decurved, tapering to blunt, rather flattened tip; possibly flexible and sensitive in life. Pelvis narrow (width 38% of total length compared with 45% in *Rallus* (*philippensis*)). Tarsometatarsus comparatively short, and, as in *Gallirallus*, lacking prominent outer "ridge" of *Rallus*. Type: *Capellirallus karamu* n. sp.

Capellirallus karamu n. sp.

Characters as given above for the genus. Available bones have the following dimensions:

Tarsometatarsus.—Length, 39.0; prox. w., 6.7; distal w., 7.0; med. w., 3.8 mm.

Tibia (parts of 2 bones used). Probable length, 65 (more or less); prox. w., 10.3; dist. w., 6.0; med. w., 3.5 mm.

Femur.—Length, 44.3; prox. w., 7.6; dist. w., 8.0; med. w., 3.8 mm.

Pelvis.—Length, 38; greatest width, 20; narrowest, 8.6 mm.

Skull.—Diameter of occipital foramen, 6; interorbital width, 5.7; total skull length (tip of bill to occiput), 88; premaxilla, 56 mm.

Holotype: An incomplete skeleton, Auckland Museum (No. 901.1).

Distribution

It seems likely that this rail had a wide distribution, at least in the North Island. From a large collection of bird bones obtained in limestone caves at Coonoor, near Dannevirke, in 1914, and sent to the Dominion Museum, Mr. J. C. Yaldwyn has lately sorted out a number of bones not referable to any described species. Some of them are clearly referable to *C. karamu*. They are in a better state of preservation than is the type material and consist of:

A complete cranium (C.130).

Right femur (C.132).

Matching pair of tarsometatarsi (C.129).

Right tarsometatarsis (C.129).

Complete pelvis (C.131).

I am also indebted to Mr. Yaldwyn for drawing my attention to an additional record from a collection of bones made by Mr. A. M. Hall in a limestone cave at Waitanguru, Waitomo, in 1949. These are some bones of an individual skeleton (133) consisting of fragments of pelvis, portions of both femora, pair of tarsometatarsi, and both tibiae. One of the tibiae is complete. Dimensions of the additional material, which show little variation from those given for the type, are here given for comparison.

A. Coonoor

Cranium.—Length, paroccipital to fronto-facial suture, 33; width (parietal), 20.5 mm.

Right femur.—L., 43.5; dist. w., 7.5; prox., 8.5; mid., 3.3 mm.

Tarsometatarsus (2 individuals).—(a) L., 39; prox., 6.5; mid., 4; dist., 7.5 mm.
(b) L., 37; prox., 6.5; mid., 3.7; dist. 7 mm.

Pelvis.—Length, 36; greatest width (post-acetabular), 78; least width (mid-iliac), 9 mm.

B. Waitanguru

Femur.—Mid., 3.5; dist., 8 mm.

Tibia.—L., 65; prox., 9; mid., 3.2; dist., 6 mm.

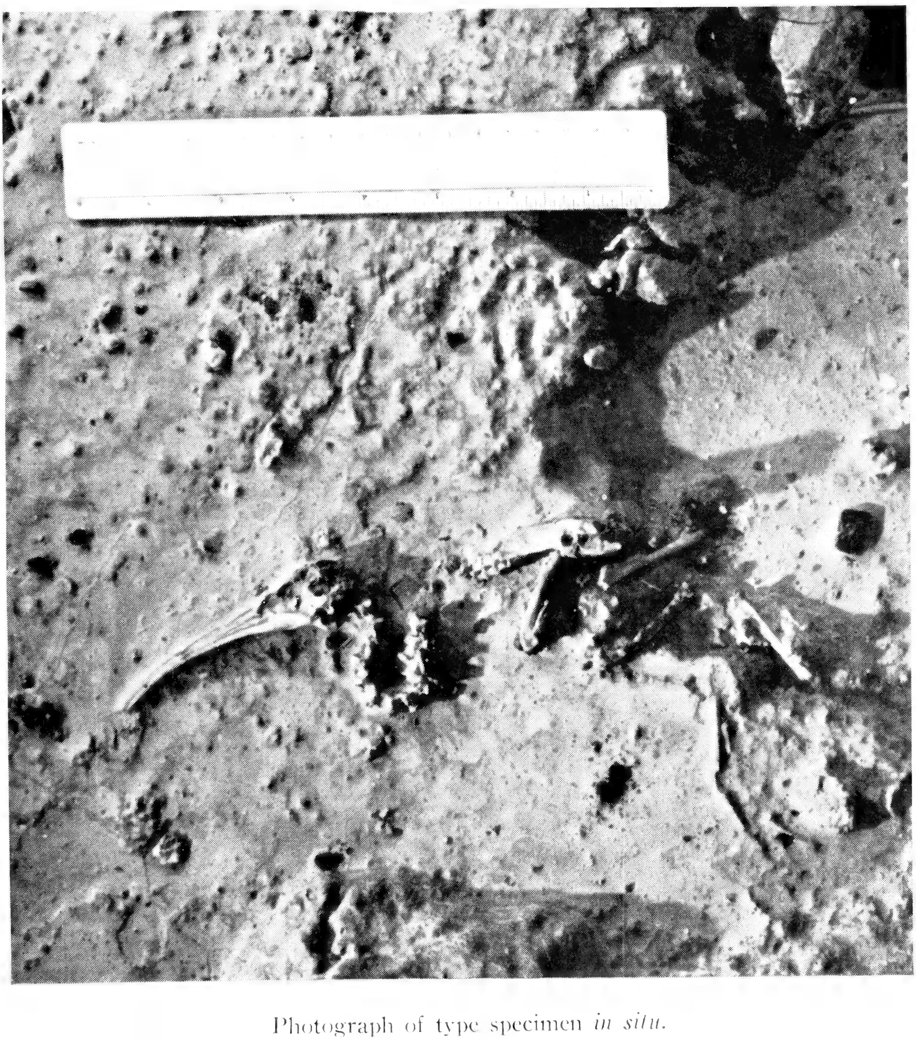
Tarsometatarsus.—L., 39; prox., 7; mid., 4; dist., 7.2 mm.

The type material, although in general less well preserved, is more completely representative of an individual bird, possessing the only known remains to date of the highly distinctive beak.

Relationships

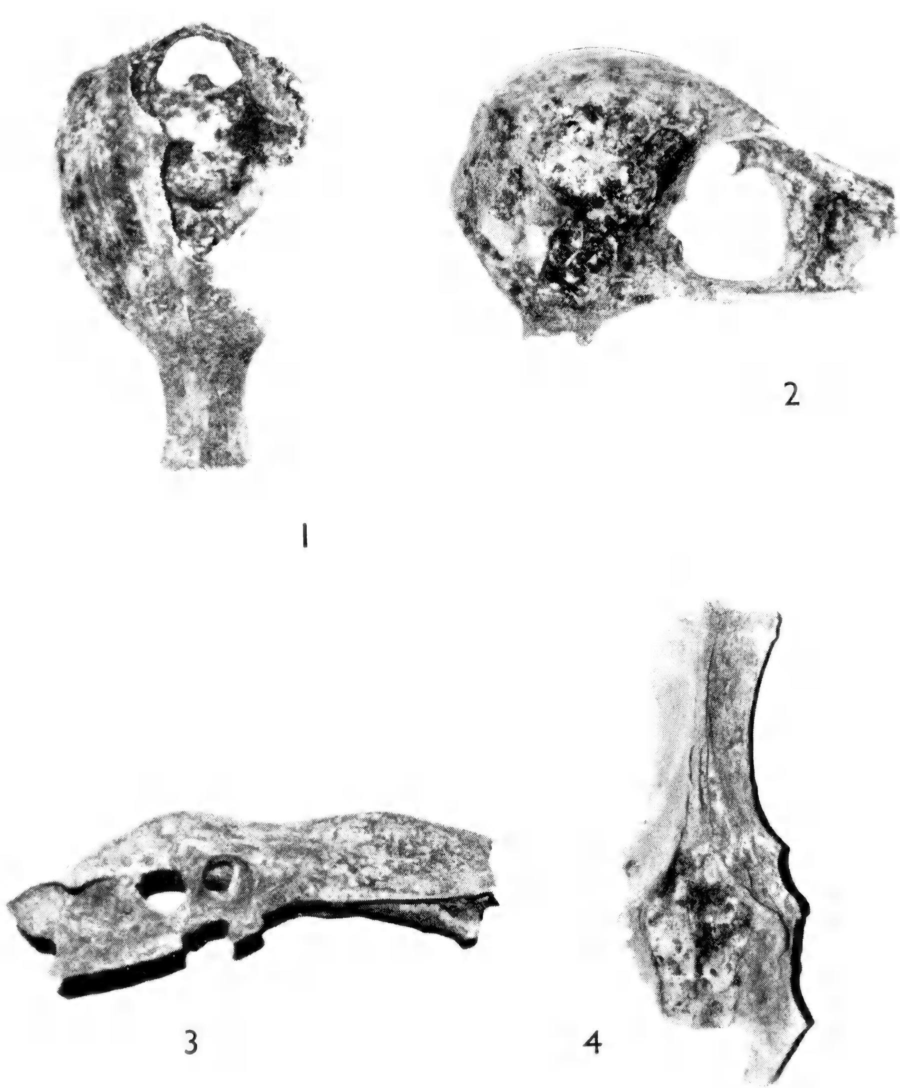
The absence of any identifiable sternum and of all wing bones makes it difficult to offer any useful comparison between the rail and related forms. One respect in which comparison can be made is in length of hind limb bones and proportions of hind limb bones one to another. If the tibia is taken as 100 in all cases, femur and metatarsus measurements in several species can be expressed as follows:

	Femur.	*Metatarsus.*
Hypotaenidia philippensis ..	71	63
Hypotaenidia sp.	80	64
Nesolimnas dieffenbachi	76	59
Cabalus silvestris	72	58
Ocydromus australis	70	56
Ocydromus greyi	68	58
Rallus karamu	69	62



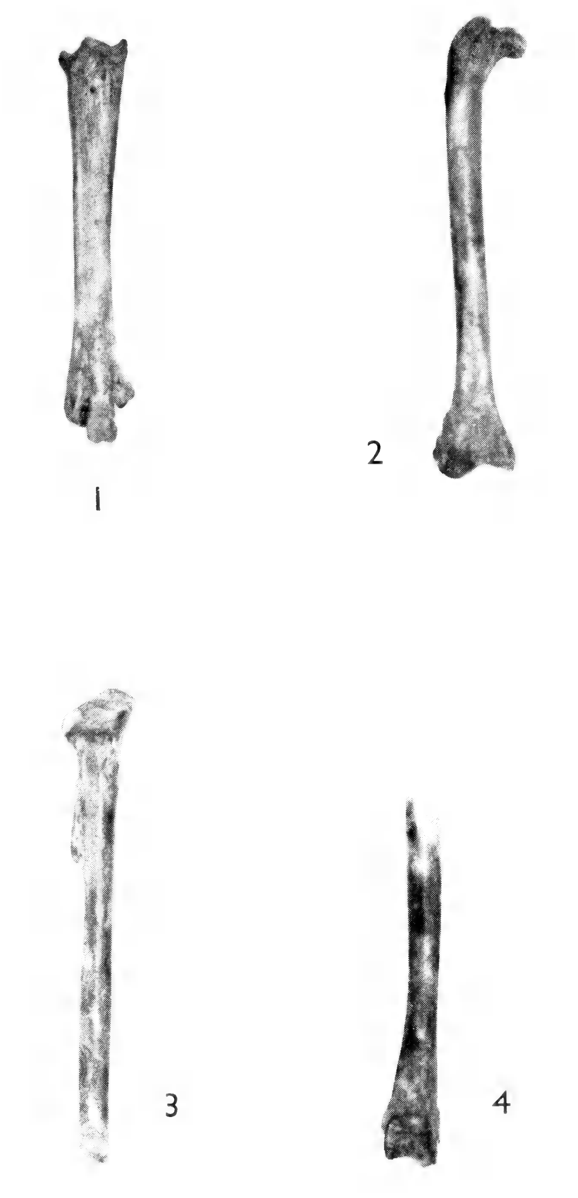
Photograph of type specimen *in situ*.

Photo: H. G. Lambert.



Capellirallus karamu (type). 1. Cranium (from above). 2. Cranium (side view). 3. Pelvis (side view). 4. Pelvis (from above).

Photos: C. Hale, Dominion Museum.



Capellirallus karamu (type). 1. Right tarsometatarsus (from front). 2. Right femur (from above). 3. Left tibia, prox. end (from behind). 4. Right tibia, dist. end (from front).

Photos: C. Hale, Dominion Museum.

A Bird Census and Some Recent Observations on Birds on Great Island, Three Kings Group

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Abstract.

Thirteen counts of land-birds on a ten-acre square quadrat on Great Island, Three Kings group, between January 2nd and 8th, 1953, gave an average of 62 birds per count (58% were bellbirds). Different weather conditions, observer-error, time of day and bird movements caused the counts to vary between 39 and 90 birds, the larger counts being characterised by a higher proportion of sight records. Although bird density varied in different parts of the quadrat, the species retained their relative order of abundance which was similar to that in other parts of the island. The breeding population was assessed at 28 pairs (11 species).

Part II contains miscellaneous observations on the breeding and feeding habits of 22 species of land and sea birds, with special reference to the effect of vegetation changes which followed the removal of wild goats in 1946. The increased ground cover provides more quail food, but reduces the area inhabited by pipits and restricts the extent of gull colonies. Conditions are improved for burrowing petrels, except where the vegetation is especially dense.

PART I. CENSUS.

A visit was arranged by the Auckland Museum to Great Island, of the Three Kings group, between 29th December, 1952, and 9th January, 1953. The main purpose of this paper is to record some quantitative observations made on the land birds during this visit. With the present data as a basis, it is hoped that future observations will determine the nature and extent of any changes in the abundance of birds. Such changes are to be expected because the removal of all the goats from the island in 1946 has already resulted in obvious changes in the vegetation (Baylis, 1948, 1951; Turbott, 1948; Holdsworth, 1951). For an account of the history and other features of the island at the time of the destruction of the goats see papers in *Records of the Auckland Institute and Museum*, Vol. 3, Nos. 4 & 5 (1948).

Modification of the vegetation was brought about by early Maori occupation, followed by the influence of goats. The forest consisted, in 1946, of a fairly uniform canopy of kanuka (*Leptospermum ericoides*), and as a result of the activities of goats the open forest floor was clothed for the most part only in sparse sedges and turf. In some localities, a few climax forest remnants gave variety to the otherwise uniform vegetation. Obvious changes since 1946 have been the appearance in many places of an undergrowth of young forest trees (Fig. 1) and of the vigorous herbaceous plant *Colensoa physaloides*, and the development of the ground layer in nearly all parts of the forest into a dense cover of matted sedges, grasses and herbs up to two feet in height (Fig. 2). This ground cover is so dense that it has checked the re-establishment of seedlings of kanuka, which even in the presence of goats had been able to grow beneath openings in the canopy (Baylis, 1951).

Unfortunately, census work was not possible in 1946 when the goats were destroyed nor during the period when the earliest stages of regeneration were taking place. The discussion of the status of land birds in relation to the effects of the goat population (Turbott, 1948) was thus based on rough estimates made by P. C. Bull (November-December, 1945) and E. G. Turbott (April-May, 1946), respectively. The bellbird* was the most abundant species, the remainder being represented only by small populations. The pipit was placed next in order of abundance, although considerably below the bellbird in numbers. Pipits and brown quail were observed feeding on the open forest floor.

In some parts of the island the new undergrowth of young trees and shrubs has provided additional cover for forest birds, and the much denser ground cover may be altering the status of at least two species. The pipit is now apparently restricted to the more open parts of the island—rocky outcrops in the forest, grassland and coastal rocks—and may thus have become less abundant since 1945-46. The brown quail was apparently not reduced in numbers, but it evidently now had difficulty in rising from the ground vegetation when flushed, sometimes even flying off partly entangled in the long seed heads of sedge (*Carex testacea*).

Although these observations suggest that some slight changes had occurred in the bird community during the period 1946-53, it is believed that the present study is early enough to provide a useful reference point from which to measure the larger changes which may occur in the future. Various additional observations made on the birds of the island during the present visit are included in Part II, but for a full account of the birds reference should be made to the earlier papers by Turbott and Buddle (1948) and Turbott (1951).

Methods.

Counts were made of the birds seen while walking over a quadrat measuring 220 yards square, i.e., ten acres in area. The south-east corner of this quadrat was also the south-east corner of the permanent Vegetation Quadrat I set up by Turbott in 1946, and full directions for locating this point have already been published (Turbott, 1948). The second permanent Vegetation Quadrat (No. II) is located towards the centre of the census quadrat. Additional topographical detail is available on the map of Great Island prepared by Battey (1951). The larger, new census quadrat slopes towards the south-east and its lower part includes two small valleys containing remnants of the original climax forest, but except for these and two rocky outcrops, the area is uniformly covered by kanuka forest (Fig. 2), which becomes increasingly stunted towards the higher north-western portion of the quadrat where it is more exposed to the wind. Six parallel counting lines, each

* Scientific names of birds are listed in Part II.

40 yards apart, were marked with light cord before the counts began, and each of these was divided into upper and lower halves with respect to the slope of the quadrat. The counts were made by the observer moving at a slow walking pace along the lines and recording all birds seen or heard at an estimated distance of up to 20 yards on either side of lines 2 to 6, but on only one side of line 1 (in order to cover the correct area).

In all, 13 counts were made over a period of seven days, and were carried out at different times of the day and under various weather conditions. On two counts the two observers walked together, counting separately, but for the remaining counts each worked alone. Each count occupied about two hours, and a separate record was made of the numbers of each species seen or heard in each half of the six counting lines. These data have been summarised in the present paper. Full details of each count are deposited at the Auckland Museum.

A limited number of traverses and observation periods carried out over other parts of the island helped to indicate the extent to which the relative abundance of species on the census quadrat was typical of the island as a whole. The traverses consisted merely of a record of the number of individuals of each species seen or heard while walking over the island in connection with other work. The observation periods were five-minute intervals, during which the observer tried to see or hear as many species as possible from a fixed point, each species being recorded only once per period. The frequency with which a species was recorded in a series of observation periods gives some measure of its abundance and conspicuousness. It has an advantage over traverses of the above type in that the observer gives his full attention to watching and listening to birds, so that the conspicuousness factor is somewhat reduced except for song.

The quadrat census, supplemented by figures for relative abundance (traverses and observation periods) on other parts of the island, has the advantage of being readily repeated, and a future census could be carried out on a comparatively brief visit, especially as the quadrat is situated near the usual landing place on the island. As two of the permanent vegetation quadrats are located within the census quadrat, fairly detailed correlation of the status of the land birds with changes in the vegetation may also be possible on the area.

Results.

The results of the 13 counts are summarised in Table 1, and contain a total of 805 records or an average of 62 individual birds per count. Of the 11 species recorded, bellbirds accounted for some 58% of the total records, followed by parakeets and quail (about 9% each) and then blackbirds at some 5%. There is considerable variation between the figures obtained during the different counts and the causes of this must now be examined.

Counts 1 and 2 were made with the observers walking together but counting independently, and the results show fairly close agreement. A similar result was obtained from counts 9 and 10, which were done in the same way. Since each pair of these counts was carried out simultaneously, the slight differences obtained are the result of observer-error. Decisions involving whether or not a given bird has been counted already

TABLE 1.

No. of Count	Date	Time: hrs.	Weather	Observer	Bellbird No.	Bellbird (a)	Bellbird (b)	Parakeet No.	Quail No.	Blackbird No.	Kingfisher No.	Starling No.	Chaffinch No.	Fantail No.	Pipit No.	Morepork No.	Banded Rail No.	Total No.
1	2/1/53	1600-1900	Overcast, N. breeze	E.G.T.	48	(60)	(21)	6	7	6	1	3	2	6	1	3	2	85
2	2/1/53	1600-1900	Overcast, N. breeze	P.C.B.	45	(67)	(27)	7	6	6	1	3	2	4	1	3	2	80
3	3/1/53	1000-1200	Overcast, N. breeze	E.G.T.	35	(46)	(23)	7	5	5	1	3	2	2	3	1	—	64
4	3/1/53	1100-1300	Overcast, N. breeze	P.C.B.	41	(51)	(24)	11	11	2	2	1	4	4	2	—	—	78
5	3/1/53	1600-1800	Cloud lifting, breeze dropping	E.G.T.	34	(59)	(6)	6	11	2	1	1	3	4	3	1	2	68
6	4/1/53	0700-0900	Calm and warm	P.C.B.	58	(71)	(29)	6	7	6	1	3	2	5	1	1	—	90
7	4/1/53	1700-1900	Drizzle and rising wind	E.G.T.	33	(36)	(15)	—	1	4	—	—	2	3	—	2	2	47
8	5/1/53	1500-1700	Strong W. breeze, drizzle	P.C.B.	34	(56)	(26)	5	5	5	—	1	1	1	1	5	—	58
9	6/1/53	0700-0900	Strong S.E. breeze	E.G.T.	22	(32)	(27)	2	3	1	1	3	3	1	2	1	—	39
10	6/1/53	0700-0900	Strong S.E. breeze	P.C.B.	28	(43)	(18)	3	3	1	1	1	2	1	1	3	—	44
11	6/1/53	1600-1800	Strong S.E. breeze	E.G.T.	29	(28)	(21)	3	7	2	—	—	2	—	—	3	—	46
12	7/1/53	1500-1700	Warm & sunny, S.E. breeze	P.C.B.	30	(23)	(33)	7	3	2	—	1	1	2	—	4	—	50
13	8/1/53	1000-1200	Hot, S.E. breeze	P.C.B.	31	(42)	(32)	11	3	1	1	1	—	1	3	4	—	56
			Total records		468	(50)	(24)	74	72	43	10	21	26	34	18	31	8	805
			Each species as % of total records		58	—	—	9	9	5	2	3	3	4	2	4	1	100
			Total of counts 1-6		261	(60)	(23)	43	47	27	7	14	15	25	11	9	6	465
			Total of counts 8-13		174	(38)	(27)	31	24	12	3	7	9	6	7	20	—	293
			Mean of six highest counts for each sp.		44	—	—	8	8	5	1	3	3	4	2	4	1	77

Note—

(a): Per cent. bellbirds recorded by sight.

(b): Per cent. bellbirds recorded in upper half of quadrat.

are probably more important in causing observer-error than are acuteness of sight and hearing. The two present observers compared notes after the counts and also had worked together previously; thus the results obtained by a completely independent observer might show greater variation.

The frequent presence of observers in the quadrat might be expected to disturb the birds and cause some of them to leave. To check this point, counts 3 and 4 were carried out with one observer walking one hour behind the other, but in this instance the later observer actually recorded more birds than the first one—a result probably attributable to observer-error. If birds were being disturbed one might expect to record fewer birds on the later counts. The number of birds recorded during the first six counts was compared with that during the last six (Table 1), and it was found that for every species except morepork owls, the later counts were very much smaller than the earlier ones. However, this may be largely due to less favourable weather conditions. (The lower records for moreporks during the earlier counts were due to the fact that their regular roosting places were not all known at this time, but once found they were more likely to be recorded on subsequent counts.) Weather conditions, especially wind, undoubtedly played an important part in causing variations in the different counts. The quadrat is completely sheltered from northerly winds, which prevailed during counts 1 to 5, which were all fairly large. Count 6, the largest, was carried out under conditions of calm and warmth. The remaining counts were low and were carried out in drizzle (7 and 8) or with a south-east wind (9-13)—the quadrat being particularly exposed to this direction. The total for count 6 (calm) is over twice that for count 10 (strong S.E. wind), although both counts were done by the same observer at the same time of day. For the remaining counts it is difficult to separate the effect of weather from that of time of day, but the latter is generally considered to be important (Colquhoun, 1940a).

However, the present counts probably provide a fair indication of the amount of variation to be expected in counts of the bird population which existed on the quadrat at that time; the last four counts did not increase the variation established by the previous nine.

When birds were heard an attempt was made to sight them if this could be done fairly quickly and without causing too much disturbance. Otherwise a single bird was recorded unless there was reason for suspecting more, but counting from sound is difficult in a species such as the bellbird, in which the song sometimes has a ventriloquial effect. The two observers varied in the proportion of birds they recorded by sight and sound respectively. For bellbirds (the only species with numbers allowing individual analysis), 53% of one observer's total records were by sight, but for the other this figure was only 42%, and statistical tests indicate that this difference is no greater than could be accounted for by chance ($p = 0.15$). The percentage of sight records of bellbirds on each count varied between 23% and 71% for one observer, and 28% and 60% for the other. When both observers did their counts at the same time the proportion of bellbirds seen by each was similar. There is evidence of a direct relationship between the proportion of sight records and the total number of bellbirds recorded on each count. For instance, count 6 produced both the largest number of bellbird records (58) and the highest proportion of sight records (71%), while count 9 (carried out at the same time of day) produced the smallest number of bellbirds (22) and a low proportion of sight records (32%). The results of other counts showed a similar trend. Thus, in addition to the observer effect, the census showed that weather and time of day are important in determining the relative frequency of records by sight and sound respectively. A high proportion of sight records suggests a high degree of bird activity, and thus conspicuousness, leading to a high total count. Unfavourable weather conditions such as wind and rain result in a small total count, less activity, reduced conspicuousness and a small proportion of sight records. Unfavourable weather conditions, especially wind, reduce vocal activity in blackbirds (Colquhoun, 1939), but the present work suggests that for bellbirds flight activity is affected first, then song, and call notes last of all.

There is evidence that birds were not evenly distributed over the census quadrat. When the total number of bellbirds recorded in the upper halves of the 6 counting lines was compared with that in the lower ones (Table 1) it was found that the former produced only 24% of the total bellbird records. For the individual counts this figure varied between 6% and 33%. If birds were evenly distributed over the quadrat the numbers found in each half should be approximately the same, but statistical tests of the present figures show that in 12 of the 13 counts the differences found were greater than could be accounted for by chance ($p = 0.03$). The concentration of bellbirds in the lower part of the quadrat could be due to its more sheltered position, to the taller trees or to the more diverse vegetation, and thus food, provided by the remnants of the original forest.

Some idea of the relative frequency of species on other parts of the island was obtained from the traverses and observation periods, and

TABLE 2.

	Traverses				Each Species as % of:		
	T1.	T2.	T3.	Total T1-3.	183 Traverse Records	805 Quadrat Census Records	22 Observation Periods.
Bellbird	14	24	38	76	42	58	100
Parakeet	7	7	27	41	22	9	55
Quail	9	4	10	23	13	9	36
Blackbird	4		7	11	6	5	23
Kingfisher	1	3	4	8	3	2	23
Starling	1		5	6	3	3	9
Chaffinch	2		4	6	3	3	9
Fantail	2		1	3	2	4	5
Pipit	2	1	1	4	2	2	5
Thrush	1	1	1	3	2	—	—
Harrier			1	1	1	—	—
Long-tailed cuckoo			1	1	1	—	—
Morepork			—	—		4	—
Banded Rail			—	—		1	5
Total	43	40	100	183	100	100	—

Note.—Traverses Nos. 1 and 2 were done by E.G.T. and No. 3 by P.C.B.

Traverse No. 3 occupied over twice the time and distance of the others.

Table 2 compares these results with those obtained from the quadrat counts. It is evident that the first four species retain their order of abundance irrespective of the method of assessment. Since a census count is only a very careful traverse count over a known area the two methods should give the same order of abundance if carried out in the one locality under similar conditions of season and weather. The results obtained (Table 2) are similar even though carried out in different localities, so it seems reasonable to assume that the land bird community of the quadrat was typical of the island as a whole, at least as regards the relative abundance of the various species. Some land birds present on Great Island were not recorded on the quadrat, but the missing species are numerically unimportant.

Discussion.

The present work was designed primarily to determine the amount of variation which might be expected in a series of counts of an approximately stable bird population. Thus a future observer, using the present methods on the same quadrat and at the same time of the year, will have some basis for judging whether or not his counts reflect a real change in the size or composition of the bird community. As a secondary consideration it was hoped to obtain a reasonable estimate of the actual number of individuals of each species living on the ten acres so that comparisons could be made with work in other areas. To this end it is now necessary to consider the meaning of the various bird counts made on the quadrat.

The several counts yielded rather different values, and this is accounted for by observer-error (double counting and under counting), and probably by movements of birds out of the area (human disturbance) or into it (e.g., to mob moreporks), and by changes in the conspicuousness of the birds themselves (largely influenced by time of day and weather conditions). Observer-error and movements of birds can either increase or reduce the count, and may act together or against each other. Their total effect cannot be accurately assessed from the data available, and they are perhaps best allowed for by taking the mean value of all the counts. Changes in conspicuousness, however, can only make the count too low, and from this point of view the highest count should be the most accurate. In view of these considerations, and from the experience gained while working in the quadrat, it was felt that the mean values for the six highest counts (Table 1) provided the best indication of the abundance of various species.

The importance of relative conspicuousness in census work on bird communities has been stressed by Colquhoun (1940b), and this must also be considered in the present work. For instance, bellbirds are highly conspicuous by virtue of their song and noisy flight, while rails are seldom heard by day and less often seen, since they live under the dense cover of the tall sedges and rarely fly even if disturbed. Parakeets with their bright colours in full sunlight, and harsh flight calls, are on occasions perhaps even more conspicuous than bellbirds, although sometimes silent and easily overlooked. While bellbirds could usually be seen at distances up to 20 yards on either side of the counting line, quail would flush only when the observer passed within a few feet of them, although their call notes sometimes allowed identification at much greater distances. Thus if it be agreed that the mean values obtained for the six highest counts provide a reasonable indication of the abundance of such birds as bellbirds and parakeets, then the comparable values for banded rail and quail are almost certainly too low. How much too low is at present unknown.

The birds counted during the census included both adults and young birds of the year. It was not possible to count these two groups separately because this would have necessitated obtaining close views of every individual and such an attempt would cause further disturbance and add greatly to the time occupied by the count. However, for purposes of comparison with other work it is necessary to convert the present figures into terms of breeding pairs. The available information does not allow this to be done accurately, but if an approximation is to be made it is best done by the observers who did the counts. In doing so they have been guided by their records of young birds actually seen and by general impressions obtained while working in the quadrat. With this in mind, the mean values for the six highest counts (Table 1) are now discussed species by species.

Bellbird. It is considered that approximately half the birds seen were young of the year. The mean value of 44 birds thus comes to represent some 11 pairs of breeding adults.

Parakeet. No young birds were seen on the island, and the only nest found contained eggs. There was no evidence that any parakeets lived exclusively on the quadrat, which provided few suitable nesting places. The birds seen feeding there probably had nests in the cliff face below. An average of four pairs of parakeets were recorded feeding on the quadrat, but the numerous birds flying about overhead made counting difficult, and three pairs is thought to be a more accurate figure.

Quail. No young were seen but a nest of eggs was found near the camp. The average figure for the counts suggests that four pairs lived on the quadrat.

Blackbird. This species was frequently heard but rarely seen. Comparison may be made with a population of blackbirds studied in Lower Hutt, where, by December, 50% consisted of young birds of the year (Bull, 1953). On this basis the Great Island quadrat would have supported one pair, but from past experience of the retiring habits of this species when living far from human influence it is thought that two pairs is a more likely figure.

Kingfisher. Two pairs of adults were seen, but as both were on the boundaries of the quadrat the population is assessed at one pair.

Starling. At the time when the census was made most starlings were in flocks, including a few young birds of the year. Single birds and small parties were also frequently seen—perhaps being temporarily detached from the main flock or not yet having joined it. These odd birds were the ones recorded during the census counts. The counts suggest a little less than one pair of adult birds per ten acres.

Chaffinch. Two pairs situated as for kingfishers, so that the area probably supported only one pair.

Fantail. Several of the birds seen were young of the year, and one pair is believed to be the breeding population.

Pipit. The breeding population is estimated at one pair.

Morepork. Two pairs of adult birds were found—one in each valley. One pair had flying young.

Banded Rail. At least one pair was present.

The above estimates give a total of 28 pairs of breeding adults and include 11 different species. Converting this to a 100-acre unit the figure becomes 280 pairs or 560 individuals. In a census on Taranga (Hen Island) Turbott (1940) found a population of 728 breeding birds (17 species) per 100 acres of forest habitat and 467 birds (8 species) on a previously-burned area then in mixed thicket and shrubs. The quadrat on Great Island cannot be taken as typical of the island as a whole, since it contains a disproportionately large amount of remnant forest and sheltered valley habitat. The upper half of the quadrat is more typical, and considering this portion alone the bird density was only 440 per hundred acres. The relatively low density of birds on Great Island as compared with Hen Island is probably related to the modified vegetation, which, lacking variety, may not provide adequate food throughout the year.

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PART II. GENERAL OBSERVATIONS.

Diving petrel. *Pelecanoides urinatrix* (Gm.). All the burrows examined were empty, although a number of dried-up remains of adults and fully fledged young were found on the steep slopes above South East Bay, and the south-western cove.

The slopes above South East Bay, formerly free of scrub, and kept relatively bare by goats, now have a dense ground vegetation which may have an effect upon this and possibly other petrels. Some burrows are now covered by dense sedges, grasses and herbaceous plants, which probably make them difficult of access. A twined mass of the trailing stems of native cucumber (*Sicyos angulata*) covers much of this area, and several dead diving petrels, including a fledgling with shreds of down still attached, were found entangled in the cucumber stems. This type of vegetation may later be replaced by mixed scrub, which would bring about a reduction in the ground cover and would be more favourable for petrels.

It should be noted that the effect of the goat population is still reflected in the distribution of burrows of petrels of various species. These birds were formerly unable to breed on most of the inland portions of the island where the hard soil, resulting from the lack of plant cover and trampling by goats, was unsuitable for burrowing (Turbott, 1948). The influence of the later stages of forest regeneration upon the distribution of petrels will thus be of considerable interest.

Fluttering shearwater. *Puffinus gavia* (Forst.). The young varied in age in different burrows from downy chicks with the first feathers showing to fully fledged young with a few wisps of down on the lower breast. The burrows are thickly scattered over the seaward slopes wherever the soil is comparatively loose, as well as under low scrub along the cliff-tops. In some places, e.g., on the saddle between North West and South East Bays, tunnels were found penetrating dense sedge as though the birds had been trying to become established there recently, but unless the soil was loose no proper burrows had been formed. Burrows were abundant on the slopes above South East Bay, this species apparently being less affected by the dense ground vegetation in this area than the diving petrel. It seemed probable, on the basis of our previous observations, that there had been some increase since 1945-46 in the numbers of burrows of this species. This was observed mainly on seaward slopes which had originally been much trampled by goats. Apart from the attempts already mentioned to form burrows amongst dense sedges on flatter areas adjacent to the seaward slopes, burrows are situated inland only in a few places in cavities among rocks. However, a burrow containing a well-grown chick was noted near the camp in Castaway Valley in a flat situation in fairly soft ground under the kanuka forest (the same burrow was in occupation during the preceding visit by an Auckland Museum party, 10th-15th January, 1951). This burrow ran underground only a few inches below the surface, beneath a deposit of kanuka twigs and camp debris; it is not known whether it had been formed in 1945-46, but it is possible that more burrows will be found in situations of this type now that there is no further trampling by goats.

The first fluttering shearwaters were heard at night shortly before 9 o'clock, but the time of arrival and the numbers heard in the air varied considerably under different weather conditions. On clear nights with moonlight the calls began later, and few birds were heard, but there was much calling on misty or cloudy nights. The chirping note of the chicks in burrows was heard as early as 8.45 on a cloudy night with some rain. The adults of the burrow near the camp were ringed*. No. 11302 (sex unknown) was ringed on arrival at the burrow at 10.30 p.m. on 2nd January, and it returned to the burrow at almost the same time on the following night (3rd). On 4th January its mate visited the burrow, also at about 10.30 p.m., and was ringed, No. 11303. On the last evening (8th) both adults were observed sitting together outside the burrow, the first to arrive being No. 11302, at 9.50 p.m. When one of the adults was being handled on arrival, it disgorged a quantity of small shrimp-like crustaceans which have been identified by Mr. R. K. Dell, of Dominion Museum, Wellington, as the common Australian and New Zealand Euphausiid *Nyctiphanes australis* G.O. Sars.† (See also identification of the same food organism cast up by young red-billed gulls.)

Grey-faced petrel. *Pterodroma macroptera* (Smith). This early breeding petrel was apparently absent during the visit. It was commonly observed in April-May, 1946 (see Turbott and Buddle, 1948).

Pterodroma sp. The "ti-ti" or "kek-kek" call characteristic of certain gadfly petrels (*P. cooki, P. inexpectata, P. pycrofti*) was heard at about 9 p.m. above Castaway Valley and from the cliff-tops to the west of the depot during this visit. The same call was heard by P.C.B. in November-December, 1945, at about the same point (not to the east of the depot as stated by Turbott and Buddle, 1948). A search for burrows was made in likely areas without success, but this as yet unidentified *Pterodroma* evidently breeds on Great Island in small numbers.

White-faced storm petrel. *Pelagodroma marina* (Lath.). A second call was noted several times in the same locality as the above, and was identified tentatively as that of the present species. Previous evidence suggesting that it may breed on the island was obtained in 1945, when remains were found in a morepork's nest.

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* For records of ringing on this visit see Bull. P. C., 1953: "Ringing Operations. Summary for the Year Ended 31 March, 1953." *Notornis*, 5, 138-141. Both of the above *P. gavia* were ringed on the left leg.

† We are indebted to Mr. Dell for his identification of the material and for referring us to the following literature on *N. australis*. It was taken, often in very large numbers, in plankton obtained during July-September, 1911, by the British Antarctic ("Terra Nova") Expedition off the Three Kings Islands (see Tattersall, W. M., 1924: "Euphausiacea," *Brit. Ant. ("Terra Nova") Exp., 1910, Nat. Hist. Rep. Zool.*, VIII: Crustacea, Pt. VIII, 1-36). Together with other species which swarm during their breeding period, it is probably an important source of food for schooling fish and sea birds, according to Sheard (Sheard, K., 1953: "Taxonomy, Distribution and Development of the Euphausiacea (Crustacea)," *B.A.N.Z. Ant. Res. Exp., 1929-1931, Rep.*, B, VIII, 1-72). *N. australis* is confined to neritic waters of Australia and New Zealand of the cooler sub-tropical zone. Most of the specimens sent to Mr. Dell were adult.

Black shag. *Phalacrocorax carbo* (L.). A single bird almost certainly of this species, which has not been recorded previously from the Three Kings group, was seen at some distance in North West Bay, where it was fishing close inshore.

Red-billed gull. *Larus novaehollandiae* Steph. Immediately after the goats were destroyed the large colonies above South East Bay appear to have expanded considerably on the upper portion of the slopes (Turbott, 1948: footnote), possibly because disturbance by goats had previously restricted the colonies to the lower slopes. The colonies in South East Bay are now reduced to a few isolated groups on bare, rocky outcrops not far above sea level, and this may be due to the dense ground vegetation mentioned above.

There is also a large colony, on slopes previously accessible to goats, above the S.W. cove, but in this area the ground vegetation is much less rank. The slopes were formerly to a large extent bare, and the area is more exposed to constant strong winds than above South East Bay. However, a considerable amount of regeneration of ground vegetation has taken place, especially on the lower portion occupied by the gulls; this bears lush mats of *Disphyma australe*, *Dichondra repens*, *Chenopodium triandrum* and *Salicornia australis*, amongst which grow grasses (*Polypogon monspeliensis* and *Poa anceps*), and herbs (*Senecio lautus* and *Gnaphalium luteo-album*). There is also a sprinkling of low bushes of ngaio (*Myoporum laetum*), taupata (*Coprosma repens*), *Hebe insularis*, and tall sedge, etc. (*Cyperus ustulatus*, *Arundo kakaho* and *Phormium*). As the ground vegetation in this area is probably increasing, it will be interesting to compare the extent of the colony as shown by photographs on later visits. It was also noted that the presence of rank vegetation in the colonies may endanger nestlings. Two young chicks were found beside one nest entangled in the soft, drooping grass *Poa anceps*; one chick was already dead and the other was firmly held by one leg, which had evidently been dislocated by the chick's struggles to escape.

Further large colonies which were also examined cover the steep slopes above Tasman Bay, and extend into the low scrub of taupata (*Coprosma repens*) at some points on the cliff-tops. The slopes to the south of the Tasman Stream, which falls into the head of the Bay, are clothed in dense iceplant (*Disphyma australe*), but the greater part of the nesting birds are concentrated on the rocky ledges near sea-level or on the steeper portions of the cliffs, only a few nesting on the slopes in hollows in the iceplant.

From observations during the present visit on the above colonies it thus seems probable that, with the increase of ground vegetation on the less steep seaward slopes of the island, colonies of this species are likely to be restricted to cliff ledges and the more rocky portions of the slopes. It seems probable that there was at first a tendency for the colonies to expand in certain areas on the seaward slopes after the destruction of the goats. However, this was only temporary owing to encroachment by the vigorously regenerating vegetation.

Most of the eggs were just hatching at the end of December, but there were a few older chicks and fledglings, and at least one almost ready to fly. The following observations were made on clutch size and hatching dates in various colonies on different days:—

S.W. cove, 30th December.—Of 134 nests with contents 76 had one egg or chick and 58 had two eggs, two chicks or an egg and a chick.

Of 135 nests, 57 had one egg, 27 had two eggs, nine had one chick, 20 had two chicks and 22 had an egg and a chick. (There were also a few empty nests and these were not counted. One-egg clutches may include some in which one egg had hatched and the chick left. Also, when only one chick was present, another might have been hiding nearby.) (P.C.B.).

Tasman Bay, 30th December.—Of 119 nests on the north side of the stream outflow 48 had one egg, 33 had two eggs, 17 had one chick, 11 had two chicks and 10 had one chick and one egg.

Of seven nests to the south of the stream outflow five contained one egg, one two eggs and one a chick. (P.C.B.)

Tasman Bay, 7th January.—Of 101 nests on the lower slopes to the south of the stream 23 had one egg, 10 had two eggs, 11 had one chick, 14 had two chicks, two had three chicks. There were six with a chick and an egg and another with two chicks and one egg; 34 nests were empty. (Breeding was more advanced here than in the colony above the S.W. cove, a proportion of the chicks which had left the nest showing scapulars and wing quills through the down, and several being at an advanced stage of fledging. The most advanced was fully fledged, with only wisps of down showing; wings and tail were not yet fully grown, but this chick was not far from the flying stage.) (E.G.T.)

South East Bay, 3rd January.—Of 33 nests, just above sea level, 18 were empty, seven contained one egg, five had two eggs, one had one young and two had two young.

Of 43 nests at the W. end of the Bay (below Castaway Stream) 13 were empty, eight contained one egg, six had two eggs, five had one young, 10 had two young and one had one chick and an egg.

(Many of the empty nests had probably been deserted by the young soon after hatching.) (P.C.B.)

Ringing was carried out at the Tasman Bay colony on 8th January by E.G.T. The 49 young birds ringed were fledglings, and this figure was probably nearly the total of young which were of suitable age in the colony. Two adults were also caught in the colony and ringed.

An additional 15 adult birds were caught and ringed at the camp in Castaway Valley where they came for scraps. (See ringing records, quoted above: Bull, 1953.)

These birds, which came about the camp when scraps were put out towards the end of the visit, seemed to stay about constantly, and were thought to be "unemployed" birds. Other such groups of apparently unoccupied birds were present on the shore, e.g., at the head of North West Bay.

Red-billed gulls feed in characteristic "swirls" of birds in the waters surrounding the Three Kings group, generally associating with fluttering shearwaters (*Puffinus gavia*). A constant passage of birds may be observed from the breeding colonies to these feeding groups at varying distances offshore, and the groups frequently change position over changing concentrations of food organisms.*

Some of the recently-fed chicks regurgitated pink shrimp-like crustaceans identified by Mr. R. K. Dell as *Nyctiphanes australis*, the same species as that taken from an adult fluttering shearwater. The chicks appear to be fed mainly on plankton, and there is further evidence of this in the mainly reddish, paste-like droppings of both adults and young.

Notes on gulls feeding on insects over forest on Great Island.—Observations have appeared in a previous paper (Turbott, 1951) on the capture of cicadas by red-billed gulls, and it was suggested that as gulls would otherwise only pass occasionally over the forest, this habit would explain visits by gulls to all parts of the island. This made it possible to account for the transport of seeds of puka (*Meryta sinclairii*) which had been eaten by the gulls, into various parts of the forest. On the present visit further observations were made, and some additions and corrections to the above discussion are now required. Observation of gulls passing across the island, especially in the area between Tasman Bay and the S.W cove, indicated that there was a considerable passage of gulls between these points, which might have included gulls passing across the island to join feeding "swirls" at various points offshore, and probably also gulls from the south-western coast attracted to the fresh-water pool above Tasman Falls, where large numbers bathed regularly. The gulls frequently followed an erratic course in order to take advantage of variations in the air currents, and the routes taken thus varied considerably, so that an individual bird might pass over a fairly wide area. A similar regular passage of gulls was observed between North West and South East Bays, the birds crossing the narrow saddle at a low altitude and gliding down to sea level.

The present visit (29th December-9th January) was made approximately a fortnight earlier than the visit in 1951 (10th-15th January), and, possibly for this reason, few cicadas† were heard at first, although the numbers later increased considerably. Gulls were again observed swooping down to capture cicadas above the canopy.

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* Sheard in a discussion of the schooling aggregation and behaviour of certain Australian fishes based upon stomach contents states that schooling obviously depended "at first or second remove, on the swarming of crustacean species for breeding purposes, as well as on swarms of their larvae, either as they became concentrated in local rips and eddies, or as they were released in floods during brief, mass hatching periods." The feeding behaviour of sea birds is evidently similarly influenced by surface concentrations of the food organisms. (See Sheard, K., 1953: *B.A.N.Z. Ant. Res. Exp., 1929-1931, Rep.*, B, VIII, 1-72.) Mr. R. K. Dell has kindly commented further (*in litt.*) on the feeding grounds for sea birds off the Three Kings Islands, and suggests that, in addition to upwelling on quite a large scale off the islands, there is probably minor upwelling, due to sudden changes in the bottom topography. Such areas of minor upwelling, e.g., off promontories, are known to encourage concentrations of feeding sea birds because the food organisms are carried to the surface.

† *Melampsalta cingulata.*

On this visit, observations were also made on the interesting relationship between gulls, hovering over the canopy to obtain cicadas, and one or more large flocks of starlings. The latter could be seen moving fairly rapidly through the open kanuka forest, and at the same time a flock of 30-40 gulls hovered over the canopy following the course taken by the starlings. Close observation by E.G.T. of a flock of starlings in Tasman Valley showed that they were feeding actively at all levels from the ground layer to the canopy, and it was noted that cicadas were several times disturbed by the flock. Another member of the party, Mr. J. S. Edwards, watched the flock of starlings at close quarters, and saw the birds feeding on top of the canopy. Mr. Edwards suggested that the starlings were probably taking large numbers of the abundant bronze beetle (*Eucolaspis brunneus*). He saw a cicada caught by a gull in mid-air, and in other cases gulls chased cicadas which had been disturbed but failed to catch them. While the gulls seemed to be interested chiefly in the relatively large cicadas, the bronze beetle was also possibly taken.

Also of interest in relation to this habit of the gulls is the observation that a small black bee† common on the heavily flowering kanuka was eaten in large numbers. This was first suggested by the discovery of gull castings containing the remains of bees on a rock above Castaway Valley. Gulls were occasionally seen apparently attempting to capture the bees above the kanuka canopy, and it was found later that bees were captured at the burrow entrance on the cliff-tops at the head of North West Bay, where the bees form a large colony in the bare clay. The gulls were often seen here running about and catching the bees as they emerged from the burrows, and fresh castings consisting entirely of remains of the bees were found nearby.

It seems clear from these observations that the insects mentioned above form a fairly important supplementary food, and that this habit serves to draw numbers of gulls to the forest canopy. On the eastern portion of the island, gulls were also observed in association with starlings in the neighbourhood of the census quadrat.

It was noted also that the gulls called while hunting in flocks over the canopy, just as in flocks feeding at sea on plankton, the behaviour in both situations forming a fairly close parallel.

Banded rail. *Rallus philippensis* L. Observed on the census area. One was also seen in Tasman Valley (Edwards).

Brown quail. *Synoicus* sp. A nest containing six eggs was found near the depot, Castaway Valley. Specimens were collected under permit to assist in determining the identity of this form. The following analyses of the stomach contents of the four specimens obtained, and of three obtained in 1946, was kindly carried out for us by Miss Ruth Mason, Botany Division, D.S.I.R.:

(a) Collected in May, 1946:

(1) seeds of: *Carex testacea* (sedge).

(2) seeds of: *Carex testacea,* mostly; *Carex virgata,* a few.

(3) no identifiable vegetable material; much animal material.

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† Specimens of the bee obtained on the island have not yet been identified.

(b) Collected in January, 1953:

(1) seeds of: *Carex testacea*, the most abundant; *Solanum nigrum* (nightshade); *Dianella intermedium* (blueberry); *Haloragis procumbens*, 1 only; *Melicytus ramiflorus* (mahoe), 2-3; *Myoporum laetum* (ngaio), 1 only.

(2) seeds of: *Carex testacea*, a good deal; *Carex lucida*, a few; *Solanum nigrum*, a good deal; *Deyeuxia* sp. (grass), a few.

(3) seeds of: *Carex testacea; Bromus mollis* (grass), a few.

(4) seeds of: *Sicyos angulata* (native cucumber); *Solanum nigrum*, a few; *Coprosma rhamnoides*, 2 only; *Melicytus ramiflorus*, a few. Some animal matter.

The analyses show that *Carex testacea*, still the most abundant element in the ground layer under the forest, continues to provide a large proportion of the food. Most of the other seeds found in the recent specimens could have been obtained, although only in a relatively few places, in 1946. The exceptions, representing additional sources of food supply since goats were removed, are *Dianella intermedium*, *Solanum nigrum* and *Sicyos angulata*, all extremely rare in 1946. As the specimens were obtained in different seasons, this may also be reflected in the analyses. However, the analyses suggest that the quail are able to feed on a much greater variety of vegetable food, and it seems probable that a more abundant total food supply is available than in 1946.

Harrier. *Circus approximans* Peale. A nest above Tasman Bay was occupied by a young bird which was fully fledged, and flew a short distance when approached closely. Remains of red-billed gulls and fluttering shearwaters were found at the nest, but no land birds. It is possible that the gulls and petrels had been picked up dead. A day later two adults and a young bird were seen flying about together over North West Bay. A pair, or single birds, were also seen on other occasions, one being observed flying slowly beneath the kanuka forest canopy in Tasman Valley.

Morepork. *Ninox novaeseelandiae* (Gm.). This species was observed on a number of occasions in different parts of the island, and several flying young still with a little down were seen.

In the course of field work a number of patches of feathers were noted on the ground, the total number recorded (P.C.B.) being 15, consisting of eight parakeets, four quail, two bellbirds and a fantail. All the birds appeared to have been completely plucked, and there was nothing left except the feathers. Considering the small area which could be examined, the total number of birds killed must have been large; two were found in the census quadrat during the work there. The birds were apparently killed at night, as several patches of feathers were found in the morning on tracks passed over on the previous day. Since there are no mammals on the island, it appeared that these birds had been killed by moreporks, and it seems that predation on small birds may be intensified during the period when young are being fed. Remains of bellbirds were found near the nests of moreporks during the visit in 1945 (Turbott and Buddle, 1948). The abundant lizards, as well as insects, also provide an important food supply, although they may be insufficient at this season.

Red-fronted parakeet. *Cyanoramphus novaezelandiae* (Sparrm.). A nest containing eight eggs was found on 30th December in a hollow, apparently formed by several old kingfishers' burrows, in the soft earth of a bank of the Tasman Stream. The eggs rested on a small amount of nesting material, mainly parakeet's feathers and a few twigs. The height of the nesting chamber was about nine inches, and the situation was about six feet above the stream bed. Adults which had been incubating, as shown by their frayed tail feathers, were also observed. Two parakeets observed at close quarters on the census quadrat were seen chewing off grass seed heads (*Danthonia semiannularis*) while perching on a low branch.

Long-tailed cuckoo. *Eudynamis taitensis* (Sparrm.). A single bird was seen twice in Tasman Valley.

Kingfisher. *Halcyon sancta* V. and H. In addition to those observed on the census area, pairs were noted near the camp and half way up the slopes of North West Bay. The latter were seen carrying food, once a cicada and on a second occasion a lizard. A nest containing five eggs was found on 30th December in the bank of the Tasman Stream.

Pipit. *Anthus novaeseelandiae* (Gm.). A nest with two eggs was found in the lower Tasman Valley on 7th January. There was also probably a nest near the depot, where a pipit was seen carrying food. On the bare cliff-top at the saddle above North West Bay this pair was observed feeding on small bees (see red-billed gull). Each bee was caught with the tip of the bill, beaten on the ground and then swallowed. Pipits up to eight in number were observed several times on the grassland and prostrate scrub of the south side of Tasman Valley, and elsewhere this species was seen mainly on bare patches or rocky outcrops in the forest, and on coastal rocks (see introduction, Part I).

Fantail. *Rhipidura fuliginosa* (Sparrm.). Adults and well-grown young, still keeping more or less to family parties, were seen in Castaway Valley, Tasman Valley and in the census area. The distinctive nature of the call note of the fantail on the island has been noted (Turbott and Buddle, 1948). The song was heard several times on the census quadrat, and the distinctive pitch and more eccentric rhythm were noted, as compared with the mainland form.

Bellbird. *Anthornis melanura obscura* Falla. Many young were observed, and a female was seen feeding two young birds on the census area. Although most of the adults were moulting, there was much song. The bellbird appeared to be feeding largely on insects, and one watched for some time was industriously searching in the head of a cabbage tree (*Cordyline australis*), apparently obtaining small caterpillars concealed in the leaf bases. A bellbird was seen catching a cicada during one of the census counts.

Chaffinch. *Fringilla coelebs* L. The full song was frequently heard, and a young bird apparently not long out of the nest was regularly heard calling in answer to the parents (see census). One nest (old) was found.

House sparrow. *Passer domesticus* (L.). Seen on the south side of the lower Tasman Valley, but nowhere else.

Song thrush. *Turdus ericetorum* Turt. Seen once.

Blackbird. *Turdus merula* L. Blackbirds were frequently heard singing strongly in the late afternoon. An old nest was found on the ground at the base of a low kanuka in Tasman Valley, concealed by overhanging sedges. Droppings found on a rock above Castaway Valley containing seeds of nightshade (*Solanum nigrum*) were probably those of this species; and one was seen holding a struggling cicada. An albino blackbird was seen in Tasman Valley.

Starling. *Sturnus vulgaris* L. The largest flock was estimated at 200 birds, and there was another flock of perhaps 50 in the Castaway Valley and quadrat areas (see under red-billed gull above). Single birds were seen feeding in the kanuka forest from time to time, moving quietly amongst the branches in contrast with the marked activity of birds forming the flocks. A young bird of the year in brown plumage was seen amongst the larger flock, but this consisted mainly of birds in adult plumage.

ACKNOWLEDGMENT.

The party was transported to Great Island in the yacht "Tara," and thanks are expressed to the yacht's owner and master, Mr. C. H. Wild, for his assistance throughout the trip.

Fig. 1. Regeneration of mixed coastal forest, of which young trees at present form an undergrowth. In foreground puka (*Meryta sinclairii*) about 9 feet high. Lower portion of census quadrat, January, 1953.

Fig. 2. Kanuka forest showing dense ground cover, mainly sedges. Upper portion of census quadrat, January, 1953.

Photos: E. G. Turbott.

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CONTENTS

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The Occurrence of Babingtonite in Spilite from Three Kings Islands

By M. H. BATTEY, Auckland Museum.

Abstract

The paper records the occurrence and optical properties of the rare mineral babingtonite in spilite. Comparison is made with other parageneses of this mineral.

In his account of spilite and keratophyre from Three Kings Islands, northern New Zealand, the late Professor J. A. Bartrum described and figured an unidentified pyroxene-like mineral in the spilite (Bartrum, 1936, p. 420 and Pl. XI, 4). He noted its striking pleochroism, probable positive optical character and large optic axial angle, and inferred from its occurrence in short veinlets, its xenomorphism, and its relatively coarse crystallization, that it crystallized from a liquid enriched in volatiles. In a footnote (p. 420) he records that Dr. N. L. Bowen, to whom he showed the slide, suggested that the mineral might belong to the epidote group. A chemical analysis is given of the rock in which it occurs.

This mineral now proves to be the rare species *babingtonite*. In the course of a more extended study of the lavas of Great Island, Three Kings Group, Professor Bartrum's material has been re-examined and another occurrence of the mineral in spilite has been found.

The original occurrence was in spilitic pillow lava that "outcrops near sea-level in a band 40 feet thick . . . traceable in the sea-cliffs for about 200 yards" (Bartrum, 1936, p. 415). The outcrop is about a quarter of a mile west of the landing-place in North West Bay, Great Island, and is accessible only from a small boat (Bartrum, personal communication). In the original slide (No. 559 in the Auckland University College Collection), as recorded by Professor Bartrum, the mineral occurs in little veinlets and nests, in the form of anhedral crystals up to 0.25 mm. across, as well as in rare smaller crystals scattered through the rock. In the veinlets it is accompanied by quartz. In some cases, where veinlets cut the acicular augites characteristic of the rock, babingtonite replaces the augite prisms (fig. 1).

Amongst Bartrum's hand specimens are some with veins up to 1-cm. wide of white prehnite which enclose, parallel with their walls, strings of dark granules that prove also to be babingtonite.

Babingtonite also occurs in spilite outcropping in the prominent crag on the spur leading to Hapuka Point on Great Island (specimen 6203 in the Auckland Museum Collection). In this rock it forms small subhedral crystals, embedded in intersertal ferriferous chlorite (brunsvigite).

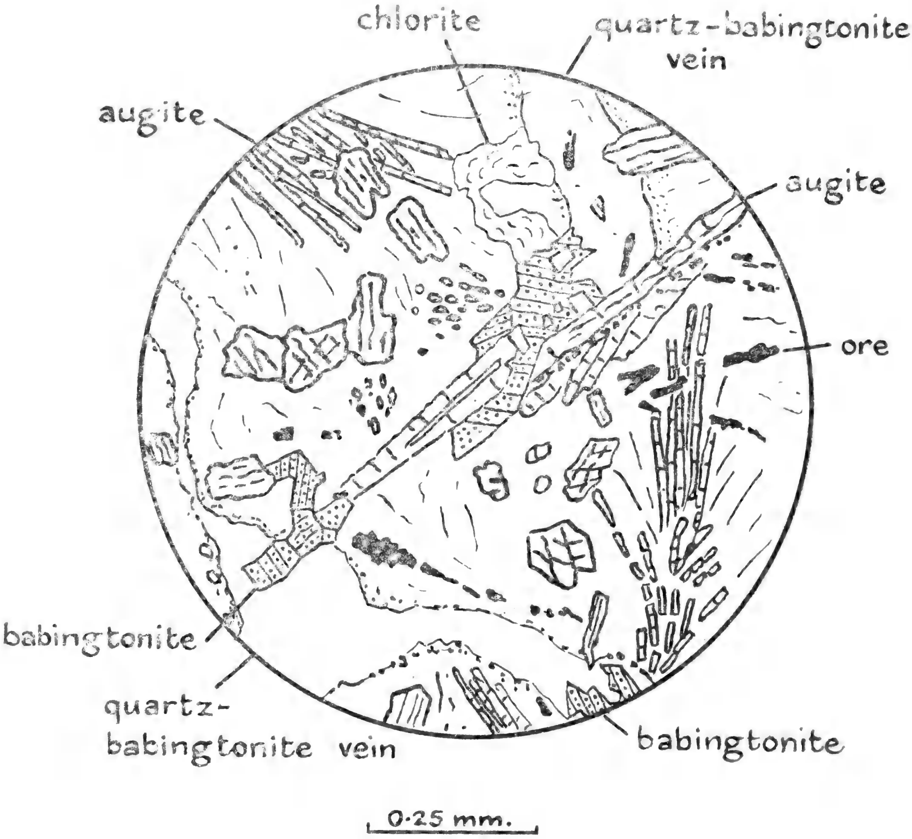

Fig. 1. Babingtonite in spilite (Slide No. 559, Auckland University College Collection).

The following optical properties were determined for the Great Island babingtonite:

n X	1.713	±	0.003	X	bright green.
n Y	1.724	±	0.003	Y	pale purple-brown.
n Z	1.744	±	0.005	Z	strong purple-brown.
$2V_z$	80°,	85°,	86°.		

Dispersion r > v distinct.

Extinction angle Z: cleavage (001) in sections normal to Y = 47°. One good cleavage is shown in sections normal to Y.

Comparative optical data are:

	Arendal and Somerville[1]	Arendal[1]	Baveno[1]	Yakuku[2]	Woburn Mass.[3]
n X	1.717	1.713	1.713	1.715	1.720
n Y	1.730	1.725	1.727	1.725	1.731
n Z	1.752	1.746	1.746	1.740	1.753
$2V_z$	75° (calc.)				76° ± 2° r > v strong

(1) Washington and Merwin, 1923.

(2) Watanabe, 1922.

(3) Richmond, 1937.

Babingtonite is a mineral conspicuous for the constancy of its properties. It apparently does not admit extensive atomic substitutions, for a number of good analyses are published, all of which agree well. One, given by Palache and Fraprie (1902), which deviated somewhat from others, was later shown by Palache and Gonyer (1932) to be incorrect. The last-quoted authors assign to the mineral the formula $Ca_2\ Fe^{\cdot\cdot}\ Fe^{\cdot\cdot\cdot}\ Si_5\ O_{14}\ (OH)$. The ratio of ferrous to ferric iron is near 1 : 1. Richmond (1937) shows that there are two of these formula units to the unit cell.

Various views on its relationships have been advanced and in the most recent study (Richmond, 1937) its relationship to rhodonite has been re-emphasized. It remains, however, an isolated mineral species.

Palache and Gonyer (1932) give a list of its parageneses in which they record four occurrences in veins or cavities in diabase, three in pegmatitic granites, a contact iron skarn, a granodiorite-slate and limestone contact and two veins in gneiss. From the present point of view the occurrences in diabase are of particular interest. In these cases it is found associated with prehnite, quartz, epidote, albite, chlorite, zeolites and calcite.

Secondary minerals formed in cavities, and partly from interstitial glass, in pillow lavas of the Watchung basalts of New Jersey were described by Fenner (1910). Amongst them was a mineral subsequently (Fenner, 1914) identified as babingtonite. Fenner made a careful analysis of the order of formation of the secondary minerals, and in his paragenetic scheme babingtonite enters with albite, quartz, actinolitic amphibole and garnet, immediately after the cessation of precipitation of labradorite, diopside and magnetite. The low temperature limit of its stability range is uncertain, since it was not separately identified in his first paper, but it clearly extends through that of prehnite, upon which it is sedentary in the New Zealand rock, while it was presumably a coprecipitate with ferriferous chlorite in the rock from Hapuka Point crag. This chlorite is uniformly distributed in intersertal position throughout the rock and there is no evidence that it has formed at the expense of any pre-existing mineral phase.

Since babingtonite is a mineral precipitating in the temperature stability field of pegmatites, its presence as a disseminated constituent in some spilites accords with the belief that crystallization of these rocks continued to temperatures much below those normal to extrusive rocks. It is not a mineral that would be produced by post-consolidation metamorphism of the rock, while the texture of specimen 6203 with its delicate cervicorn (and quite unaltered) augites is clearly magmatic. The mineralogy of the rock probably indicates that magmatic crystallization continued to the low temperatures at which babingtonite is stable. Final separation of residual fluids led to the formation of babingtonite-bearing prehnite veins.

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Melolonthinae (Coleoptera) from the Three Kings Islands

By B. B. GIVEN, Entomological Research Station, Nelson.

Introduction

The five specimens of melolonthine coleoptera dealt with in this paper were collected by Mr. E. G. Turbott and Mr. J. S. Edwards during May, 1946, and January, 1953, respectively, while visiting the islands to study regeneration of vegetation following the eradication of goats which had previously caused much havoc in the area.

In correspondence, Mr. Turbott writes: ". . . I mentioned the beetle (as an *Odontria*) in my paper (p. 262) because I thought it might be characteristic of Great Island during the days of the goat-induced park-like vegetation (kanuka canopy, with sedges, etc., forming a ground layer). It seemed possible that this situation would change with regeneration of a mixed forest. . . . I should add, however, that there were quite a few coming to the light in May, 1946, which were not captured." The conclusion embodied in this statement by Mr. Turbott is quite likely to be correct, and it will be very interesting to determine whether or not this species of *Odontria* becomes less plentiful as forest regeneration proceeds.

It is less likely that the second species (*Xylostygnus piceus* Broun) will be affected by the vegetational change.

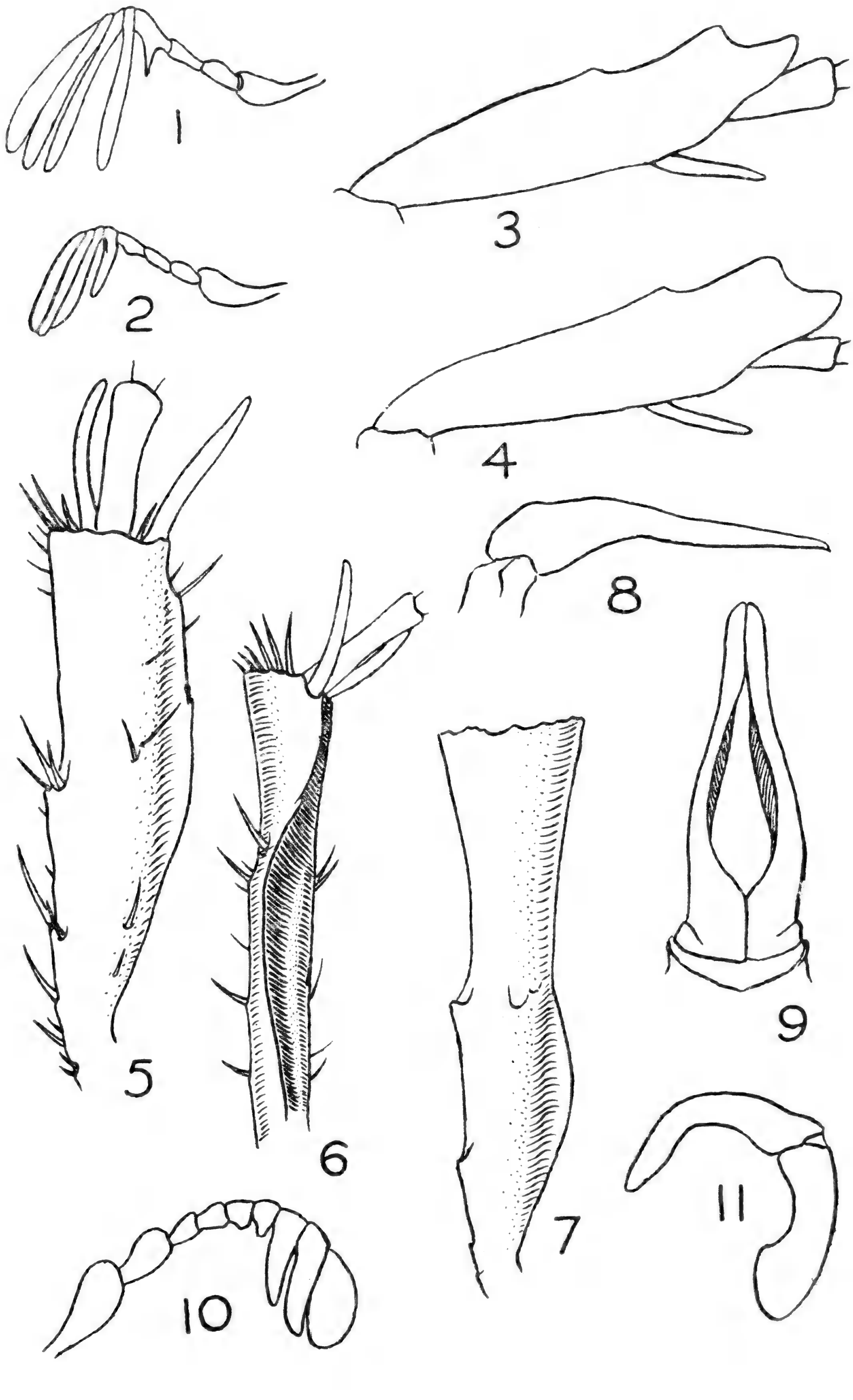
Collections of insects from the outlying islands about New Zealand are of great value in assessment of inter-specific relationships. In the case of the *Odontria* species herein described, this is amply demonstrated, and even the *Xylostygnus* species has characters which, should further evidence be forthcoming from other islands, may affect the status of *X. brookesi*. It is therefore of the utmost importance that our outlying and coastal islands should be carefully studied and collected.

The opportunity of studying this small but interesting collection has been accepted with gratitude, and it is with pleasure that due acknowledgment is made to the Director and the Entomologist of the Auckland Institute and Museum for the loan of the specimens.

Xylostygnus piceus Broun. Figs. 10, 11.

1881—*Xylostygnus piceus* Broun. Man. N.Z. Coleopt., IV, p. 956.

The single male specimen of this species in the collection was taken by Mr. J. S. Edwards amongst rocks on the north-west cliffs of Great Island. Description of the species can be found in Broun (1881), or Given (1952, p. 100).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EXPLANATION OF FIGURES.

Figure

1. *Odontria carinata* n. sp. male antenna.
2. ,, ,, ,, female antenna.
3. ,, ,, ,, male fore tibia.
4. ,, ,, ,, female fore tibia.
5. ,, ,, ,, male hind tibia, anterior aspect.
6. ,, ,, ,, male hind tibia, ventral aspect.
7. ,, ,, ,, female hind tibia, anterior aspect (spines omitted).
8. ,, ,, ,, male parameres, lateral.
9. ,, ,, ,, male parameres, postero-dorsal.
10. *Xylostygnus piceus* Broun male antenna.
11. ,, ,, ,, parameres and basal shield, lateral.

The specimen under discussion is similar to the type, except for the pronotal outline which is similar to that of *X. brookesi* Broun (see Given, 1952, plate 21). This is a genus which is apparently confined to the north-east coast of New Zealand and the nearby coastal islands. Of material so far collected, specimens from the mainland (near Auckland and Whangarei) show strongest relationship to *X. brookesi*, diverging in the direction of *piceus* in northern specimens. Specimens from the islands (Tiritiri, Mokohinau, Three Kings) are of *piceus* affinity, diverging towards *brookesi* in the north (Three Kings). It is possible that if the genus is found on other islands and further north on the mainland, the species *brookesi* may collapse. Recent work at the British Museum (Natural History) indicates that through the species *Ocnodus unidentatus* Lea, the genus *Xylostygnus* Broun may ultimately collapse under *Ocnodus* Burm.

The figures (10, 11) illustrate the antenna and male genitalia of the Three Kings specimen.

Odontria carinata n. sp. **Figs. 1-9.**

Male: Colour rich deep red brown with faint alternate interstitial mottling on elytra, head piceus or dark brown, ventral surface somewhat lighter and more reddish, legs red brown. Pronotum and elytra, with a fine moderately dense brassy pilosity, sternal elements with pilosity rather longer.

Head large, coarsely, uniformly and moderately closely punctate on clypeus and frons; eyes prominent; antennae (fig. 1) quadrilamellate, with an internal process on joint 4. Fore tibia (fig. 3) tridentate; hind tibia highly distinctive, being strongly and somewhat sinuously carinate ventrally (figs. 5, 6).

Genital parameres (claspers) elongate, slender, and almost bilaterally symmetrical (figs. 8, 9).

Length, 17.5 mm.

Female: As male except for antenna (fig. 2) and hind tibia (fig. 7). The fact that the fore tibia illustrated in fig. 4 is less acute apically than that of the male is probably due to wear.

Types

Holotype male, collected by E. G. Turbott, Great Island, at light, May 5, 1946. Allotype female, collected by J. S. Edwards, Great Island, amongst rocks, north-west cliffs, January 5, 1953. Paratype male, collected by E. G. Turbott, Great Island, May 5, 1946, from kanuka (*Leptospermum ericoides* A. Rich.). Paratype female, collected by J. S. Edwards, Great Island, amongst rocks, north-west cliffs, January 5, 1953.

All type material is in the collection of the Auckland Institute and Museum.

Remarks

Apart, perhaps, from *O. magnum* Given, this is the largest known member of the genus *Odontria*. In colour and vestiture it is very similar to *O. xanthosticta* White, but in genitalia is closer to *marmorata* Broun or perhaps *striata* White or *varicolorata* Given. In antennal characters, closest affinity appears to be with *sylvatica* Broun, *velutinum* Given, *xanthosticta* White, and *varicolorata* Given. The carinate hind tibiae are very distinctive, and perhaps unique in the genus.

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The Molluscan Land Operculate Genus Liarea

By A. W. B. POWELL, Auckland Museum.

Abstract.

Over 3,000 specimens from 150 localities in the North Island of New Zealand were used in this taxonomic and distributional survey. There are two groups of species in *Liarea*, one with a simple suture and the other with a margined suture.

A feature of the simple sutured group is the hydrophanous epidermal pattern, which varies with the age of the individual and is best developed under conditions of maximum alternation of wetting and drying. Two new species and five new subspecies are described.

INTRODUCTION.

The genus *Liarea* is restricted to the North Island of New Zealand with its maximum development in the Northland Peninsula, only sporadic occurrence south of there and complete absence from the Central Plateau and East Coast south of the Bay of Plenty.

According to Thiele (1929) the genus belongs to the *Pupinidae*, which he makes a subfamily of the *Cyclophoridae*. His associated genera are all of Indo-Malayan-Australian occurrence and the assumption is that *Liarea* is a relatively recent acquisition from that region.

There are no known fossil occurrences for *Liarea* other than those from post-Pleistocene consolidated dunes near Cape Maria van Diemen, so there is no positive indication of the length of time these snails have been in New Zealand. The fact that *Liarea* is mainly of northern North Island occurrence may be due to climatic rather than to time considerations, but on the other hand the comparatively large number of not very clearly differentiated local forms suggests segregational trends during a late stage of topographical development.

Even at the assumed specific level there are no strongly marked divergences and there is evidence in the species *ornata* that two groups, (A) *hochstetteri* with a margined suture and (B) *egea-turriculata* with a simple suture, have been closely enough allied in the not very distant past to enable the production of hybrid stock. Even now there are no very marked differences in the dentition of the several species representative of the two groups so far examined. All the group (A) *hochstetteri* series have a widely expanded labial flange and all but one, *ornata*, are without an epidermal pattern. In the group (B) *egea-turriculata* series the labial flange ranges from subobsolete to wide, and most of the species and subspecies develop an elaborate epidermal pattern in the adult.

The position is complicated by the fact that most of the group (B) species and subspecies assume several transitional forms in the development of the epidermal pattern, due to wear and age. There is an initial

Rec. Auck. Inst. Mus. Vol. 4, No. 5, pp. 271-293, 20th December, 1954

more or less unicoloured delicately axially costate stage followed by loss of part, or of all of the ribbing, accompanied by, or followed by a differential loosening of the adhesion of the epidermis, which results in varied and often quite complicated patterns. With increasing age and exposure the epidermis lifts more and more until the appearance is uniformly pale, a condition found in many empty shells.

The form of the pattern seems to be rather haphazard, having no significance other than a tendency towards predominence of axial streaks in *turriculata* and *egea* and zigzags, chevrons and tessellations in *tessellata* and *aupouria*.

The epidermal patterns in *Liarea* seem to be parallelled in the Philippine genera of the helicoid group centred around *Helicostyla* and in cyclophorids from the same region.

Concerning these Philippine shells, Pilsbry (1894), described the surface as "covered with a thin transparent cuticle, often porous, when it becomes white and opaque, producing the 'hydrophanous' pattern which ornaments most species."

Why the epidermal patterns should assume such complicated and regular designs is not clearly understood, but it may be related to differential porosity in the formation of the shell.

The group (A) *carinella-hochstetteri* series and the group (B) *turriculata-egea* series frequently occur at the same locality, but they invariably occupy different ecological stations, the former tending towards a hydrophile and the latter towards a xerophile.

Group (A) favours the damp gullies and recesses of the forest, especially amongst rotting masses of nikau palm debris, but Group (B) occupies the better drained slopes and ridges of the forest floor, and is found most frequently under fallen leaves and around clumps of *Carex*.

That the "hydrophanous" pattern develops or is accentuated by alternations of wetting and drying is suggested by the fact that forms of group (B) from the perhumid areas such as Waipoua Forest, Broadwood, and elevated areas of Great Barrier Island show the absence of or only a slight tendency towards patterning. That climate has an influence upon shell size is indicated by the general tendency towards the distribution of small sized species at and south of Auckland and increasing size north of there, with the maximum sized form in the extreme north.

The *egea* series in particular exhibits a spectacular cline or probably more explicitly a geocline of the usage of Huxley (1939). That is, quantitative gradation based upon topographic or spatial separation. In text figure 3 the interruptions to the obvious cline are represented by two size breaks, one coincident with the long sandy isthmus, probably long devoid of suitable forest cover, which joins Awanui with the Cape Maria van Diemen-North Cape block, and the other, now less effective, coincident with the Auckland Isthmus and north of there.

In this latter instance former extensive volcanism may have caused a lengthy period of unsuitable conditions, temporarily segregating southern typical *egea* from its now larger northern counterpart.

The distributional map for the *egea* series (Text fig. 1A) also suggests that typical *egea* reached Great Barrier, Little Barrier and

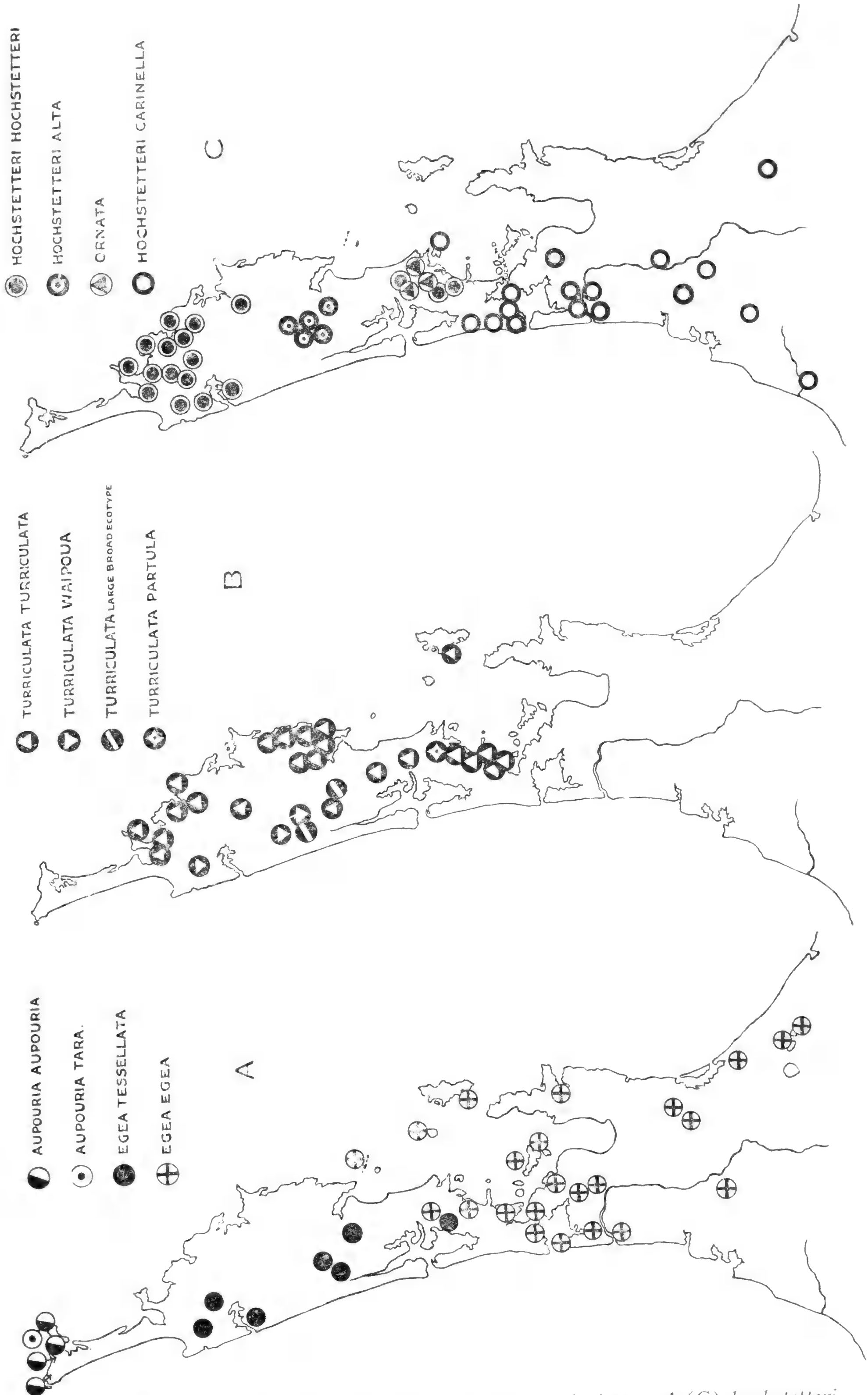

Fig. 1. Distributional patterns in (A) *egea*, (B) *turriculata*, and (C) *hochstetteri* series.

Chicken Islands by the Coromandel route, not necessarily a continuous land connection, whilst the assumed Auckland Isthmus volcanic phase allowed the development in temporary isolation of a larger sized counterpart of *egea* north of Auckland.

In *turriculata* there seems to be no genuine subspeciation, but a tendency towards larger size in localities where optimum conditions of a more luxuriant leaf mould prevail, i.e., slopes of Manaia, Waro and Whangarei. West of Whangarei a large more capacious whorled form occurs in or adjacent to elevated perhumid areas. These may be more correctly evaluated as ecotypes.

It was noted that the small typical form of *turriculata*, 7 mm. to 9 mm. in height, was invariably found where there was little accumulation of leaf mould.

In general, land snails develop more heavily calcified shells wherever there is an abundant source of lime, but in the case of *Liarea turriculata*, the distributional area for which is spread over a number of rock formations, including limestone, there is no apparent difference in size or weight of shell that could be correlated with the nature of the soil.

The *carinella-hochstetteri* series exhibit a clinal pattern also, with the small sized *carinella* distributed at and south of Auckland and the larger *hochstetteri* to the north of Auckland.

This series does not reach the far northern block and its largest member is not found in the far north but in and adjacent to the perhumid areas west and south-west of Whangarei. Ecotypes follow the pattern of an exaggerated spread of the flanged peristome in perhumid areas irrespective of geographic considerations.

Garnier (1950, 1951) has given very useful summaries of the New Zealand climate, but the paucity of stations relevant to Northland does not permit a close correlation between the snail occurrences and the climatic factors. From his map of North Island moisture types (1951, p. 89) two types only are involved in the *Liarea* distribution, the perhumid and the humid.

There is an indication, however, that the scale of winter temperatures may be a limiting factor in the distributional patterns. The summer temperatures for the whole area involved, apart from high altitude perhumid areas, are more uniform and are less likely to present a critical distributional factor.

The furthest south occurrence of the genus is in *lepida* Suter, considered by its author to be a subspecies of *turriculata*. Its relationship, however, is nearer to *egea*, but it is distinctive enough to warrant specific status.

This species occupies a relatively small distributional area extending from the vicinity of Masterton to Ormondville and Mauriceville, and thence westward through the Manawatu Gorge to the Horowhenua coastal plain.

It is separated from the distributional areas of the northern members of the genus by the central plateau and apparently the country extending westward to the vicinity of the Awakino River, Taranaki.

The Taupo pumice showers and other volcanic disturbances associated with the Central Plateau may be one of the causes of discontinuity in the *Liarea* distributional patterns in the southern part of the range. Climatic influences would count also, since the evidently critical winter low temperatures associated with the central higher altitude perhumid areas would be a decidedly limiting factor in respect to the reoccupation of areas that were formerly devastated by the pumice showers.

The genus *Liarea* is comparable with certain New Zealand freshwater molluscan genera such as *Potamopyrgus, Isidora* and *Hyridella,* all of which are evidently plastic and are undergoing rather rapid responses to a series of changing environmental influences.

The close similarity in the dentition of the species of *Liarea* so far examined shows that the external differences do not as yet reflect very significant morphological changes. The several forms which I evaluate subspecifically undoubtedly represent species in the making that only time will resolve.

Much of our former almost continuous forest cover is now broken up into innumerable small isolated patches, and so it is probable that this artificially induced isolating factor may accelerate subspeciation and speciation in the future.

The gathering of material for this paper has been spread over the past twenty years, and apart from the results of my own field work I have had the use of extensive material collected by Mr. Norman Gardner and the late Mr. A. C. O'Connor.

Although the material examined consists of 150 locality lots and is represented by over 3,000 specimens, the present survey must be considered merely a provisional outline.

The topography of Northland is so broken that further localised subspecies will almost certainly be discovered when a more evenly distributed series of stations is achieved and in particular when more of the high country is investigated.

ACKNOWLEDGMENTS.

The writer is greatly indebted to the late Mr. A. C. O'Connor, to Mr. Norman Gardner, and to Messrs. R. A. and H. S. Prouse for transport and for their participation in the field work. Also to Dr. J. Marwick, of the New Zealand Geological Survey, and later to Mr. R. K. Dell, of the Dominion Museum, for the loan of the *Liarea* material in the Suter collection, and to Mr. G. L. Wilkins, British Museum (Natural History), for photographs of the holotype of *Liarea turriculata* Pfeiffer.

This paper was read in part in a Symposium on "The Species Concept" at the Eighth New Zealand Science Congress, Auckland, May, 1954.

SYSTEMATIC KEY.

A. *SUTURE MARGINED*

(a) Labial flange wide
  Epidermal pattern present .. .. *ornata*
  Epidermal pattern absent
    Spire 1½-1 2/3 height of aperture
      Adult size 6.3 mm.-8.7 mm. .. .. *h. carinella*
      Adult size 7.5 mm.-10.4 mm. .. .. *h. hochstetteri*
    Spire 2-2½ height of aperture
      Adult size 8.6 mm.-12.9 mm. .. .. *h. aita*

B. *SUTURE SIMPLE*

(a) Labial flange subobsolete
  Epidermal pattern present
    Spire 2 height of aperture
      Adult size 9.1 mm.-10.0 mm. .. .. *a. tara*

(b) Labial flange narrow
  Epidermal pattern present
    Spire 1½ to 1 2/3 height of aperture
      Adult size 5.8 mm.-8.6 mm.
        Epidermal pattern bold axial streaks *e. egea*
    Spire 2 to 2¼ height of aperture
      Adult size 7.2 mm.-17.7 mm.
        Epidermal pattern bold axial streaks
          Spire narrowly tapered .. *t. turriculata*
        Epidermal pattern zigzags and tessellations
          Spire bluntly conical .. .. *e. tessellata*
      Adult size 9.8 mm.-13.20 mm.
        Epidermal pattern streaks and chevrons
          Spire broadly and bluntly conical *a. aupouria*
  Epidermal pattern absent
    Spire 2 height of aperture
      Adult size 7.6 mm.-10.30 mm. .. .. *t. waipoua*

(c) Labial flange wide
  Epidermal pattern present
    Spire 2 height of aperture
      Adult size 6.3 mm.-7.9 mm. .. .. *lepida*
  Epidermal pattern absent
    Spire 1½ to 1 1/3 height of aperture
      Adult size 7.0 mm.-8.2 mm. .. .. *t. partula*

LOCALITY KEY.

A. Cape Maria van Diemen-North Cape block	*a. aupouria*
Kerr Point near North Cape only	*a. tara*
B. Northland Peninsula (south of Awanui)	
Mainly east coast	*t. turriculata*
West coast perhumid areas	*t. waipoua*
West and central areas south to Woodcocks	*c. tessellata*
West to east in north mainly east to Auckland ..	*h. hochstetteri*
West and south, vicinity of Whangarei	*h. alta*
Wellsford-Leigh-Omaha	*ornata*
South of Warkworth	*t. partula*
C. East Coast Islands	
Chickens and Little Barrier Islands	*c. egea*
Great Barrier Island	*c. egea* and *t. turriculata*
Kawau Island	*h. carinella*
Waiheke Island	*c. egea*
D. Auckland Isthmus	
Mainly east coast	*e. egea*
Mainly west coast	*h. carinella*
E. South of Auckland	
Mainly western to Awakino	*h. carinella*
Mainly central and eastern to Te Puke and Rotorua ..	*c. egea*
F. Wellington	
Wairarapa-Manawatu-Horowhenua	*lepida*

See text figure 1 for maps showing detailed plotting of stations: A. *egea*, B. *turriculata*, C. *hochstetteri* series.

A. THE HOCHSTETTERI SERIES.

The distinguishing features of the *hochstetteri* series are the margined suture, the more or less uniform coloration without "hydrophanous" patterns (except in *ornata* n. sp.), the strongly carinated body-whorl and the flat, broadly expanded, concentrically striated flange-like lip, encircling the inner, narrow, slightly raised peristome.

The known geographic range of the *hochstetteri* series is from Awanui in Northland to Awakino in Northern Taranaki.

The *hochstetteri*, *alta* and *carinella* subspecies favour the more or less constantly moist locations in the forest, and are most frequently found clinging to rotting fallen leaf sheaths of the nikau palm. Since these snails are thus not subject to extremes of alternate wetting and drying, as is the case with the *turriculata-egea* series, which favour drier situations, this may be the factor that determines the presence or absence, or the degree of development, of a hydrophanous pattern.

It is significant that the habitat of *ornata*, the only member of the *hochstetteri* series to develop the hydrophanous pattern, is in relatively dry, well drained situations, and conversely that the *turriculata* ecotypes from perhumid or verging upon perhumid locations show only slight tendencies towards epidermal patterning.

Another variation in the *hochstetteri* series that may be considered ecotypic rather than subspecific is in the relative expanse of the outer-lip flange, which is narrow in populations from the relatively dry coastal areas of the vicinity of Mangonui and Bay of Islands and very wide in the perhumid western areas. The maximum development of this feature is shown in examples from Herekino Gorge.

The physical function of the expanded outer-lip flange may be to assist the animal's ability to cling to the soft, slimy surface of decaying vegetation by operating as a suction disc, and it may also serve as a copulatory aid.

The only sinistral example of the genus known to me is a specimen of *hochstetteri* typical, in my collection, from Oretere Bush, near Kaeo.

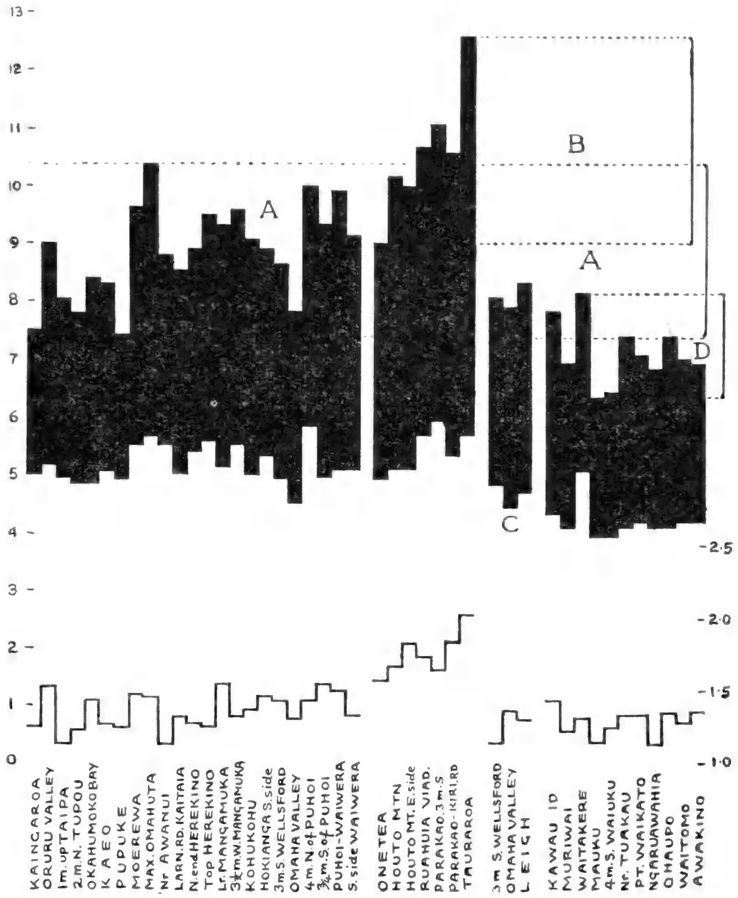

Fig. 2. Histogram of populations for *Liarea hochstetteri* series. Columns represent an average of at least ten adult specimens for each locality (see left-hand scale in mm.). Top of column represents height averages and bottom of column width averages. Stepped line below plots the spire height index (see right-hand scale in mm.). A = *hochstetteri hochstetteri*. B = *hochstetteri alta*. C = *ornata*. D = *hochstetteri carinella*.

Liarea hochstetteri hochstetteri (L. Pfeiffer). Pl. 44, fig. 6; Pl. 45, figs. 9-12.

1861—*Realia hochstetteri* Pfeiffer, Malak. Bl. 8, p. 149.
1865—*Realia hochstetteri*: Pfeiffer, Monog. Pneumonopomorum Viventium, 2nd suppl., p. 170.
1913—*Realia hochstetteri*: Suter, Manual N.Z. Mollusca, p. 196, Pl. 38, fig. 32.

Shell of moderate size, 7.5 mm. to 10.4 mm. in height with broadly conical spire and a strongly angled to keeled body-whorl. Whorls 7 to 7½, including a depressed globose protoconch of two smooth whorls. Spire-whorls, lightly convex, rapidly and regularly increasing. Suture supra-margined with a narrow rounded sharply raised cord. Spire one and a-half to one and two-third height of aperture. Spire height index (i.e., body-whorl width into spire height), 1.12 to 1.56 with an average of 1.36. Sculpture consisting of closely spaced retractive narrow axial plications. Aperture ovate-rotund, slightly oblique, subangled above. Peristome with a slightly raised inner rim, surrounded by a broadly expanded concentrically striated thin flange. Perforation open, rather broadly crescentric, margined by a rounded cord. Colour ranging from uniformly dark horny to sepia.

Type: Bay of Islands (Hochstetter) K. K. Hofmuseum, Vienna. "Long. 9, diam. 4 mill."

The dimensions given by Pfeiffer indicate either an abnormally narrow shell or more likely a basis of measurement different from the one adopted in this paper. My method gives the diameter as the maximum distance from the point of greatest diameter of the body-whorl on the left to the point of greatest convexity of the outer lip flange on the right, measured at right angles to the vertical axis of the shell.

Typical *hochstetteri* occurs only in Northland, where it occupies a block extending from coast to coast south of Awanui to Hokianga on the West Coast and Bay of Islands on the east coast. It extends southwards through the inland country between Whangarei and towards the west coast, where it is represented by the taller-spired *hochstetteri alta* n. subsp. (described following) and reaches its apparently southern limit, again approximating the typical subspecies, in the east coast area from Wellsford to Waiwera.

The latter present a rather different appearance by having the plications standing out as white threads on a shining dark-horny to sepia ground colour.

Further inland collecting stations between Kawakawa and south of Whangarei are required to determine if there is a continuity between the northern and southern typical *hochstetteri* populations, irrespective of the tall-spired *hochstetteri alta*, which is sandwiched between, but more to the westward. Suter recorded *hochstetteri* from Whangarei Heads, but I have not been able to substantiate this record in the field.

Locality	Smallest*	Largest	Average	Spire Ht. Index
Kaingaroa	7.10 x 4.80	7.80 x 5.20	7.5 x 5.0	1.25
Oruru Valley, Mangonui	8.10 x 5.10	9.90 x 5.40	9.0 x 5.2	1.53
One mile up Taipa	7.80 x 4.90	8.50 x 5.20	8.1 x 4.9	1.26
Two miles West of Tupou	7.10 x 4.70	8.20 x 5.00	7.7 x 4.8	1.22
Okahumoko Bay	8.25 x 4.80	8.60 x 4.90	8.4 x 4.8	1.43

Locality	Smallest*	Largest	Average	Spire Ht. Index
Kaeo	8.20 x 4.80	8.60 x 5.30	8.3 x 5.1	1.28
Pupuke	7.20 x 4.90	7.70 x 4.90	7.4 x 4.9	1.25
Three miles S. of Moerewa	—	9.70 x 5.50	—	1.49
Maxwell's, Omahuta	10.10 x 6.00	10.80 x 5.80	10.4 x 5.7	1.47
Near Awanui	8.50 x 5.70	9.20 x 5.50	8.8 x 5.5	1.12
Larner's Road, Kaitaia	8.20 x 4.80	9.10 x 5.10	8.6 x 5.0	1.32
North entr. Herekino Gorge	8.10 x 5.10	9.80 x 5.80	8.9 x 5.4	1.28
Top of Herekino Gorge	9.20 x 5.80	9.90 x 5.50	9.5 x 5.6	1.25
Lower Mangamuka Gorge	8.60 x 5.30	9.80 x 5.20	9.3 x 5.2	1.56
3½ m. W. of Mangamuka	9.10 x 5.10	10.00 x 5.50	9.6 x 5.5	1.32
Kohukohu, Hokianga	9.30 x 5.10	9.20 x 5.00	9.1 x 5.0	1.38
Hokianga, South side	8.60 x 5.50	9.10 x 5.10	8.9 x 5.3	1.46
Three miles S. of Wellsford	8.50 x 4.90	8.90 x 5.00	8.7 x 4.9	1.42
Omaha Valley	7.60 x 4.30	8.10 x 4.70	7.8 x 4.5	1.30
Four miles North of Puhoi	9.20 x 5.50	10.60 x 6.00	10.0 x 5.8	1.42
¾ mile South of Puhoi	8.80 x 5.00	9.80 x 5.00	9.3 x 4.9	1.54
Puhoi-Waiwera	9.60 x 5.20	10.00 x 5.00	9.9 x 5.1	1.50
South side of Waiwera	8.80 x 5.00	10.10 x 5.30	9.2 x 5.1	1.32
Average of combined averages of above lots:			8.8 x 5.1	1.36

* Smallest sized example with adult labial features.

Dentition: Pl. 48, fig. 39. Kaeo, Northland.

Localities: Kaingaroa, between Awanui and Mangonui (A. E. Brookes, 1917); Oruru Valley, near Mangonui (A.W.B.P. coll.); one mile up south side of Taipa Estuary (A.W.B.P., 20/1/1950); Oruaiti Bush, Northland (N. Gardner, August, 1950); two miles west of Tupou Bay, east of Mangonui (Map N. 7, Ref. 144884) (A.W.B.P., 20/6/1947); Okahumoko Bay, Whangaroa (Mrs. I. Worthy, 1948); Oreteri Bush, near Kaeo (Mrs. I. Worthy); Pupuke, near Whangaroa (Mrs. I. Worthy); Bay of Islands (type) (Hochstetter); three miles south of Moerewa (N. Gardner); Maxwell's Farm, Omahuta, five miles south of Mangamuka Bridge (A. Hancox, 1948); near Awanui (W. La Roche); Quarry, Larner's Road, Kaitaia (N. Gardner, December, 1947); northern entrance to Herekino Gorge (A.W.B.P., 31/1/1950); Manukau North, near Herekino (N. Gardner, 2/1/1950); Top of Herekino Gorge (Mrs. I. Worthy); Mangamuka Gorge, south entrance (A.W.B.P., January, 1948); Mangamuka Bridge to Tutekehua, Lower Mangamuka Gorge (A. Hancox, 1948); 3½ miles west of Mangamuka Gorge (Mrs. I. Worthy); Hick's Bush, near Kohukohu-Broadwood Road Junction (A. E. Brookes); Kohukohu, Hokianga; Hokianga River, south side (W. La Roche); six miles south of Warkworth (K. Hipkins); three miles south of Wellsford (N. Gardner, 27/3/1948); Omaha Valley, near Matakana (N. Gardner, 25/3/1948); four miles north of Puhoi (N. Gardner, 28/3/1948); three-quarter of a mile south of Puhoi (N. Gardner, 29/3/1948); half a mile south of Waiwera (N. Gardner, October, 1947); north side of Waiwera-Puhoi hill (Map N. 38, 202990, ca. 300ft.) (A.W.B.P., April, 1947).

Liarea hochstetteri alta n. subsp. Pl. 45, figs. 13 and 14.

Shell relatively large with narrowly conical spire and weakly carinated body-whorl. Whorls 9, including a depressed globose protoconch of 2 smooth whorls. Spire whorls lightly convex, gradually increasing to the eighth, the ninth very little wider. Suture supra-margined with a narrow rounded sharply raised cord. Spire twice to two and a half times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.58 to 2.14 with an average of 1.77. Sculpture consisting of closely-spaced retractive narrow axial plications. Aperture ovate-rotund, slightly oblique, subangled above. Peristome with a slightly raised narrow inner rim, surrounded by a broadly expanded concentrically striated flange. Perforation narrow, crescentic, margined by a rounded cord. Colour dark sepia.

Holotype: Between Tauraroa and Waiotira. Auckland Museum. Height 12.75 mm.; diameter 5.60 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
Onetea, Northern Wairoa	9.00 x 5.00	9.10 x 4.90	9.0 x 4.9	1.58
Houto Mountain (pale)	9.20 x 5.00	11.20 x 5.10	10.2 x 5.1	1.67
East slope, Houto Mountain	8.60 x 4.90	11.20 x 5.20	10.0 x 5.1	1.82
Ruahuia Viaduct	9.80 x 5.60	11.40 x 5.70	10.7 x 5.7	1.73
Three miles S. of Parakao	10.90 x 6.00	11.20 x 5.80	11.1 x 5.9	1.63
Parakao-Kirikopuni	9.70 x 5.20	11.60 x 5.50	10.6 x 5.3	1.83
Tauraroa-Waiotira	12.3 x 5.60	12.90 x 5.90	12.6 x 5.7	2.14
Average of combined averages of above lots:			10.6 x 5.4	1.77

The subspecies *alta* is larger than typical *hochstetteri* and has a relatively much taller spire. The peristome is broadly expanded as in the ecotype from Herekino and other western perhumid areas. Examples from Onetea, Northern Wairoa, and the western slopes of Houto Mountain are pale to dark horny.

Localities: Between Tauraroa and Waiotira, west side of railway track (A.W.B.P., 27/3/1949) (Map N. 24, Ref. 725750, 250-300ft.) (Holotype); Ruahuia Viaduct, Parakao-Kirikopuni Road, Mangakahia District (Map N. 19, Ref. 477941, ca. 500ft.) (A.W.B.P., 28/10/1947); three miles south of Parakao, Mangakahia District (N. Gardner, October, 1947); Parakao-Kirikopuni Road, Mangakahia District, foot of western slope of Houto Mountain (Map, Dargaville, N. 23, Ref. 480897, 200-250ft.) (A.W.B.P., 28/10/1947); Onetea, Northern Wairoa.

Liarea hochstetteri carinella (L. Pfeiffer). Pl. 44, fig. 7; Pl. 45, fig. 15.

1861—*Realia carinella* Pfeiffer, Malak. Bl. 8, p. 150.
1865—*Realia carinella*: Pfeiffer, Monog. Pneumonopomorum Viventium, 2nd suppl. p. 170.
1913—*Realia carinella*: Suter, Manual N.Z. Mollusca, p. 195, Pl. 38, fig. 30.

Shell small, 6.3 mm. to 8.7 mm. in height, with narrowly conical spire and a very sharply angled and keeled body-whorl. Whorls 7, including a depressed globose protoconch of 2 smooth whorls. Spire whorls lightly convex, regularly increasing, the whole outline of the spire straight, to slightly concave between the protoconch and the second to third post-nuclear whorls. Spire one and a-half to one and two-thirds height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.16 to 1.42, with an average of 1.29. Suture supramargined with a narrow rounded sharply raised cord. Sculpture consisting of closely spaced retractive narrow weak axial threads which become subobsolete over the base. Aperture vertical, ovate-rotund, subangled above. Peristome with a slightly raised inner rim, surrounded by a broadly expanded concentrically striated thin flange. Perforation open, narrowly crescentic, margined by a rounded cord. Colour light brown, or warm dark-brown.

Type: Drury and Taupiri (Hochstetter). K. K. Hofmuseum, Vienna. "Long. 7, diam. 3¼ mill."

Again the dimensions given by Pfeiffer indicate that the width is understated. A sight measurement based upon the greatest width, taken at right angles to the axis of the shell, shows 4.10 mm. for a shell 7 mm. in height.

Although the extremes appear recognisably distinct, the differences between *hochstetteri hochstetteri* and *hochstetteri carinella* are not very marked when large series from numerous localities are considered. The former ranges the larger (8.8 mm. x 5.1 mm. average) with capacious whorls and the latter the smaller (7.1 mm. x 4.2 mm. average) with a narrower spire and less capacious whorls. Also, the axials tend towards obsolescence on the base only in *carinella*, but not invariably so. The spire height index shows a similar range of variation in both subspecies.

The histogram (Text fig. 2) shows clearly the constantly smaller size range of the Auckland and south of Auckland *carinella* subspecies. See also the map (Text fig. 1C.), which shows the *carinella* distributional area from the northern end of the Waitakere Range to Awakino; all western drainage except for an isolated eastern location at Kawau Island.

Locality	Smallest	Largest	Average	Spire Ht. Index
Waitakere Range	7.60 x 4.70	8.70 x 5.50	8.2 x 5.1	1.30
Muriwai	6.80 x 4.00	7.00 x 4.10	6.9 x 4.1	1.21
Kawau Island	7.60 x 4.20	7.90 x 4.40	7.8 x 4.3	1.42
Mauku	5.90 x 3.70	6.80 x 4.20	6.3 x 3.9	1.26
Four miles South of Waiuku	6.00 x 4.00	6.80 x 4.00	6.4 x 3.9	1.23
Near Tuakau	7.00 x 4.00	7.80 x 4.20	7.4 x 4.1	1.32
Port Waikato	6.50 x 4.10	7.50 x 4.20	7.1 x 4.2	1.32
Ngaruawahia	6.70 x 4.20	6.90 x 4.10	6.8 x 4.1	1.16
Ohaupo	7.10 x 4.00	7.50 x 4.20	7.4 x 4.1	1.32
Waitomo Caves	6.10 x 3.80	7.50 x 4.40	7.0 x 4.2	1.29
Awakino Gorge	6.40 x 3.90	7.50 x 4.50	6.9 x 4.2	1.36
Average of combined averages of above lots:			7.1 x 4.2	1.29

Localities: Above School House Bay, Kawau Island (A.W.B.P., July, 1949); Muriwai, West Coast, Auckland (A.W.B.P.); Swanson, Waitakere Range (H. Suter coll.); Pukematakeo, Waitakere Range (Map N. 41, Ref. 063566, 1104 ft.) (N. Gardner, 15/1/1948); Huia, Manukau (N. Gardner, 1947); Titirangi, Auckland (N. Gardner, October, 1946); Mt. Wellington lava fields, Auckland (A. Suter); four miles south of Waiuku (A.W.B.P., 1927); Mauku, Pukekohe (N. Gardner, October, 1947); Maketu, Hunua Range (H. Suter coll.); near Tuakau (A.W.B.P., March, 1946); Port Waikato (W. La Roche); Hill behind Ngaruawahia (N. Gardner, 7/1/1949); Ohaupo, Waikato (H. Suter Coll.); Mt. Pirongia (A. E. Brookes); Tarukenga, Rotorua (H. Suter coll.); Entrance to Waitomo Caves (A.W.B.P., February, 1949); Awakino Gorge (A.W.B.P., 1926).

Liarea ornata n. sp. Pl. 48, fig. 37.

Shell small, 8.4 to 8.7 mm. in height with conical, straightsided whorls and subangled to keeled body-whorl. Whorls $6\frac{1}{2}$ to 7, including a depressed globose protoconch of two smooth whorls. Spire-whorls almost flat in outline, regularly increasing. Suture prominently supra-margined with a rounded sharply raised cord. Spire one and a-half times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.28 to 1.36 with an average of 1.31. Surface smooth and polished, with subobsolete closely to irregularly spaced axial growth lines. Base rounded, smooth, with a deep broadly crescentic umbilicus margined by a rounded cord. Aperture ovate-rotund, oblique and sub-angled above. Peristome with a slightly raised narrow inner rim, surrounded by a moderately wide concentrically striated thin flange. Colour dark reddish-brown with a conspicuous hydrophanous pattern in pale buff in the form of elaborate chevrons. The base is uniformly dark brown, the umbilical cavity and outer lip flange pale brown.

Holotype: Three miles south of Wellsford. Auckland Museum. Height, 8.4 mm; diameter 5.0 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
Three miles S. of Wellsford	7.90 x 4.40	8.40 x 5.00	8.1 x 4.8	1.28
Omaha Valley	7.40 x 4.40	8.50 x 4.50	7.9 x 4.4	1.36
Leigh	7.80 x 4.40	8.70 x 5.00	8.3 x 4.7	1.30
Average of combined averages of above lots:			8.1 x 4.6	1.31

This species is the only one of the *hochstetteri* series to exhibit the hydrophanous pattern so characteristic of the *egea-turriculata* series. That it belongs to the *hochstetteri* series and not to the latter is clearly shown by the margined suture, rim-margined umbilicus and expanded outer lip flange.

It occupies a compact block of territory extending from the vicinity of Warkworth to Leigh and Omaha.

Typical *hochstetteri* occurs in association with *ornata* at one locality, Warkworth, but no intergradation is evident.

An original hybrid origin is suspected for *ornata,* which now seems to have acquired genetical isolation, and if this is so hybridism must have occurred in the past when the *hochstetteri* and the *egea-turriculata* series were less strongly differentiated than they are at present. Certainly under present circumstances elsewhere, in locations where both series occur more or less together, there is no sign of hybrid influences.

Localities: Three miles south of Wellsford in reserve near bridge, main highway (Map N. 33, Ref. 072233, 200ft.) (N. Gardner and A.W.B.P., January, 1952) (Holotype); Omaha Valley, Matakana (N. Gardner, 28/3/1948); Leigh (Map N. 34, Ref. 290322, 30-50ft.) (A.W.B.P., 26/2/1948).

B. THE EGEA-TURRICULATA SERIES.

The distinguishing features of the *egea-turriculata* series are the simple unmargined suture, the well developed hydrophanous epidermal pattern, the rounded body-whorl, subangled at most, the relatively narrow labial flange and the small to vestigial umbilical cavity.

The known geographical range of the *egea-turriculata* series is from the northernmost tip of Northland to the Horowhenua Plain north of Wellington. South of Auckland the series extends to the Waikato and eastwards to Rotorua, but is absent from the remaining southern and eastern areas of the North Island, apart from *lepida* which occupies a compact area from the Wairarapa, the Manawatu and the Horowhenua Plain.

The species *turriculata* is restricted to the Northland Peninsula to as far north as Kaingaroa, near Awapuni. Its preference is for the warmer and drier eastern areas, but a presumed subspecies of slightly broader proportions with an obsolete or less prominently developed hydrophanous pattern, occupies sporadically, perhumid and verging upon perhumid locations, mostly in central areas, to the westward or in high country.

The *egea* series exhibit a spectacular geocline with an increasing size range from south to north, as already explained in the introduction, and is graphically shown in the histogram (Text fig. 3).

Liarea egea egea (Gray). Pl. 44, fig. 4; Pl. 47, figs. 27-32.

1850—*Realia egea* Gray, Proc. Zool. Soc. (Lond.) for 1849, p. 167.
1852—*Realia egea*: Pfeiffer, Monog. Pneumopomorum Viventium, p. 305.
1913—*Realia egea*: Suter, Manual N.Z. Mollusca, p. 196, Pl. 38, fig. 31.

Shell small, 5.8 mm. to 8.6 mm. in height with broadly conical spire, whorl outlines strongly convex with body-whorl rounded to weakly subangled. Whorls 6 to 6½, including a small papillate protoconch of two smooth whorls. Suture simple. Spire one and a-half to one and two-thirds height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.13 to 1.58 with an average of 1.35. Umbilicus small to moderate, crescentic and often margined with a weak cord. Aperture ovate to oblique D-shaped. Peristome narrow, slightly raised and surrounded by a moderate to relatively narrow thin flange. Sculpture in well preserved examples consists of numerous narrow membranous axials which rapidly wear down and leave faint narrow axial thread-like folds on an otherwise smooth surface. The initial colour pattern is a broad basal spiral band on a uniform ground colour of light to dark brown. After the wearing down of the axials the hydrophanous epidermal pattern develops on the spire and is usually a bold design of broad axial streaks, often flexuous but seldom chevroned to any extent.

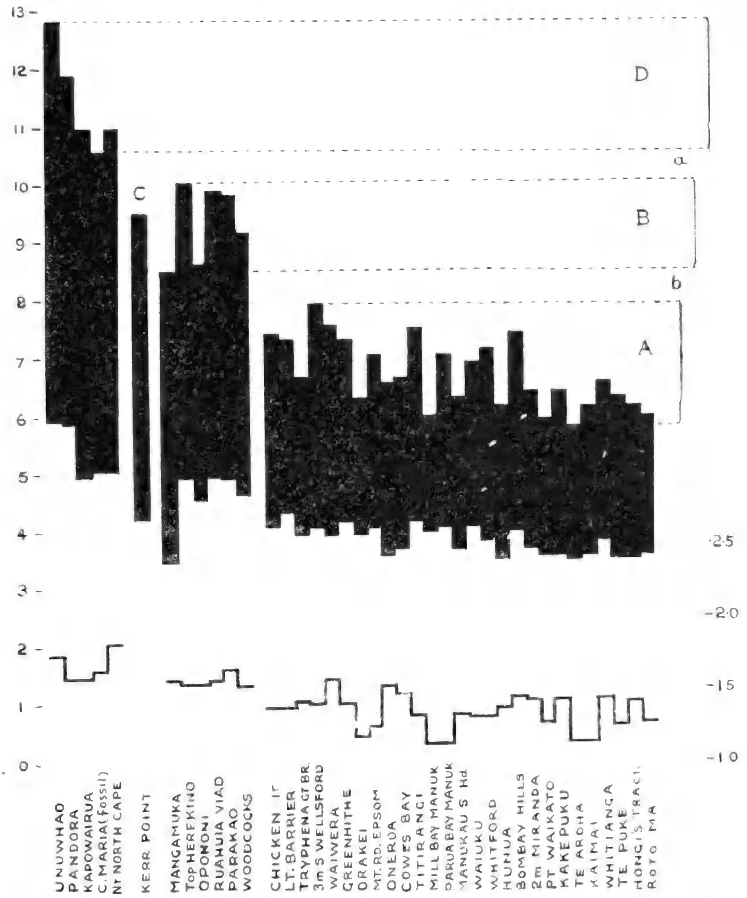

Fig. 3. Histogram of populations for *Liarea egea* series. A = *egea egea*. B = *egea tessellata*. C = *aupouria tara*. D = *aupouria aupouria*. Note the geocline with size gaps coincident with (a) the far northern sandy isthmus and (b) the east coast to the north of Auckland.

Type: Auckland (Greenwood), British Museum (Natural History). "Length 2½ lines" (Gray).

Locality	Smallest	Largest	Average	Spire Ht. Index
Chicken Island	6.75 x 3.80	8.00 x 4.25	7.4 x 4.1	1.38
Little Barrier Island	6.90 x 4.20	7.90 x 4.60	7.3 x 4.3	1.38
Tryphena, Great Barrier	6.20 x 3.90	7.00 x 4.00	6.7 x 3.9	1.42
Three miles S. of Wellsford	7.00 x 4.00	8.60 x 4.20	7.9 x 4.1	1.40
Waiwera	6.60 x 3.90	8.40 x 4.20	7.6 x 3.9	1.58
Greenhithe	6.70 x 4.10	8.00 x 4.30	7.3 x 4.2	1.40
Orakei, Auckland	5.90 x 4.00	6.90 x 4.00	6.3 x 3.9	1.18
Mt. Rd., Mt. Eden, Auck.	6.10 x 3.30	8.00 x 4.40	7.1 x 4.1	1.27
Oneroa, Waiheke Island	5.80 x 3.40	7.40 x 3.90	6.6 x 3.6	1.56
Cowes Bay, Waiheke	6.70 x 3.70	7.00 x 3.70	6.7 x 3.7	1.48
Whitford	6.80 x 3.50	7.30 x 4.00	7.2 x 3.8	1.32
Two miles W. of Miranda	6.10 x 3.70	7.00 x 3.80	6.4 x 3.7	1.42
Hunua	6.00 x 3.25	7.00 x 3.80	6.2 x 3.5	1.38
Bombay Hill	6.30 x 3.70	7.90 x 4.00	7.4 x 4.0	1.45
Te Aroha	5.60 x 3.50	6.00 x 3.50	5.8 x 3.5	1.28
McLaren's, Kaimai	5.60 x 3.30	6.40 x 3.50	6.2 x 3.6	1.26
Whitianga	5.80 x 3.60	7.10 x 4.10	6.6 x 3.8	1.44
Hongi's Track	5.70 x 3.30	6.60 x 3.80	6.2 x 3.5	1.42
Roto Ma, Rotorua	5.70 x 3.30	6.60 x 4.00	6.0 x 3.6	1.29
Te Puke	6.20 x 3.50	6.60 x 3.80	6.3 x 3.5	1.26
Mill Bay, Manukau	5.70 x 4.00	6.20 x 4.00	6.0 x 4.0	1.13
Titirangi Beach	7.30 x 4.50	7.90 x 4.10	7.5 x 4.2	1.32
Parua Bay, Manukau	6.90 x 3.90	7.40 x 4.10	7.1 x 4.1	1.13
Manukau South Head	6.00 x 3.50	7.30 x 4.00	6.3 x 3.7	1.33
Waiuku	6.40 x 4.00	7.10 x 4.20	6.7 x 4.1	1.32
Port Waikato	5.70 x 3.00	6.50 x 4.00	5.9 x 3.6	1.29
Average of combined averages of above lots:			6.7 x 3.9	1.35

Dentition: Pl. 48, fig. 38. Whitford, Auckland.

Localities: Chicken Islands (2nd island from east) (A.W.B.P., "Will Watch" Exped., February, 1934); Little Barrier Island (A. E. Brookes); Tryphena, Great Barrier Island (N. Gardner, January, 1951); Three miles south of Wellsford (N. Gardner); Waiwera (T. F. Cheeseman); Greenhithe (N. Gardner); Hillyer's Creek, Auckland (A.W.B.P., 25/4/1927); Orakei Bush, Auckland (A.W.B.P.); Mountain Road, Mt. Eden, Auckland (N. Gardner); Mt. Wellington lava fields, Auckland (W. La Roche); Between Oneroa and Palm Beach, Waiheke Island (A.W.B.P., January, 1933); Onetangi, Waiheke Island (N. Gardner, 21/2/1948); Cowes Bay, Waiheke Island (W. La Roche); Four miles south of Howick, Auckland (A.W.B.P., 4/6/1927); Whitford (N. Gardner, 5/6/1948); Hunua Falls (N. Gardner, August, 1947); Hunua Range (H. Suter coll.); Summit of Bombay Hill (N. Gardner, 7/1/1949); Two miles west of Miranda (Raines Rd.) (N. Gardner, 26/12/1948); Te Aroha (W. H. Webster); Whitianga (K. Hipkins, 1948); McLaren's Falls, Lower Kaimai (N. Gardner, 27/12/1948); Upper Kaituna River, Te Puke (N. Gardner, 27/12/1948); Two miles east of Roto Ma Lake, Rotorua (N. Gardner, 5/1/1949); Hongi's Track, Rotorua (N. Gardner, 5/1/1949); Titirangi Beach (N. Gardner, November, 1947); Mill Bay, Manukau Harbour (N. Gardner, December, 1947); French Bay, Manukau Harbour, in Manuka scrub (N. Gardner); Waikowhai Bush, Manukau Harbour (D. H. Graham); Cornwallis, Manukau (A.W.B.P.); Manukau South Head (W. La Roche); Parua Bay, Manukau (N. Gardner, December, 1947); Mauku, near Patumahoe (N. Gardner, October, 1947); Waiuku (W. H. Webster); Tuakau (H. Suter coll.); Port Waikato (W. La Roche); Mt. Kakepuka, near Te Awamutu (N. Gardner, 7/4/1947).

The typical subspecies is found around Auckland, south of there to the Waikato and eastwards to Rotorua. Northwards it extends sporadically to Wellsford and to the islands of Little Barrier, Great Barrier, and the Chickens. North of Wellsford to Hokianga and Herekino a larger subspecies (described following) is distributed, and this exhibits a complex chevroned to tessellated hydrophanous pattern.

Liarea egea tessellata n. subsp. Pl. 44, fig. 5; Pl. 47, figs. 24-26.

Shell of moderate size, 8.6 mm. to 11.0 mm. in height with tall conical spire. Whorl outlines strongly convex, with body-whorl rounded to weakly subangled. Whorls 6½ to 7, including a small papillate protoconch of two smooth whorls. Suture simple, deeply impressed. Spire twice height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.40 to 1.64 with an average of 1.54. Umbilicus moderate, broadly crescentic, margined by a weak cord. Aperture ovate-rotund, only slightly subangled above. Peristome narrow, slightly raised and surrounded by a narrow thin flange. Sculpture consisting of numerous weak axial threads which rapidly wear off, leaving the surface smooth. Hydrophanous epidermal pattern a striking complicated alternation of dark reddish-brown and buff in the form of axial streaks, zigzags and chevrons, often resulting in tessellation. Base uniformly dark or with a broad dark band on the upper part of the base only.

Holotype: Opononi, Hokianga. Height 8.7 mm.; diameter 4.5 mm. Auckland Museum.

Locality	Smallest	Largest	Average	Spire Ht. Index.
3½ miles W. of Mangamuka	7.90 x 4.20	9.00 x 4.50	8.5 x 4.4	1.57
Top of Herekino	9.20 x 4.50	11.00 x 5.30	10.1 x 4.9	1.54
Opononi	8.00 x 4.70	9.40 x 4.90	8.7 x 4.6	1.54
Owhatu, Herekino	8.20 x 4.70	10.30 x 4.70	9.5 x 4.6	1.48
Two miles W. Tangowahine	8.60 x 4.20	10.60 x 5.00	9.6 x 4.7	
Ruahuia Viaduct	9.50 x 4.80	10.00 x 4.90	9.8 x 4.9	1.57
1¾ miles East of Parakao	9.30 x 4.90	10.10 x 5.00	9.8 x 4.9	1.64
Three miles S. of Wellsford	7.00 x 4.00	8.60 x 4.20	8.0 x 4.1	1.40
Woodcocks	8.00 x 4.50	10.20 x 4.80	9.2 x 4.7	1.52
Average of combined averages of above lots:			9.2 x 4.6	1.53

The subspecies *tessellata* is not only larger than *egea* typical with half to one more whorl, but it has a relatively taller spire and almost invariably a more complicated zigzag to tessellated pattern.

Its range is from Woodcocks to Herekino, Northland, over central and western areas of the peninsula, and it favours the warmer and drier, more open outskirts of the forest.

Localities: Top of Herekino Gorge (Mrs. I. Worthy); 3½ miles west of Mangamuka Gorge, southern entrance (Mrs. I. Worthy); Opononi, Hokianga (W. La Roche) (type); Two miles west of Tangowahine, Dargaville District (Map No. 23, Ref. 427786) (A.W.B.P., 28/10//1947); Ruahuia Viaduct, Parakao-Kirikopuni Road, Mangakahia District (Map N. 19, Ref. 477941) (A.W.B.P., 28/10/1947); 1¾ miles east of Parakao, north side of road, Mangakahia District (Map N. 19, Ref. 504986) (A.W.B.P., 25/10/1947); Three miles south of Wellsford (N. Gardner); Between Tauraroa and Waiotira, west side of railway track (A.W.B.P., 27/3/1949) (Map N. 24, Ref. 725750, 250-300ft.); Woodcocks (Map N. 33, Ref. 093086, ca. 550ft.) (A.W.B.P., 11/2/1948).

Liarea aupouria aupouria n. sp. Pl. 44, fig. 2; Pl. 48, figs. 33 and 33a.

Shell largest for the genus, 9.80 mm. to 13.20 mm. in height. Tall-spired but broad in proportion. Whorl outlines moderate convex with body-whorl rounded and only occasionally weakly subangled. Whorls 7½, including a blunt dome-shaped protoconch of two whorls followed by a half-whorl of closely spaced brephic axial threads. Suture simple, deeply impressed. Spire twice to two and a-quarter times height of aperture. Spire height index (i.e., bodywhorl width into spire height)

1.59 to 1.82 with an average of 1.67. Umbilicus small, crescentic, not margined. Aperture relatively large, oblique ovate to D-shaped, strongly subangled above. Peristome narrow, slightly raised and surrounded by a relatively narrow thin flange. Sculpture of rather closely spaced weak axial threads which rapidly wear off, leaving a smooth surface. Colour reddish-brown to dark sepia with a complex hydrophanous epidermal pattern in buff to pale yellowish brown. The pattern ranges from simple broad irregular axial streaks to complicated zigzags and chevrons. The base is mostly light brown with a broad diffused spiral band above, or the entire base may be dark brown.

Holotype: Unuwhao, 850-900ft. Height 13.20 mm.; diameter 6.0 mm. Auckland Museum.

Locality	Smallest	Largest	Average	Spire Ht. Index
Unuwhao	12.10 x 5.60	13.20 x 6.00	12.8 x 5.9	1.74
Pandora	10.80 x 5.60	12.80 x 6.00	11.9 x 5.8	1.59
Kapowairua	10.00 x 5.00	11.10 x 5.00	11.0 x 4.9	1.59
Cape Maria (fossil)	9.80 x 5.00	12.00 x 5.60	10.6 x 5.1	1.63
Near North Cape	11.00 x 5.00	11.70 x 5.10	11.0 x 5.1	1.82
Average of combined averages of above lots:			11.4 x 5.3	1.67

Localities: Cape Maria van Diemen (mainland) consolidated dunes, site of type locality for *Placostylus ambagiosus priscus* Powell (A.W.B.P.); Kahuronaki (Kahuroa on survey maps), between Te Paki and Kapo Wairua Road, ca. 700-800ft. (A.W.B.P., February, 1944); S.E. slope of hill behind Pandora, Spirits Bay (A.W.B.P., February, 1944); Hill behind lagoon, Spirits Bay (A.W.B.P., January, 1952); Waterfall gully at Kapo Wairua, Spirits Bay (N. Gardner, March, 1949); Unuwhao, between Spirits Bay and Tom Bowling Bay, 800-900ft. (A.W.B.P.); Coastal cliff, half mile south of North Cape (N. Gardner, January, 1952).

The species is characterised by its large size, broad whorls and narrow apertural flange. It is restricted to the far northern Cape Maria van Diemen-North Cape block, and apart from a local subspecies, described following, is the only *Liarea* found in that area.

Other land snails restricted to this far Northland block, i.e., *Paryphanta watti* Powell, the subfossil *Rhytida duplicata* Suter, its Recent descendant *duplicata vivens* and a number of subspecies of *Placostylus ambagiosus*, all point to former insular isolation of this block from the rest of the Northland Peninsula, to which it is now joined by a long, sandy isthmus lacking in suitable forest covering.

Liarea aupouria tara n. subsp. Pl. 48, fig. 34.

Shell of moderate size, 9.10 mm. to 10.0 mm. in height. Tall-spired but of narrow proportions. Whorl outlines moderately convex, body-whorl rounded without angulation. Suture simple, deeply impressed. Whorls 7½, including a blunt dome-shaped protoconch of two whorls. Spire twice to two and a quarter times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.68 to 1.89 with an average of 1.77. Umbilicus small, narrowly crescentic. Aperture ovate-rotund, subangled above. Peristome narrow, slightly raised, reinforced around the outer-lip section only by a slight thickening, scarcely a flange. Sculpture in the form of irregular weak axial threads. Colour pattern dark olive brown with a variable hydrophanous epidermal pattern in buff to straw colour. The pattern varies from simple rather diffused axial streaks to intricate zigzags and chevrons. Base uniformly dark or pale with a broad upper spiral band of dark brown.

Holotype: Kerr Point herbfield, North Cape block, among decaying leaves under stunted clumps of *Hebe speciosa brevifolia* Cheesem. on steep northern cliff face. Height 9.1 mm.; diameter 4.0 mm. Auckland Museum.

This subspecies was found in abundance during the Auckland Museum Three Kings Expedition of January, 1953, in Mr. Colin Wild's yacht "Tara."

Although the subspecies bears superficial resemblance to *turriculata* it is at once distinguished by the greatly reduced, almost non-existent, labial flange. Closer inspection reveals the relationship with *aupouria*, the only other *Liarea* from the far northern block, from which it differs in its much smaller size, more slender proportions and more diffused epidermal pattern.

Undoubtedly the local rigorous conditions of the habitat, which afford little shade and is subject to periods of extreme dryness in summer, have induced the development of this distinctive subspecies.

Locality	Smallest	Largest	Average	Spire Ht. Index
Kerr Point	9.10 x 4.10	10.0 x 4.30	9.5 x 4.2	1.77

Liarea turriculata (L. Pfeiffer). Pl. 44, fig. 1; Pl. 46, figs. 16-23.

1855—*Realia turriculata* Pfeiffer Proc. Zool. Soc. (Lond.) for 1854, p. 304.
1865—*Realia turriculata*. Pfeiffer Monog. Pneumopomorum Viventium, 2nd Suppl., p. 170.

Shell of moderate size, 7.2 mm. to 11.7 mm. in height with tall slender spire and a rounded body-whorl. Whorls moderately convex, 7 to 7½, including a small smooth protoconch of two globose whorls. Suture impressed, simple. Spire twice to two and a half times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.50 to 2.30 with an average of 1.87. Umbilicus a narrow crescent without a margining rib. Aperture ovate, subangled above. Peristome a narrow raised rim surrounded by a moderate to relatively narrow thin flange. Sculpture in well preserved examples of closely spaced regular narrow membranous axials often bearing short minute bristles. Initial coloration yellowish-brown with a broad spiral zone of dark brown on the upper part of the base. After the wearing down of the axials the hydrophanous epidermal pattern develops on the spire. This is usually in the form of bold, somewhat irregular axial streaks. The ground colour of the shell deepens to a dark brown and the porous or lifted areas of the epidermis form the interstices to the pattern. In occasional specimens a tendency towards a zigzag pattern forms on the penultimate and body whorls. In some examples the whole of the base is dark. The apertural flange is brown to dark-brown and the rim of the peristome light brown.

Type: New Zealand. British Museum (Natural History). "9 x 3 2/3 mills." Pfeiffer (loc. cit.) later gave the locality for *turriculata* as Kakepuku (Hochstetter).

Mr. N. Gardner collected a large number of *Liarea* from Mt. Kakepuku, near Te Awamutu, but all are typical *egea egea*.

A drawing made from a photograph of the type specimen kindly supplied by Mr. Wilkins of the British Museum (Pl. 46, fig. 21) clearly shows that the name applies to the form of *Liarea* common around

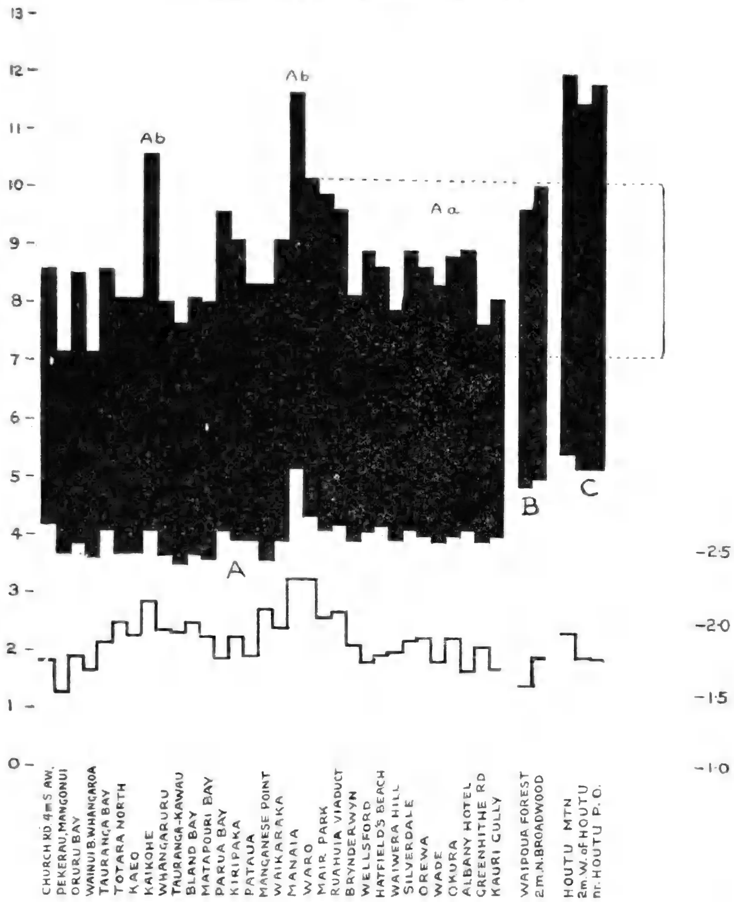

Fig. 4. Histogram of populations for *Liarea turriculata* and subspecies. A = *turriculata turriculata*. B = *turriculata waipoua*. C = *turriculata turriculata* (broad ecotype or subspecies?). Aa = small typical ecotype. Ab = large slender ecotype from broadleaf substrata.

Whangarei and extending up the East Coast of Northland to at least Whangaroa. Mair Park, Whangarei, is here nominated as the type locality for *turriculata*, since Kakepuku is obviously incorrect.

Subspeciation or incipient subspeciation is apparent in the *turriculata* assemblage in the western high country perhumid areas, in the vicinity of Houto Mountain west of Whangarei and again south of Warkworth. The first and last of these merit subspecific nomination, but the second is not named at this stage since there is insufficient material from the vicinity to properly evaluate its relationship to the smaller and proportionately narrower typical subspecies.

It is also noted that in material from near Auckland there is a distinct trend towards a less slender shell as the *egea egea* distributional area is approached or entered, i.e., Albany and Kauri Gully, Northcote.

Locality	Smallest	Largest	Average	Spire Ht. Index
Church Rd., E. of Awapuni	8.50 x 4.00	9.30 x 4.40	8.6 x 4.2	1.72
Pekerau Valley, Mangonui	6.80 x 3.60	8.20 x 3.90	7.2 x 3.7	1.50
Oruru Bay, Mangonui	8.10 x 3.70	9.10 x 4.00	8.5 x 3.8	1.75
Whatuwhiwhi	7.80 x 3.70	8.00 x 3.70	7.9 x 3.7	1.75
Wainui Bay, Whangaroa	7.00 x 3.30	7.90 x 3.90	7.2 x 3.6	1.66

Locality	Smallest	Largest	Average	Spire Ht. Index
Totara North	7.50 x 3.70	9.00 x 3.90	8.1 x 3.7	2.00
Tauranga Bay, Whangaroa	8.00 x 4.20	9.00 x 4.00	8.6 x 4.1	1.89
Kaeo	7.20 x 3.50	9.10 x 4.00	8.1 x 3.7	1.75
Kaikohe	9.60 x 4.20	11.30 x 4.00	10.6 x 4.1	2.14
Home Point, Bland Bay	7.80 x 3.70	8.50 x 3.90	8.1 x 3.7	2.00
Whangaruru	7.70 x 3.50	8.40 x 3.80	8.0 x 3.7	1.93
Tauranga-Kawau Point	7.10 x 3.40	8.20 x 3.70	7.7 x 3.5	1.91
Helena Bay	7.70 x 3.70	8.20 x 3.70	7.9 x 3.6	1.96
Matapouri Bay	7.60 x 3.20	8.20 x 3.90	8.0 x 3.6	1.90
Kiripaka	8.00 x 3.80	10.30 x 4.10	9.1 x 3.9	1.90
Pataua	8.00 x 3.90	8.50 x 4.00	8.3 x 3.9	1.76
Manaia	11.00 x 5.20	12.90 x 5.30	11.7 x 5.2	2.30
Parua Bay	9.20 x 4.00	10.10 x 4.30	9.6 x 4.1	1.74
Manganese Point	7.90 x 3.40	8.90 x 3.50	8.3 x 3.6	2.10
Waikaraka, Onerahi	8.00 x 3.80	10.00 x 3.90	9.1 x 3.9	1.96
Waro, Hikurangi	9.80 x 4.00	10.80 x 4.80	10.2 x 4.3	2.30
Mair Park, Whangarei	9.00 x 4.00	10.40 x 4.40	9.9 x 4.1	2.03
Ruahuia Viaduct	9.00 x 3.90	10.50 x 4.50	9.7 x 4.2	2.08
Brynderwyn Hill	8.00 x 4.00	8.50 x 4.00	8.2 x 3.9	1.83
1½ miles S. of Pukapuka Rd.	8.50 x 4.10	9.40 x 4.10	8.9 x 4.1	1.72
South side Waiwera Hill	7.60 x 3.80	8.25 x 4.00	7.9 x 3.9	1.80
Hatfield's Beach	8.20 x 4.10	9.30 x 4.40	8.7 x 4.2	1.79
Orewa	8.00 x 3.80	10.00 x 4.20	7.8 x 4.0	1.90
White Hills, Silverdale	8.40 x 4.00	9.50 x 4.25	8.9 x 4.1	1.89
Wade Estuary	8.00 x 3.90	8.50 x 4.00	8.3 x 3.9	1.72
Okura	8.30 x 4.00	9.10 x 4.10	8.8 x 4.0	1.90
Albany	8.70 x 4.10	9.10 x 4.20	8.9 x 4.1	1.67
Greenhithe Road	7.60 x 3.90	8.00 x 3.90	7.7 x 3.9	1.83
Kauri Gully, Northcote	7.90 x 4.10	8.40 x 3.90	8.1 x 4.0	1.69
Average of combined averages of above lots:			8.7 x 3.9	1.87

Dentition: Pl. 48, fig. 40. Houto Mountain, west of Whangarei.

Localities: Church Road, near Kaingaroa, east of Awanui (A.W.B.P.); head of Pekerau Valley, near Lake Ohia, Mangonui (A.W.B.P., January, 1948); Oruru Bay, Rangiawhia Peninsula, Doubtless Bay (A.W.B.P., 21/1/1950); Whatuwhiwhi, Rangiawhia Peninsula (D. Forsyth); Wainui Bay, Whangaroa (R. K. Dell); Totara North (W. La Roche); Tauranga Bay, near Whangaroa (N. Gardner, 28/12/1949); Kaeo (Mrs. I. Worthy); Pupuke, near Whangaroa (Mrs. I. Worthy); Kaikohe (R. Cumber); Home Point, Bland Bay (A.W.B.P., 7/2/1948); Whangaruru, northern headland (A.W.B.P., 9/2/1948); Tauranga Kawau Point, north of Whananaki (N. Gardner, October, 1947, Map N. 16, Ref. 949285); Helena Bay (N. Gardner, October, 1949); Matapouri Bay (A.W.B.P.); Kiripaka Reserve, near Ngunguru (A.W.B.P.); Pataua, half mile back from beach, near Whangarei Heads (A.W.B.P., January, 1948); Manaia, Whangarei Heads (R. K. Dell); Manganese Point, Parua Bay, Whangarei (A.W.B.P., 26/10/1947); Waikaraka, Onerahi-Parua Bay Road, Whangarei (N. Gardner, 26/10/1947, Map N. 20, Ref. 900927); Waro, Hikurangi (A.W.B.P., 18/11/1950); Mair Park, Whangarei (N. Gardner, 1947); Houto Mountain, west of Whangarei (E. Fairburn); East slope of Houto Mountain, near Houto Post Office, Mangakahia District (A.W.B.P., 25/10/1947, Map N. 19, Ref. 507916); Maungatapere highway, 1¾ miles east of Parakao, north side of road (A.W.B.P., 25/10/1947, Map. N. 19, Ref. 504986); Three miles south of Parakao (N. Gardner, October, 1947); Five miles west of Titoki (N. Gardner, October, 1947); Ruahuia Viaduct, Parakao-Kirikopuni Road, Mangawahia District (A.W.B.P., 28/10/1947, Map N. 19, Ref. 477941); Kaihu (H. Suter coll.); Maungaturoto (A.W.B.P., 28/11/1927); Brynderwyn Hill, near Kaiwaka (A.W.B.P., 1/4/1947); 1½ miles south of Pukapuka Road, south of Warkworth (N. Gardner, 27/3/1943); South side of Waiwera Hill (N. Gardner, September, 1947); north end of Hatfield's Beach, near Waiwera (N. Gardner, October, 1947); Eare's Bush, Orewa (A. E. Brookes, 1944); White Hills, near Silverdale (N. Gardner, 11/10/1947); Wade (Weite) Estuary, ridge, south side near mouth, ca. 300ft. (A.W.B.P., 26/12/1949); Okura, near Wade River (A.W.B.P., 24/1/1949); Hobson Road, near Albany (N. Gardner, 11/10/1947); half mile along Greenhithe Road from main highway (N. Gardner, August, 1947); Kauri Gully, Northcote (N. Gardner, October, 1947).

Liarea turriculata waipoua n. subsp. Pl. 44, fig. 3; Pl. 48, fig. 36.

Shell of moderate size, 7.6 mm. to 10.30 mm. in height, tall-spired with a proportionately wide body-whorl and a rapidly tapered spire, with rather straight outlines. Whorls only slightly convex. Whorls 7 to 7½, including a small semi-globose protoconch of two smooth whorls. Suture impressed, simple. Spire twice height of the aperture. Spire height index (i.e., body-whorl width into spire height) 1.48 to 1.76 with an average of 1.66. Umbilicus a narrow crescent without a margining rib. Aperture ovate-rotund, subangled above. Peristome a narrow, slightly raised rim surrounded by a moderate to relatively narrow thin flange. Sculpture of closely spaced, regular, narrow, membranous axials bearing short minute bristles. Colour uniform brown to dark reddish brown with a spiral zone of darker brown upon the upper part of the base. In some examples (Broadwood) there is an indistinct paler zone immediately above the basal band on the body-whorl and also below the suture on the spire whorls.

No examples so far taken exhibit a hydrophanous pattern, but in aged examples the whole epidermis lifts and becomes pale yellowish-brown.

Holotype: Waipoua Forest, Northland (N. Gardner). Auckland Museum. Height 10.6 mm.; diameter 5.1 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
North side Mangamuka	7.60 x 3.90	9.40 x 4.60	8.3 x 4.1	1.76
Broadwood	10.10 x 4.90	10.30 x 4.90	10.2 x 4.9	1.75
Waipoua Forest	8.70 x 5.00	10.60 x 5.10	9.6 x 5.0	1.48
Average of combined averages of above lots:			9.2 x 4.5	1.66

Localities: Waipoua Forest, Northland (N. Gardner, 2/1/1950) (type); two miles north of Broadwood (N. Gardner, 2/1/1950).

Liarea turriculata partula n. subsp. Pl. 48, fig. 35.

Shell small, 7.0 mm. to 8.2 mm. in height with broadly conical spire of slightly bulging outline Whorls 6 to 6½, including a blunt dome-shaped protoconch of two whorls. Whorls moderately convex, body-whorl rounded. Suture simple, impressed. Spire one and a-half to one and one-third times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.17 to 1.41 with an average of 1.30. Umbilicus a relatively large crescent with a weak margining rib. Aperture oblique ovate-rotund, subangled above. Peristome a narrow, raised rim surrounded by a wide thin flange. Surface polished, sculptured with distant subobsolete oblique narrow membranous axials. Colour pale brown to light reddish-brown with a dark reddish-brown spiral band at the top of the base. Variations range from uniform pale yellowish-brown to reddish-brown with a dark red-brown base. Hydrophanous pattern absent.

Holotype: 1½ miles south of Pukapuka Road near main highway south of Warkworth (N. Gardner, 28/3/1948). Auckland Museum. Height 8.2 mm.; diameter 4.6 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
1½ miles S. Pukapuka Road	7.00 x 4.00	8.20 x 4.70	7.7 x 4.3	1.30

This subspecies has the simple suture and rounded body-whorl of *turriculata* coupled with the wide labial flange, open rim-margined umbilicus and lack of hydrophanous epidermal pattern, features characteristic of *hochstetteri*. With it occurs typical *turriculata* but not *hochstetteri*. The subspecies may well have had a hybrid origin, but it seems now to be stabilized, for there appear to be no intermediate forms between it and *turriculata*.

Deciding its taxonomic position in harmony with an admittedly arbitrary nomenclatural system is difficult, and in aligning the subspecies with *turriculata* I have presumed a *turriculata* dominance on the evidence of the simple suture, rounded body-whorl and lack of strong axial sculpture.

The subspecies is known only from the type locality, but a large block of surrounding country remains to be investigated.

Liarea lepida (Suter). Pl. 44, fig. 8.

1904—*Realia turriculata lepida* Suter, Proc. Malac. Soc. 6, p. 157.
1913—*Realia turriculata lepida*: Suter Man. N.Z. Mollusca, p. 197.

Shell small, 6.3 mm. to 7.9 mm in height with narrowly conical straight sided spire. Whorl outlines convex, body-whorl rounded. Suture simple, deeply impressed. Spire a little more than twice height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.41 to 1.65, with an average of 1.55. Umbilicus crescentic, narrow but deep. Aperture ovate-rotund, subangled above. Peristome a narrow slightly raised rim margined externally but not across the parietal wall with a relatively wide thin flange. Sculpture of closely spaced regular very oblique narrow membranous axials, becoming obsolete over the body-whorl and absent from the base. Colour pale olive, with a hydrophanous pattern of irregular pale buff maculations, or similar patterning in darker-brown. The base is uniformly olive to dark brown without markings or zones.

Holotype: Forty-mile Bush, near Mauriceville (H. Suter). Dominion Museum, Wellington.

Locality	Smallest	Largest	Average	Spire Ht. Index
Poison Point, Masterton	7.00 x 3.90	7.40 x 3.70	7.2 x 3.8	1.65
Mauriceville	6.25 x 3.40	7.75 x 4.00	7.0 x 3.7	1.54
Hastwell	6.30 x 3.40	6.80 x 4.00	6.5 x 3.6	1.41
Manawatu Gorge	7.80 x 3.90	7.90 x 4.00	7.8 x 3.9	1.62
Florida Road, Levin	7.50 x 4.00	7.60 x 4.00	7.5 x 4.0	1.44
Average of combined averages of above lots:			7.2 x 3.8	1.55

Suter made his *lepida* a subspecies of *turriculata*, but it is better evaluated as a distinct species characterized by its many slowly increasing whorls and straight spire outlines. Its distributional area is far removed from that of the Northland *turriculata* and it is much more likely to have had a common ancestry with the *egea* group. From *egea* it is readily distinguished by the same differentiating characters cited in reference to *turriculata*.

It is the most southern *Liarea* known and has a compact area of distribution ranging from Northern Wairarapa through the Manawatu Gorge and down the Horowhenua coastal plain.

Localities: Forty-mile Bush, near Mauriceville (type); Hastwell; Seventy-mile Bush, near Ormondville (H. Suter); Poison Point, Masterton (Powell coll., Auckland); Manawatu Gorge (A. E. Brookes); Florida Road, Levin (N. Gardner, 28/12/1952).

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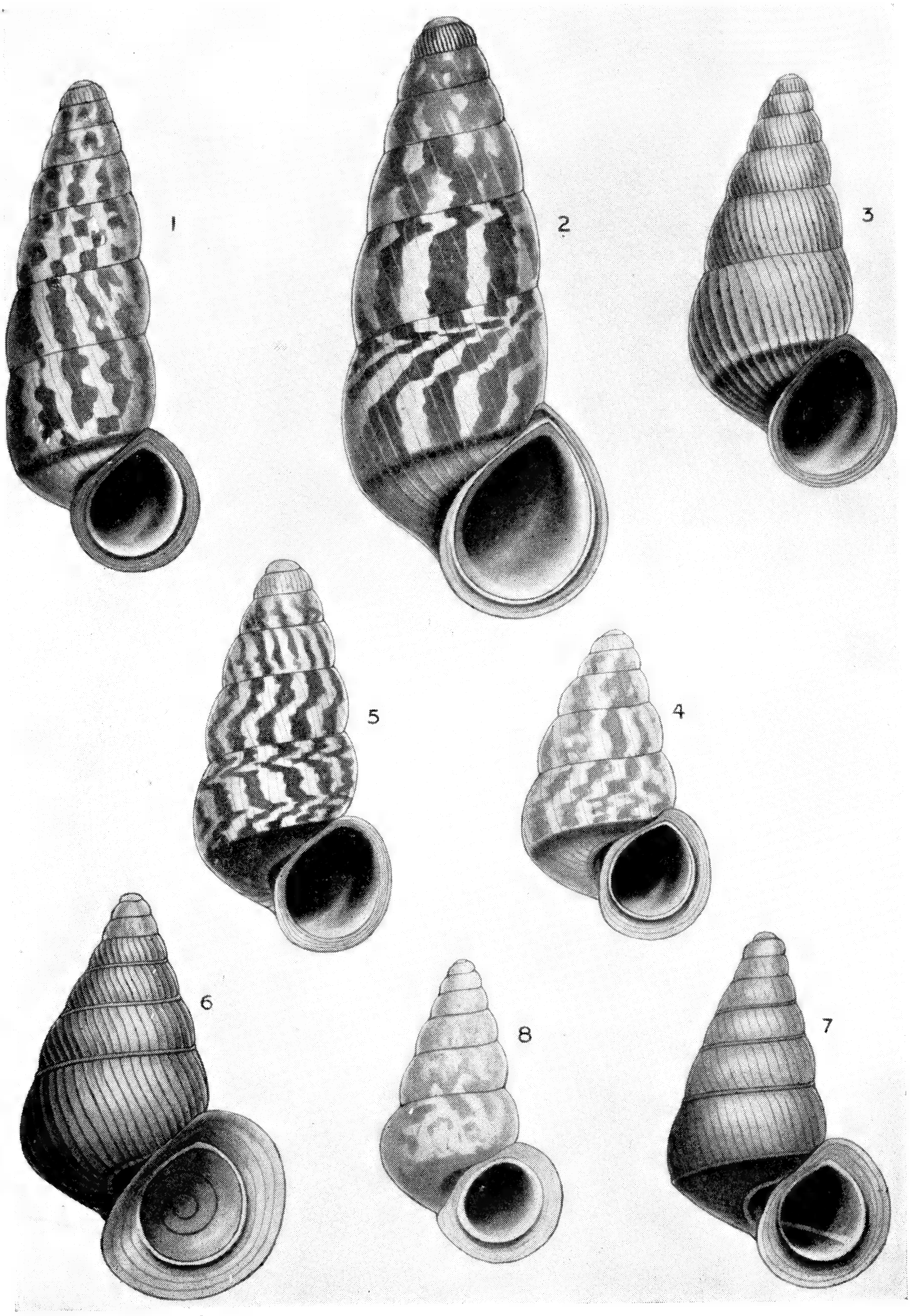

Fig. 1. *Liarea turriculata turriculata* (Pfeiffer) Mair Park, Whangarei (10.6 mm. x 4.1 mm.).
Fig. 2. *Liarea aupouria aupouria* n. sp. Unuwhao, 850-900 feet, Northland (Holotype, 13.2 mm. x 6.00 mm.).
Fig. 3. *Liarea turriculata waipoua* n. subsp. Waipoua Forest, 8.9 mm. x 4.5 mm.).
Fig. 4. *Liarea egea egea* (Gray). Orakei Bush, Auckland (6.75 mm. x 4.00 mm.).
Fig. 5. *Liarea egea tessellata* n. subsp. Opononi, Hokianga (Holotype, 8.7 mm x 4.5 mm.).
Fig. 6 *Liarea hochstetteri hochstetteri* (Pfeiffer), near Awanui (ecotype with extra large labial flange. 8.5 mm. x 5.5 mm.).
Fig. 7. *Liarea hochstetteri carinella* (Gray). Muriwai, Auckland, West Coast (7.7 mm. x 4.6 mm.).
Fig. 8. *Liarea lepida* (Suter). Forty-mile Bush, Mauriceville (Topotype, 7.0 mm. x 3.7 mm.).

(Figures 1-8 to uniform scale)

PLATE 45.

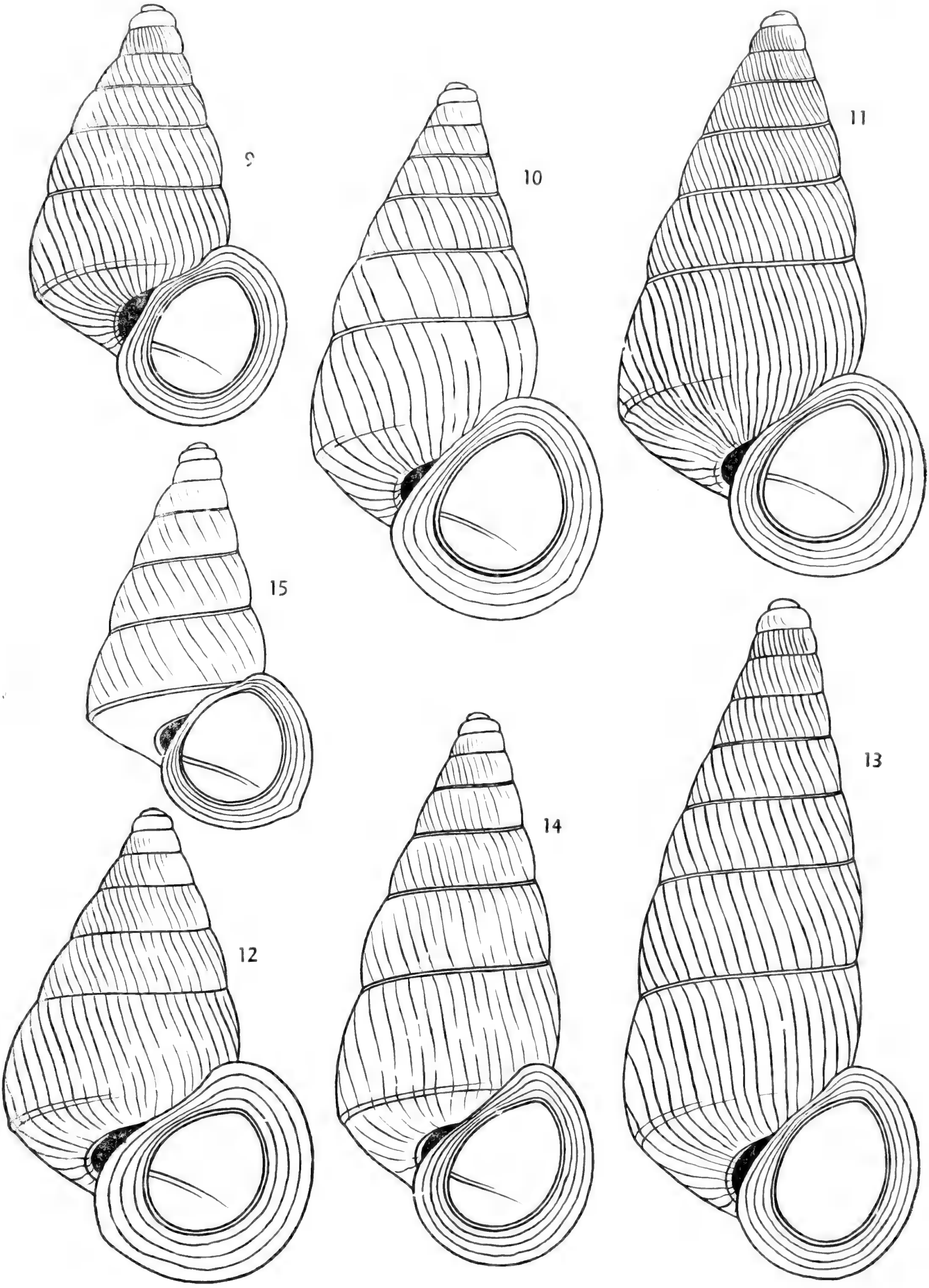

Fig. 9. *Liarca hochstetteri hochstetteri* (Pfeiffer). Two miles West of Tupou Bay, Mangonui (7.9 mm. x 5.0 mm.).
Fig. 10. *Liarca hochstetteri hochstetteri* (Pfeiffer). North side of Waiwera-Puhoi Hill (10.25 mm. x 5.75 mm.).
Fig. 11. *Liarca hochstetteri hochstetteri* (Pfeiffer). Maxwell's Farm, Omahuta (11.0 mm. x 6.0 mm.).
Fig. 12. *Liarca hochstetteri hochstetteri* (Pfeiffer). Near Awanui (Wide labial flange ecotype) (9.00 mm. x 5.75 mm.).
Fig. 13. *Liarca hochstetteri alta* n. subsp. Between Tauraroa and Waiotira (Holotype, 12.75 mm. x 5.60 mm.).
Fig. 14. *Liarca hochstetteri alta* n. subsp. (pale coloured ecotype). Houto Mountain, west of Whangarei (10.5 mm. x 5.0 mm.).
Fig. 15. *Liarca hochstetteri carinella* (Pfeiffer). Muriwai, West Coast, Auckland (7.0 mm x 4.0 mm.).

(Figures 9-37 to uniform scale)

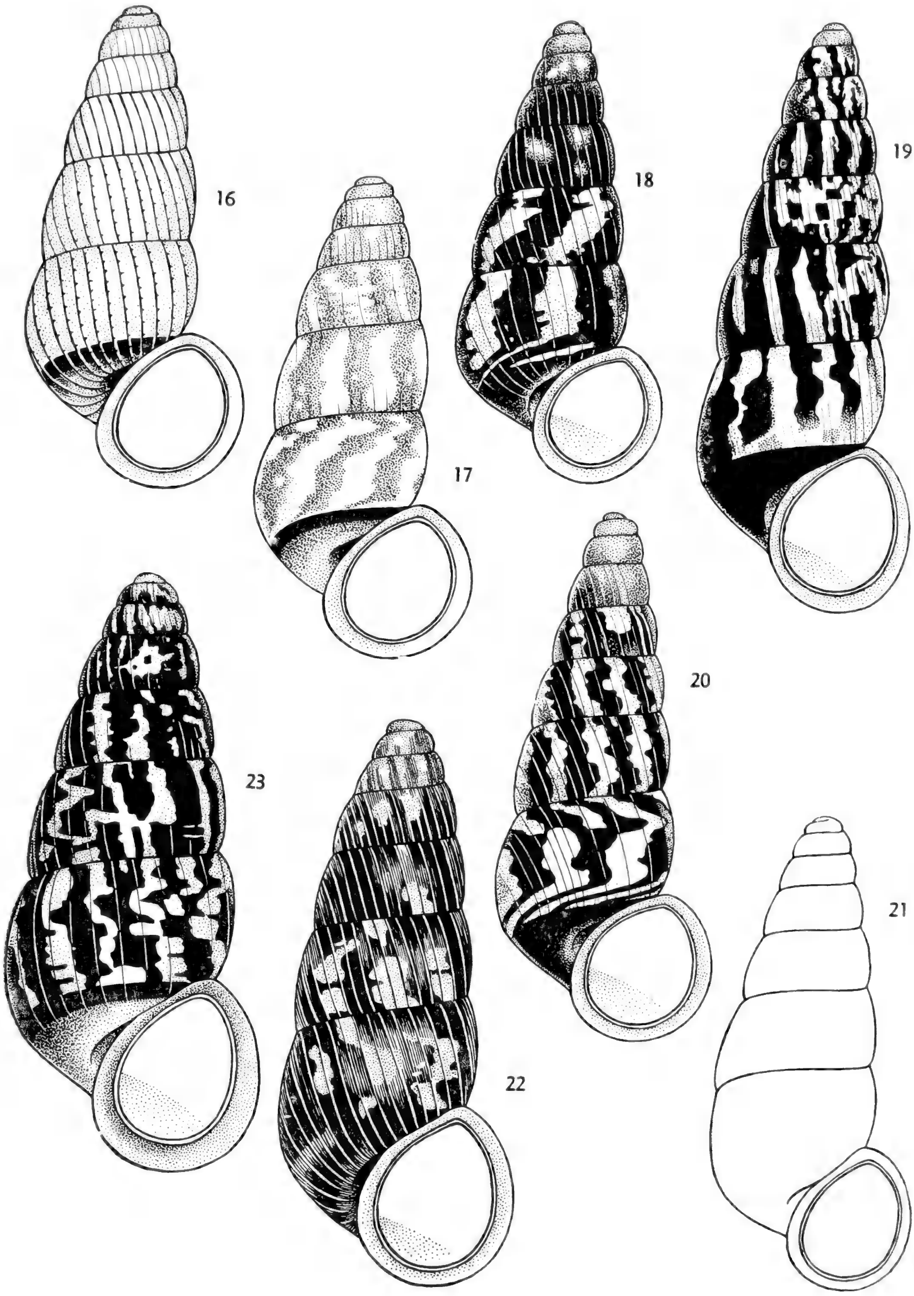

Fig. 16. *Liarea turriculata* (Pfeiffer) (Initial sculpture and pattern). Waikaraka, Onerahi.

Fig. 17. *Liarea turriculata* (Pfeiffer) (Worn sculpture plus hydrophanous pattern). Waikaraka, Onerahi.

Fig. 18. *Liarea turriculata* (Pfeiffer). Whangaruru (8.6 mm. x 4.0 mm.).

Fig. 19. *Liarea turriculata* (Pfeiffer). Mair Park, Whangarei (11.0 mm. x 4.0 mm.).

Fig. 20. *Liarea turriculata* (Pfeiffer). Waro, Hikurangi (10.0 mm. x 4.0 mm.).

Fig. 21. *Liarea turriculata* (Pfeiffer). From photograph of holotype.

Fig. 22. *Liarea turriculata* (Pfeiffer). Between Houto Post Office and Titoki (10.5 mm. x 4.5 mm.).

Fig. 23. *Liarea turriculata* (Pfeiffer) (Broad ecotype or subspecies?) Eastern slope of Houto Mountain (11.3 mm. x 5.0 mm.).

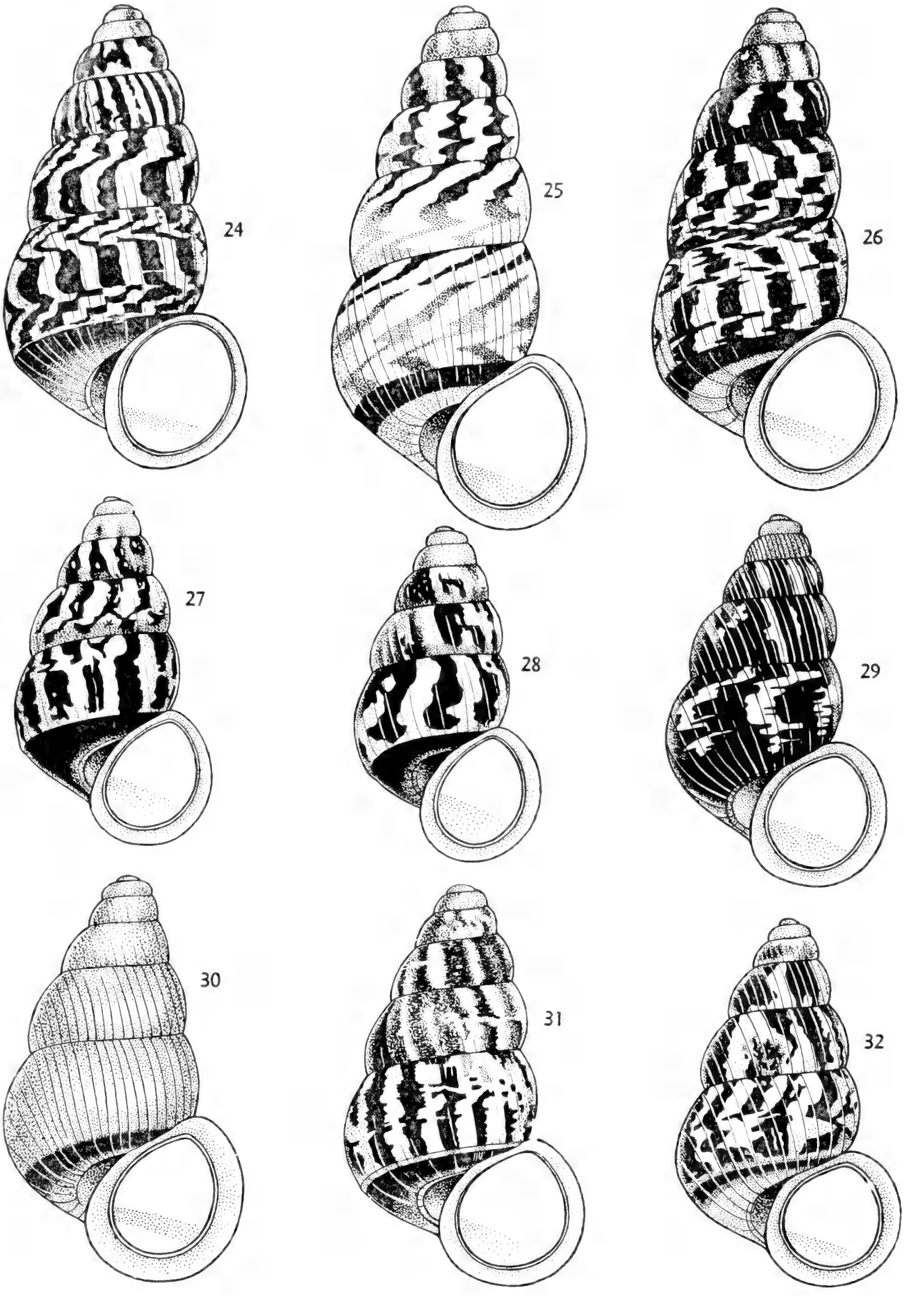

Fig. 24. *Liarea egea tessellata* n. subsp. Opononi, Hokianga (Holotype) 8.7 mm. x 4.5 mm.).

Fig. 25. *Liarea egea tessellata* n. subsp. Ruahuia Viaduct (10.0 mm. x 4.9 mm.).

Fig. 26. *Liarea egea tessellata* n. subsp. Woodcocks (9.1 mm. x 4.75 mm.).

Fig. 27. *Liarea egea egea* (Gray). Te Puke (6.6 mm. x 3.8 mm.).

Fig. 28. *Liarea egea egea* (Gray). Mt. Kakepuka (6.35 mm. x 3.60 mm.).

Fig. 29. *Liarea egea egea* (Gray). Chickens Islands (7.1 mm. x 4.1 mm.).

Fig. 30. *Liarea egea egea* (Gray). Greenhithe, Auckland (7.6 mm. x 4.6 mm.) (Initial sculpture and pattern).

Fig. 31. *Liarea egea egea* (Gray). Mountain Road, Mt. Eden, Auckland. (7.6 mm. x 4.9 mm.)

Fig. 32. *Liarea egea egea* (Gray). Orakei Bush, Auckland. (6.9 mm. x 4.0 mm.)

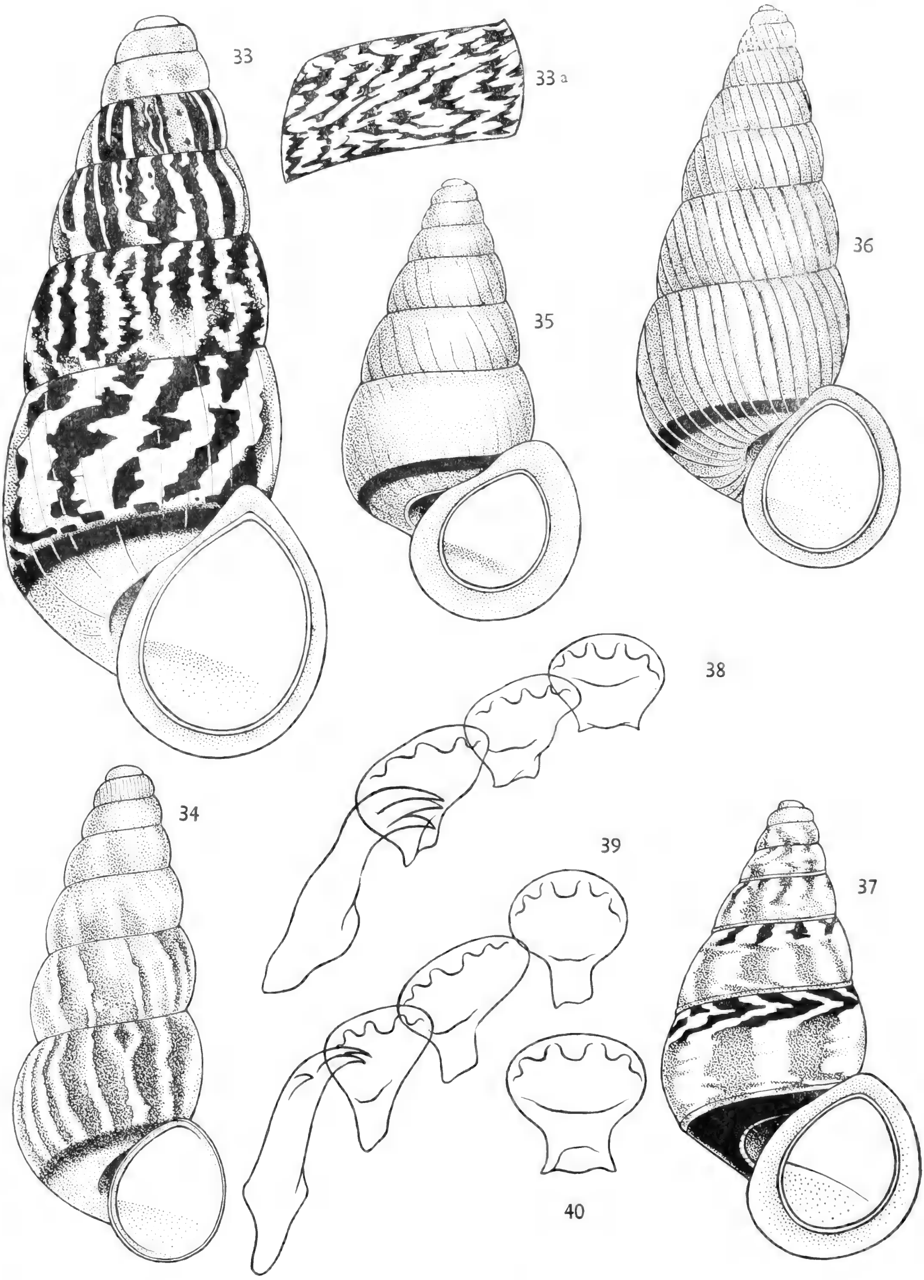

Fig. 33. *Liarea aupouria aupouria* n. sp. Unuwhao, Northland. (Holotype, 13.20 mm x 6.0 mm.) 33a. Extreme zigzag pattern.

Fig. 34. *Liarea aupouria tara* n. subsp. Kerr Point, Northland. (Holotype, 9.1 mm. x 4.0 mm.)

Fig. 35. *Liarea turriculata partula* n. subsp. Pukapuka Road, south of Warkworth. (Holotype, 8.2 mm. x 4.6 mm.)

Fig. 36. *Liarea turriculata waipoua* n. subsp. Waipoua Forest, Northland (Holotype, 10.6 mm. x 5.1 mm.).

Fig. 37. *Liarea ornata* n. sp. Three miles south of Wellsford (Holotype, 8.4 mm. x 5.0 mm.).

DENTITION.

Fig. 38. *Liarea egea egea* (Gray). Whitford, Auckland.

Fig. 39. *Liarea hochstetteri hochstetteri* (Pfeiffer). Kaeo, Northland.

Fig. 40. *Liarea turriculata turriculata* (Pfeiffer). Houto Mountain, west of Whangarei.

Variation in Hebe (SCROPHULARIACEAE) at Huia and Blockhouse Bay, New Zealand

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Abstract.

Measurements of specimens from two populations of Hebe have been plotted in pictorialized scatter diagrams. The diagrams support the existing taxonomic arrangement. The value of such diagrams for the recognition of taxa, for the illumination of relationships, and for the illustration of variation is stressed.

Last December I wrote a short paper (Cooper, 1954) to draw the attention of New Zealand botanists to the value of the techniques devised by Dr. Edgar Anderson (Anderson, 1949) for the study of hybridization in wild populations. In this paper I have used the techniques to illustrate the complex pattern of variation in vegetative and floral characters of *Hebe* from two localities near Auckland.

Huia is a bay on the Manukau Harbour and is 23 miles west of Auckland City. The bay is at the southern end of the Waitakere Ranges and the steep hills about it are clad in coastal scrub and second growth forest. Specimens of *Hebe* were gathered on the east and west sides of the bay, along the road to Whatipu between Little Huia and Mt. Donald McLean, and along a track from this hill to the Karamatura Stream. I am indebted to Mrs. K. Wood for most of the collections from Huia.

Duck Creek is a small stream entering the Manukau Harbour in Blockhouse Bay, and the stream valley contains remnants of coastal forest and scrub. The Blockhouse Bay specimens were gathered on the margins of the forest and in the scrub. Samples of both populations were collected at random, but specimens were chosen deliberately from approximately the same position on each plant.

The following characters were measured for the first four diagrams:

1. Length of one of the pair of leaves immediately below the inflorescence.
2. Width of the leaf.
3. Length of the second internode below the inflorescence.
4. Length of the pedicel of a fully opened flower in the raceme.
5. Length of the fully opened flower.

Internode length and leaf width were chosen as the vertical and horizontal axis respectively and the measurements of these characters were plotted as scatter diagrams. Leaf, pedicel and flower lengths are represented in the diagrams as rays from the dots. The measurements of 35 plants from Huia and of the same number of plants from

Blockhouse Bay were grouped in three equal categories to determine the values to be given for no rays, short rays and long rays.

The first diagram shows the pattern of variation in a collection from Huia. In the lower left-hand corner of the diagram plants with small internodes and narrow leaves have short leaves, pedicels and flowers. In the upper right-hand corner of the diagram a plant with long internodes and broad leaves has long leaves, pedicels and flowers. Specimens near these two extremes show to a lesser degree the characters of the extremes.

The second diagram shows the pattern of variation in one of the collections made at Duck Creek, Blockhouse Bay. Again the characters are correlated, but most of the specimens are larger than those from Huia.

In the third diagram the measurements of herbarium specimens collected in the district between Auckland City and the West Coast are plotted. In the upper right-hand corner of the diagram the four symbols with long rays represent herbarium collections of *Hebe macrocarpa* (Vahl) Ckn. et Allan, identified as this species by Cheeseman. The number alongside each symbol refers to the list of species and hybrids given later. In the lower left-hand corner there are four dots without rays representing the type collections of *H. obtusata* (Cheesem.) Ckn. et Allan, and immediately above them are two dots without rays representing type collections of *Veronica x bishopiana* Petrie, a suspected hybrid between *H. obtusata* and *H. salicifolia*. The intermediates represented by dots with a single short or long ray are *H. salicifolia* (Forst. f.) Pennell var. *stricta* (Hook. f.) Ckn. et Allan and var. *longiracemosa* (Ckn.) Ckn. et Allan. The intermediate represented by a symbol with two long rays in the centre of the diagram is a specimen of *H.* x *macrosala* Ckn. et Allan, a putative hybrid between *H. macrocarpa* and *H. salicifolia*. Only a few specimens of each species and hybrid are shown on the diagram as the herbarium collections of *Hebe* from the Auckland district are small, and frequently the material in a species folder is so uniform that there can be little doubt that it all came from a single plant. Other specimens have been added to the herbarium because they are unusual in one or more characters, and sometimes these abnormal specimens outnumber the typical specimens.

An analysis of the descriptions in Cheeseman's Manual of the New Zealand Flora, ed. 2, 1925, and the published notes of Cockayne and Allan, indicates that the critical characters used for the separation of the species are plant habit and size, leaf shape and size, flower colour and size, and capsule shape and size. On the five vegetative and floral characters used in these diagrams the Huia collection comprises:

H. obtusata.—Dots without rays in the lower left-hand corner.

Petrie's x *bishopiana.*—Dots without rays slightly above and to the left of *H. obtusata.*

H. salicifolia var. *stricta.*—Intermediate symbols with short rays.

H. x *macrosala.*—Dots with some long rays towards the upper right-hand corner.

H. macrocarpa.—Dot with three long rays in the upper right-hand corner.

The Blockhouse Bay collection comprises:

H. salicifolia var. *stricta*.—Dots with short rays.

H. x *macrosala*.—Dots with some long rays.

H. macrocarpa.—Dots with three long rays.

In using these names I am following Cockayne and Allan (1926), who transferred the wild species of *Veronica* to the genus *Hebe* and recognized the following species and hybrid swarms as native to the Waitakere Ranges and suburbs of Auckland:

1. *H. obtusata* (Cheesem.) Ckn. et Allan. This species was described by Cheeseman from plants collected on the sea cliffs at Karekare and Muriwai.

2. *H. salicifolia* (Forst. f.) Pennell var. *stricta* (Hook. f.) Ckn. et Allan. The type material cited by J. D. Hooker in Flora Novae Zelandiae 1: 191, 1853, was collected by Banks and Solander. This collection was not made in the Auckland district and may not be identical with Auckland plants.

3. *H. salicifolia* (Forst. f.) Pennell var. *longiracemosa* (Ckn.) Ckn. et Allan. Cockayne described this variety in Trans. N.Z. Inst. 49: 61, 1917, and gave the distribution of it as Egmont-Wanganui botanical district. Cockayne and Allan (1926) mentioned that the variety occurs without evidence of polymorphy throughout that district. Cheeseman in the Manual, ed. 2, 791, 1925, recorded the variety from the Volcanic Plateau, East Cape and South Auckland districts, and in his herbarium there is a specimen which he collected at the Waitakere Falls.

4. *H. macrocarpa* (Vahl) Ckn. et Allan. Vahl's paper and the type are not available, and Cockayne and Allan (1926) considered the species to be a linneon which required extended study in the field. *Hebe macrocarpa* (Vahl) Ckn. et Allan var. *latisepala* (Kirk) Ckn. et Allan has not been included in the scatter diagram of herbarium specimens as it has not been reported from the vicinity of Auckland City or the Waitakere Ranges.

5. *H.* x *macrosala* Ckn. et Allan. (*H. macrocarpa* x *salicifolia*).

6. *H.* x *affinis* (Cheesem.) Ckn. et Allan. The type locality of Cheeseman's var. *affinis* was "headlands in the Waitemata and Manukau Harbours." Cockayne and Allan (1926) considered the variety to be part of the hybrid swarm between *H. macrocarpa* and *H. salicifolia*, which they named *H.* x *macrosala*.

7. Petrie (1926) described *Veronica bishopiana* as a hybrid between *H. salicifolia* and *H. obtusata* from plants collected on rocky knobs between Huia Hill and Little Huia. Cockayne and Allan (1926) could not determine the status of the plant "since his [Petrie's] description might well apply to an "invariable" species, and there is only one specimen in his herbarium."

Dr. Edgar Anderson in a paper on recombination in species crosses (Anderson, 1939) pointed out that many generations of deliberate breeding would be required to break all the linkages between multiple factor characters and that from this there followed two obvious criteria of hybridization under natural conditions:

1. The intermediacy of separate characters will be correlated. Hybrids intermediate in one character will tend to be intermediate in

others. Hybrids which are most like either parent in any one character will tend to resemble that parent in all other characters.

2. Variation between individuals will lessen as parental character combinations are approached.

On the Huia diagram specimens matching the type collection of Petrie's x *bishopiana* are intermediate between specimens resembling Cheeseman's *H. obtusata* and others which are recognized as *H. salicifolia*. Again, in the Blockhouse Bay diagram specimens matching Cockayne and Allan's *H.* x *macrosala* are intermediate between specimens resembling the reputed parents *H. macrocarpa* and *H. salicifolia*. *Hebe macrocarpa* flowers mainly in August and *H. salicifolia* flowers in June and July, but the flowering times of the two species overlap and the difference in flowering times is not a barrier to hybridization.

It seems then that the scatter diagrams of internode, leaf and floral characters support the existing taxonomic arrangement to some extent, but the plants obviously need further study. It is remarkable in view of the number of species recognized previously that none of the herbarium material matches the specimens in the extreme left-hand corner of the Huia diagram. These may be depauperated specimens of *H. obtusata* and *H. salicifolia* var. *stricta*.

Another hypothesis to account for the variation is that the two extremes, represented by rayless dots on the Huia diagram and long rayed dots on the Blockhouse Bay diagram, are "species" while all the intermediate forms are part of a hybrid population between them. Genetic analysis of the populations would be necessary to provide some supporting evidence for this suggestion and that study is outside the scope of this paper, the purpose of which is to stress the potential value of mass collections and scatter diagrams in formal taxonomy. It is obvious, however, that the diagrams illustrate the range of variants in each population remarkably well and would be a useful guide to a geneticist in planning the analysis of the populations.

It may be doubted whether a collection of 35 plants is an adequate sample of a population. Two subsequent collections from the Blockhouse Bay area show, however, a similar pattern of variation to that of the first collection. It may also be doubted whether the variation in the Huia and Blockhouse Bay collections should be explained on genetical grounds. The genus *Hebe* is notoriously plastic and the variation may be the result of ecological factors. In making the collections, however, small areas were chosen which appeared to be uniform in soil and climatic conditions. On an exposed clay bank at Blockhouse Bay, eleven flowering plants were found which were obviously dwarfed, being 30 cms. or less in height. The measurements of five characters of these plants are plotted on daigram 4. The dots are all at the extreme lower left-hand corner of the diagram, as the plants have very short internodes and narrow leaves, but the pedicels and flowers of ten of the eleven specimens are represented by rays. Probably the flowers are less plastic than the stems and leaves and indicate that the plants are dwarfed members of the intermediate group.

As a check on the diagrams further collections were made from fruiting plants and the following characters of each specimen were measured:

1. Length of one of the pair of leaves immediately below the inflorescence, as before.

2. Width of same.
3. Length of the second internode, as before.
4. Width of a ripe capsule.
5. Length of same.

In diagrams numbered 5, 6, 7 and 8, the measurements of these additional collections from Huia, Blockhouse Bay, the Cheeseman Herbarium, and the clay bank near Duck Creek, have been plotted. The arrangement of the symbols in the diagrams of fruiting specimens is very similar to the pattern of variation illustrated in the first four diagrams of flowering plants.

General: From pictorialized scatter diagrams such as those of the Huia and Blockhouse Bay populations of *Hebe*, information can be obtained regarding:

1. The grouping of characters;
2. The relationships of taxa; and
3. The variation within taxa.

1. *Character groupings*: Robson (1928) remarked "ill defined as they may be and of varying dimensions, a certain tendency to character groupings of a certain stability is fairly recognizable [in biological material]." The designation of such groupings as "species" or "variety" presents difficulty, however. The system is arbitrary, but only in this respect—the character groupings themselves have reality. The discernment of morphological similarities and differences is intuitive through contemplation of the form of plant structures (cf. Agnes Arber, pp. 121-126, 1954), and Woodson (personal communication), has described the process as "the unconscious application of the frequency curve technique." In a pictorialized scatter diagram a number of frequency curves may be studied together and the diagram, which was devised originally for the study of hybrid populations, should prove to be of great value for the recognition of plant taxa.

2. *Relationships*: Robson (1928) wrote: ". . . if the systematist were to adopt some method of expressing character groupings and combinations as an adjunct to his traditional method, it would illustrate the structural relationships of allied forms in a very useful manner." In a study of the Australian and New Zealand species of *Pittosporum* (unpublished) I interpreted the distribution of life-forms, the various kinds of inflorescence, the various leaf types and capsule types as due to evolution by reduction, possibly under the influence of aridity, and used a scatter diagram of the average measurements of five characters for each species in support of my hypothesis.

3. *Variation within taxa*: Clausen (1951) emphasized that the local population is the basic unit in plant evolution and that there is considerable individual variation within each local population, even in populations of apomictic species that propagate as clones. He used photographs, diagrams, histograms, graphs and tables to illustrate this variation, and his illustrations convey a much clearer impression than the subspecific or varietal epithet. The scatter diagram should prove as valuable as the other illustrations mentioned to provide an accurate pictorial image of the variation in a local population or larger taxonomic category.

Table 1.

Mass collection of flowering specimens from Huia, mainly between reference points 088420 and 066397 on the N.Z. Lands and Survey Waitakere map of 1943 (1:63360 series).

No.	Internode length.	Leaf width.	Leaf length.	Pedicel length.	Flower length.
1	15	16	56	4	9
2	15	11	36	3	7
3	14	15	45	2	5
4	16	18	64	3	8
5	12	10	51	2	7
6	16	22	80	2	8
7	16	23	91	3	10
8	11	19	65	2	9
9	8	11	38	2	7
10	14	12	50	3	7
11	10	8	27	2	5
12	8	16	37	3	6
13	6	15	50	3	6
14	7	13	42	2	6
15	5	11	26	1.5	5
16	14	17	67	3	7
17	11	10	35	3	6
18	15	13	36	2	6
19	11	14	37	2	5
20	8	8	28	2	7
21	7	11	47	2	6
22	7	10	46	2	6
23	24	21	94	4	8
24	11	9	42	2	5
25	17	13	60	3	7
26	9	10	44	2	5
27	15	11	50	2	5
28	11	13	43	3	7.5
29	13	12	57	2	9
30	8	11	35	2.5	6
31	6	12	30	2	4
32	6	7	21	2	4
33	15	14	54	2	6
34	9	18	58	2	6
35	15	17	65	3	7

Table 2.

Mass collection from Duck Creek, Blockhouse Bay, between reference points 237517 and 232515 on the N.Z. Lands and Survey Titirangi map of 1944 (1:25,000 series).

No.	Internode length.	Leaf width.	Leaf length.	Pedicel length.	Flower length.
81	27	20	67	4	8
82	22	21	73	4	8
83	24	23	78	4	8
84	23	20	73	4	7
85	16	20	66	3	6
86	23	19	74	4	7
87	17	18	71	4	7
88	17	13	52	3	6
89	19	11	36	3	7
90	29	26	82	4	8

No.	Internode length.	Leaf width.	Leaf length.	Pedicel length.	Flower length.
91	20	20	84	4	6.5
92	18	19	54	4	6.5
93	25	25	101	4	8
94	14	16	59	3	7
95	15	15	52	3	7
96	19	17	70	3	8
97	21	21	64	4	9
98	24	19	91	5.5	9
99	15	21	75	4	8
100	13	15	63	3	7.5
101	19	18	70	3	7
102	17	13	45	3	7.5
103	17	19	61	3	7
104	25	17	68	3	9
105	18	17	69	3	8.5
106	16	19	60	3	7
107	19	16	64	4	8
108	18	19	54	4	7
109	13	16	52	3	7
110	18	19	89	4	8
111	20	22	109	4	7
112	14	17	57	3	6
113	12	19	67	3	7
114	18	21	77	4	8
115	25	25	92	5	8

Table 3.

Flowering Specimens in the Cheeseman Herbarium, Auckland Museum.

Identity, Locality and No.	Internode length.	Leaf width.	Leaf length.	Pedicel length.	Flower length.
Hebe obtusata					
Muriwai, 7670	10	15.5	35	2	6
Muriwai, 7671	10	14	24	1.5	6
Muriwai, 7672	12	14	22	2	5
Kare Kare, 7673	8	16	31	2	6
Veronica bishopiana					
Huia, 2160	12	14	45	2	5
Huia, 7674	14	13	40	2	5
Hebe salicifolia var. *stricta*					
Woodhill, 7763.1.	13	15	59	2	6
Woodhill, 7763.2.	22	16	68	2	5.5
New Lynn, 7764	14	12	63	2	5
var. *longiracemosa*					
Waitakere Falls, 7775	19	20	79	2	6
Hebe macrocarpa					
Anawhata, n.n.	18	22	86	4	8
Nihotupu, 7713.1.	29	21	87	4	8
Nihotupu, 7713.2.	23	23	83	4	8
Nihotupu, 7714	20	24	107	4	8
Hebe x *macrosala*					
Northcote, 7739 (as *H.* x *affinis*)	15	16	67	2	8

Table 4.

Collection of flowering specimens from an exposed clay bank above Duck Creek, Blockhouse Bay, at reference point 235516 on the N.Z. Lands and Survey Titirangi map of 1944 (1 : 25,000 series).

No.	Internode length.	Leaf width.	Leaf length.	Pedicel length.	Flower length.
40	5	7	32	2.5	6
71	7	10	33	3	7
72	4	8	16	3	6.5
73	3	9	23	2	5
74	6	13	38	3	7
75	5	12	38	3	6.5
76	5.5	10	37	3	7
77	9	14	42	3	7
78	6	9	27	3	7
79	5	13	43	3	7
80	9.5	7	27	3	5

Table 5.

Mass collection of fruiting specimens from Huia.

No.	Internode length.	Leaf width.	Leaf length.	Capsule width.	Capsule length.
17	11	10	35	2	3
18	15	13	36	2	2.5
19	11	14	37	2	3
25	17	13	60	2	3
27	15	11	50	2	4.5
28	11	13	43	5	7
30	8	11	35	2	3
32	6	7	21	2	3
34	9	18	58	3.5	5
327	18	19	77	5	6
329	13	14	60	4.5	5.5
331	20	18	85	5	6
341	9	9	42	2	3
344	12	12	43	2	3
346	7	11	45	2	3
347	14	10	41	2	3.5
348	19	19	85	4	6
349	17	17	70	3.5	5.5
350	16	17	69	3	5.5
351	18	24	83	4	7
352	9	17	67	2	3
353	18	23	79	4	7
354	7	11	45	2	3
355	8	13	63	2	3.5
356	8	14	62	2	4
357	9	15	47	2.5	3.5
358	17	19	76	5	8.5
359	8	9	37	2.5	3
360	13	25	62	4	6
361	9	13	60	2	3.5
362	5	15	44	2	3.5
363	10	18	77	4	5
364	12	15	81	2.5	4
365	6	15	44	2	3
366	10	6	32	2	3

Table 6.

Mass collection of fruiting specimens from Duck Creek, Blockhouse Bay.

No.	Internode length.	Leaf width.	Leaf length.	Capsule width.	Capsule length.
143	14	12	49	3	4
145	17	15	68	4	5.5
150	23	17	79	4	6
151	30	21	87	4	6
156	10	12	42	2.5	3
158	13	14	43	2.5	4
159	19	19	64	4	5
160	25	18	88	4	6
163	17	18	51	3.5	5.5
176	19	11	50	2	3
177	18	15	81	3.5	5
181	20	23	90	4.5	6.5
186	15	9	38	2	3
187	18	9	44	2	3
189	14	13	40	3.5	5.5
190	10	10	50	1.5	3
194	13	14	64	3	5
197	17	16	75	3.5	5.5
199	17	19	67	4	6
200	21	17	64	3.5	6
201	19	22	103	2	3
203	17	19	80	4	5.5
205	13	17	54	4	5.5
206	21	15	75	3	6
207	19	18	62	4	6.5
208	21	15	73	3.5	6.5
210	22	18	67	4	6.5
211	14	20	66	4	5.5
214	24	20	82	4	6.5
215	22	15	70	3.5	5
216	30	23	109	5	7
224	20	23	90	3	6
225	30	17	89	4	7
226	15	18	59	4	6
233	22	22	82	3.5	6

Table 7.

Fruiting specimens in the Cheeseman Herbarium, Auckland Museum.

Identity, Locality and No.	Internode length.	Leaf width.	Leaf length.	Capsule width.	Capsule length.
Hebe obtusata					
Muriwai, 7670	10	13	29	2.5	3.5
Muriwai, 7671	11	17	36	2.5	4
Muriwai, 7672	11	16	28	3	5
Kare Kare, 7673	8	16	31	2.5	4
Anawhata, n.n.	7	15	21	2	3
Veronica bishopiana					
Huia, n.n.	9	13	44	2	3
Hebe salicifolia var *stricta*					
Woodhill, 7763.1	13	15	59	2	3
New Lynn, 7764	14	12	63	2	3

Identity, Locality and No.	Internode length.	Leaf width.	Leaf length.	Capsule width.	Capsule length.
var. *longiracemosa*					
Waitakere Falls, 7775	19	20	79	2	3.5
Hebe macrocarpa					
Nihotupu, 7713.2	23	23	83	4	6
H. x *macrosala*					
Northcote, 7730 (as *H.* x *affinis*)	15	16	67	3.5	6

Table 8.

Collection of fruiting specimens from an exposed clay bank above Duck Creek.

No.	Internode length.	Leaf width.	Leaf length.	Capsule width.	Capsule length.
72	4	8	16	3.5	5
74	6	13	38	3.5	6
75	5	12	38	3	5
76	5.5	10	37	3.5	5
77	9	14	42	4	6
79	5	13	43	3.5	5
80	9.5	7	27	3	4.5

Notes—

1. All measurements are in mm.
2. "Internode length" refers to the second internode beneath the lowermost pair of racemes on a mature woody branchlet.
3. "Leaf width" and "leaf length" were measured on one of the pair of leaves subtending the lowermost racemes.
4. "Pedicel length" refers to the pedicel of a fully-open flower near the base of one of the racemes.
5. "Flower length" is the length of the calyx and corolla of the fully-open flower.
6. "Capsule width" and "length" refer to a mature capsule near the base of a raceme.

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Diagrams of Measurements in Tables 1-4 to show Variation in flowering specimens of *Hebe*.

Fig. 1. 35 specimens from Huia, collected July-August, 1954.

Fig. 2. 35 specimens from Blockhouse Bay, collected July-August, 1954.

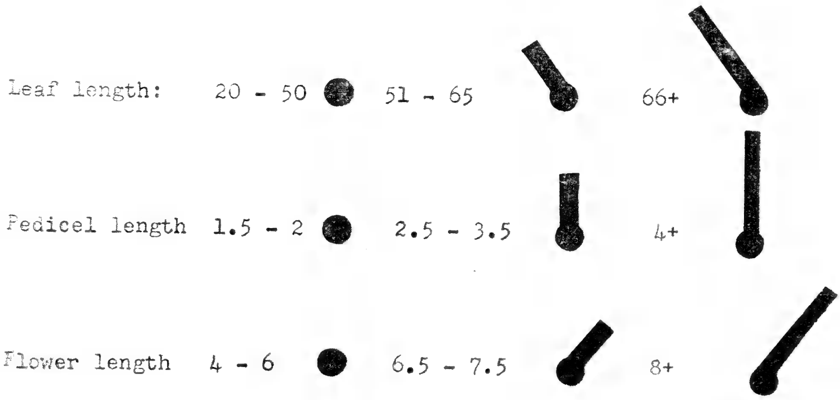
Fig. 3. 15 specimens in the Cheeseman Herbarium. The numbers alongside the symbols refer to the species and hybrids:

1. *Hebe obtusata*.
2. *H. salicifolia* var. *stricta*.
3. *H. salicifolia* var. *longiracemosa*.
4. *H. macrocarpa*.
5. *H.* x *macrosala*.
7. *Veronica* x *bishopiana*.

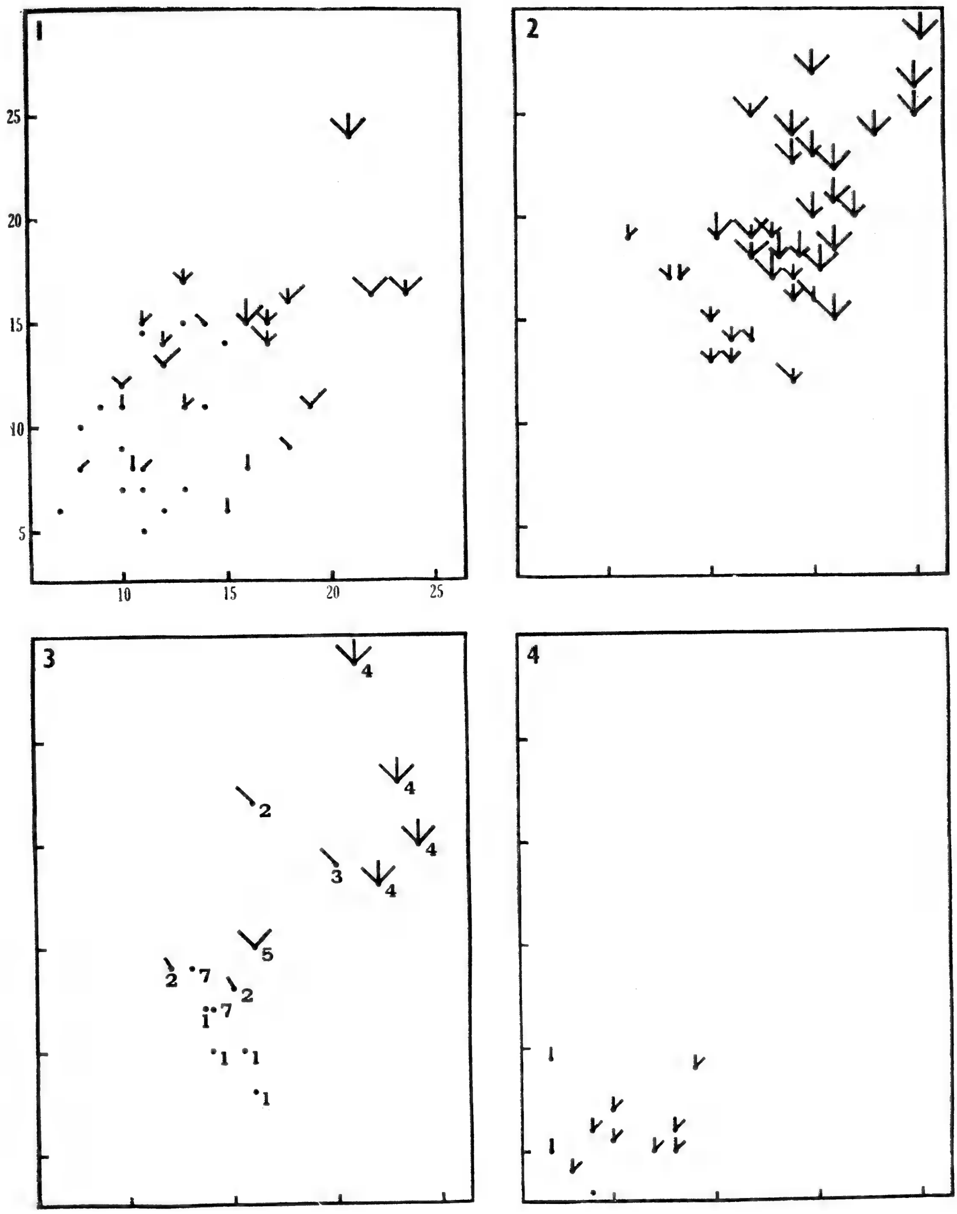
Fig. 4. 11 dwarfed specimens from a clay bank above Duck Creek, Blockhouse Bay, collected August, 1954.

Horizontal axis, leaf width; vertical axis, internode length.

Three other characters diagrammed by rays:



All measurements are in mm.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2
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25

Diagrams of Measurements in Tables 5-8 to show Variation in fruiting specimens of *Hebe.*

Fig. 5. 35 specimens from Huia collected July-November, 1954.

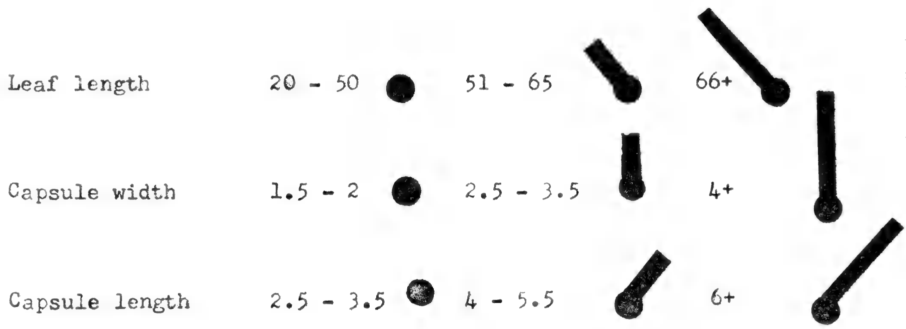
Fig. 6. 35 specimens from Blockhouse Bay collected September-October, 1954.

Fig. 7. 11 specimens in the Cheeseman Herbarium. The numbers alongside the symbols refer to the species and hybrids:

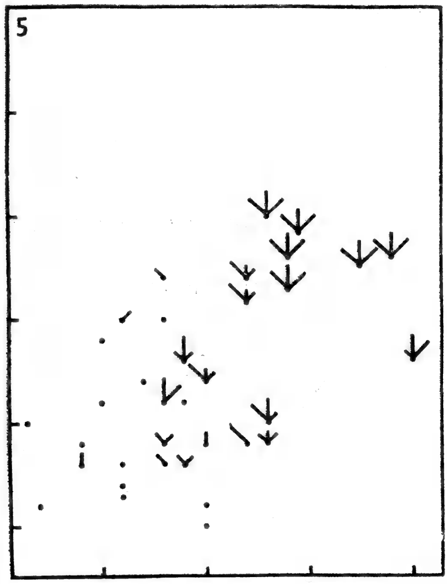
1. *Hebe obtusata.*
2. *H. salicifolia* var. *stricta.*
3. *H. salicifolia* var. *longiracemosa.*
4. *H. macrocarpa.*
5. *H.* x *macrosala.*
7. *Veronica* x *bishopiana.*

Fig. 8. 7 dwarfed specimens from a clay bank above Duck Creek, Blockhouse Bay, collected August, 1954.

Horizontal axis, leaf width; vertical axis, internode length.



All measurements are in mm.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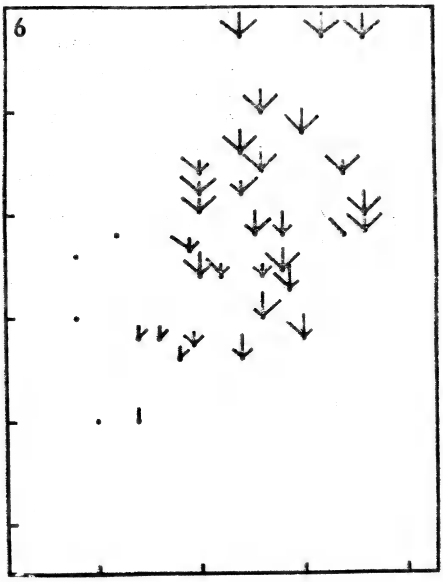
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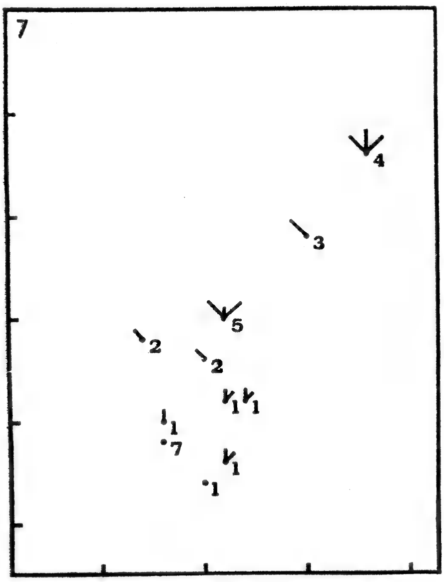
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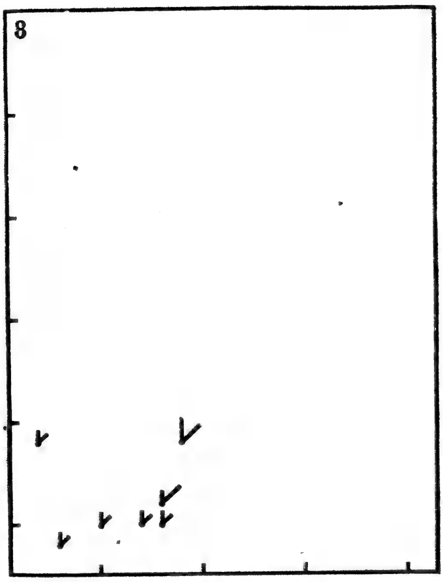
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RECORDS
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CONTENTS

Vol. 4, No. 6

Observations on the Structure of Far Northern New Zealand

By M. H. BATTEY, Auckland Museum.

Abstract.

Evidence is presented for the occurrence of two epochs of compression in northern North Auckland Peninsula since the Middle Tertiary, in the first of which the pressure was directed from north and south, while in the second it was from east and west.

East-west fold axes due to north-south compression are important in the region north of the Bay of Islands. A later system of tear faults extends from North Cape to the west head of Whangaroa Bay, coinciding with the belt of intrusion and mineralization recognised long ago by Hector, and is thought to be related to compressive force from east and west.

Such successive foldings at right angles have already been indicated by Lillie in other parts of New Zealand, particularly as an alternative to Macpherson's supposed swinging strike in the Waiapu district.

The idea that fold axes strike north-west in the Far North is not confirmed, except in so far as the whole New Zealand Ridge may represent a geanticline.

INTRODUCTION.

The structural interpretation of the North Auckland Peninsula has long been a matter of uncertainty. Two main ideas have been proposed. The first, which was, in general, held by the Old Geological Survey, is that the trend of the Peninsula is not that of the fold axes but was determined by later fractures. This view was adopted by Benson in 1924. The other proposal was that the trend of the Peninsula does reflect that of the fold axes, and was held tentatively by Ferrar (1927) on the basis of a few observations of strike in the older rocks. Bartrum and Turner (1928) supported this view, being apparently largely influenced by the north-west trend of "foliation" in the gabbro at North Cape. While this second hypothesis may be correct in so far as the New Zealand Ridge as a whole represents a geanticline, it is felt that to draw a group of north-west-trending anticlines and synclines throughout the length of the Peninsula, as has been done by Macpherson (1946), may be misleading.

DIRECTIONS OF FOLD AXES.

Study of the available information on the Far North (north of the Bay of Islands) suggests that we have here fold axes running between west-south-west and west-north-west, oblique to the length of the North Auckland Peninsula.

Of this large region the North Cape area is perhaps the best known. A map, compiled from the work of McKay (1894) and Bartrum and Turner (1928), is presented to show the available information on the dip and strike and distribution of the beds there (fig. 1). Two points about the map call for comment: (1) McKay showed andesitic conglomerate extending over the area marked as Cretaceous, between the two question marks and east-south-east of them. Bartrum and Turner found Cretaceous lavas in this area, but patches of andesitic conglomerate are shown flanking the Cretaceous, for it is very probable that McKay had some basis for his opinion, while Bartrum and Turner examined only exposures adjacent to the track from Te Paki to Te Hapua. (2) The beds around the northern and western shores of Parengarenga Harbour were placed *below* the andesitic conglomerate by McKay. Bartrum and Turner, however, place them above the conglomerate, for conglomerate emerges from beneath them in low cliffs on the north shore of the harbour, and this later conclusion is here adopted.

The recorded dips and the distribution of the beds suggest very strongly that there is a system of folds trending about west-north-west in the North Cape area. Data on the attitude of the Cretaceous lavas and sediments are scanty, but the strike observed at Pandora suggests that the long straight coast between Spirits Bay and Te Reinga may be a strike coast. The youngest beds recorded as affected by this folding are the sandstones, mudstones and grits (t3) which immediately overlie andesitic conglomerates dated as Miocene (Altonian) (Couper, 1952).

A second map (Pl. 49) covers the area between North Cape and Whangaroa Harbour on the east and Herekino River on the west. In the south-eastern part of this region Bell and Clarke (1909) infer the existence of two anticlinoria of late Palaeozoic to Triassic beds, the more southerly, inland one running west-south-west and the other, further north, on the coast east of Whangaroa Harbour, running west-north-west. Westwards, the geology is not well known and we are dependent mainly upon McKay's map of 1894. There appear to be two massifs of older rocks, of unknown age, lying in an east-west line south of Kaitaia. They comprise much igneous material, partly intrusive and probably partly ancient lava flows. They may in part be Cretaceous in age and comparable with the Cretaceous lavas of the North Cape area. This is believed to be true of lavas, pillowy in part, around Mangonui, in the south-east corner of Doubtless Bay, for these lavas, on the coast at Taipa, appear to be conformable with the Cretaceous beds in the lower part of Taipa River; but no boundary can yet be drawn between these supposedly Cretaceous lavas and any older rocks that may be present.*

The 1948 Geological Map of New Zealand, published by the Geological Survey, subdivides McKay's Cretaceo-Tertiary formation in a broad way, into beds of Cretaceous (Mata) and Tertiary (Landon) age, with a strip of rocks of Arnold age east of Kaitaia and some Wanganui beds in Victoria Valley. These distinctions are very valuable and serve to show the general trend, between west-south-west and due west, of the axes of folding in the area between Reef Point and Whangaroa Harbour. In Taipa River (south shore of Doubtless Bay) the strike of the Cretaceous beds is east and west, the dip south at moderate to high angles, for a mile across the strike.

In Rangiawhia Peninsula (Battey, 1950) two main formations are present, breccia, conglomerate and grits standing vertical, striking west

* It is well known, on definite evidence from other parts of North Auckland, that contemporaneous lavas occur in both Permian and Cretaceous parts of the marine sedimentary sequence.

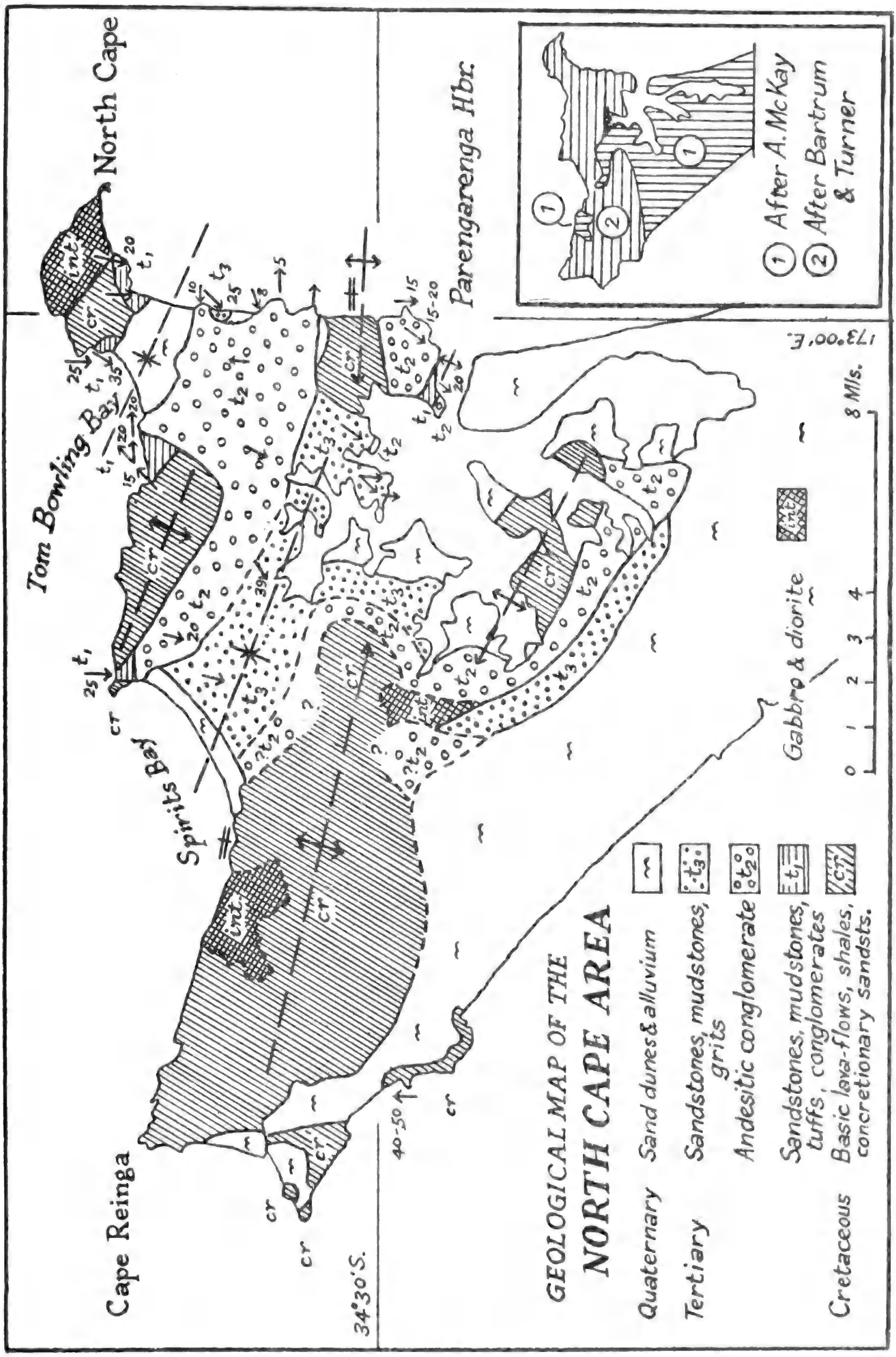
GEOLOGICAL MAP OF THE
NORTH CAPE AREA
Quaternary
Sand dunes & alluvium
Tertiary
Sandstones, mudstones, grits
Andesitic conglomerate
Sandstones, mudstones, tuffs, conglomerates
Cretaceous
Basic lava-flows, shales, concretionary sandsts.
Gabbro & diorite
Cape Reinga
Spirits Bay
Tom Bowling Bay
North Cape
Parengarenga Hbr.
34°30'S.
173°00'E.
8 Mls.
① After A. McKay
② After Bartrum & Turner

Fig. 1.

and younging south along the south-east coast, which rest unconformably upon a group of basic pillow lavas and keratophyres, in which a roughly westerly strike is inferred from correlation of pillow lava bands and from topographic expression of the main keratophyre horizon. Neither group is satisfactorily dated, but there are some grounds for referring the extremely heavy conglomerates (with included graphic granite boulders 9ft. across) to the same transgression as the conglomerates at the base of the Cretaceous succession at Whangaroa (also with granitic pebbles) recorded by Bell and Clarke (1909).

In Mount Camel (fig. 2), to the west-north-west, both basic pillow lavas and keratophyres similar to those of Rangiawhia occur, and from the distribution of characteristic types of keratophyre a strike about N85°W is inferred. For this whole group of pillow lavas and keratophyres the name Mt. Camel formation, used by Bell and Clarke (1910) is convenient. In passing it may be noted that a very similar group of rocks builds the western part of Great Island in the Three Kings Group. It seems reasonable to regard the Mt. Camel formation at Rangiawhia and Mt. Camel as representing an anticlinal axis.

To sum up, we seem to have fold axes striking west-south-west forming an eastward-pointing V with west-north-west folds in the south, an east-west group in the angle of the V, and a dominance of the west-north-west trend in the north. Broadly speaking, we can regard these folds as due to compression from north and south, or north-north-east and south-south west.

TRANSCURRENT FAULTING.

This fold system is cut across obliquely by a fault system running between N30°W and 40°W along the north-east coast, with which is associated a large dyke-like intrusion of gabbro and diorite with subsidiary andesite dykes. This zone was recognised long ago by Hector (1891) as extending from North Cape through Rangiawhia Peninsula and Stephenson's Island to Cape Brett. He pointed it out in connection with the mineralization that has taken place at points along its course. In 1894 Hector described the antimony prospects in the Cape Brett area and records a general trend of N40°W for the stibnite lodes in that south-eastern extension of the zone.

Mapping at Rangiawhia has shown that there the faults of this system are tear faults (transcurrent faults) with sinistral displacement (i.e., north-westward movement on the north-east sides of the planes) with an aggregate horizontal shift of at least $2\frac{1}{4}$ miles, distributed over a belt of country $3\frac{1}{4}$ miles wide (Battey, 1950, with maps).

This faulting is later than the folding of the upper Cretaceous rocks (with *Aucellina*) which are intruded by the associated igneous rocks and sheared by the movements at Pa Island on the west shore of Whangaroa Bay (see also the Survey 1 inch map of 1909).

It is to the stress system associated with this transcurrent faulting and multiple dyke-injection that the north-westerly foliation in the North Cape gabbro must be ascribed. The new data thus necessitate a revision of the view of Bartrum and Turner (1928) that this mineralogical banding is due to folding about north-westerly axes, and removes one of the principal criteria on which this interpretation of the structure was based.

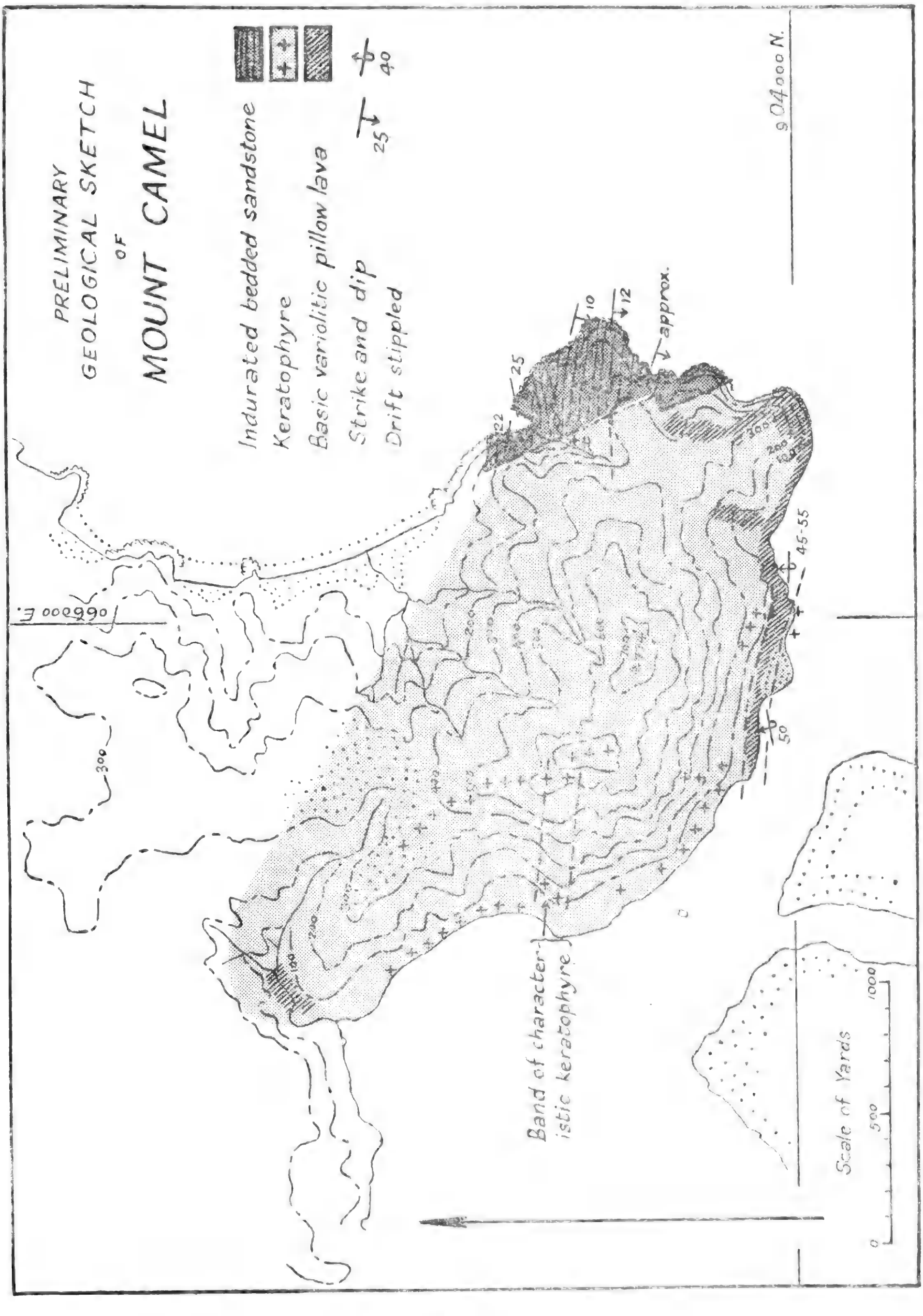
PRELIMINARY
GEOLOGICAL SKETCH
OF
MOUNT CAMEL
Indurated bedded sandstone
Keratophyre
Basic variolitic pillow lava
Strike and dip
Drift stippled
25
40
904000 N.
066000 E.
approx.
Band of character-
istic keratophyre
Scale of Yards
0
500
1000

Fig. 2.

MECHANICS OF FAULTING.

The directions of the sub-vertical dykes associated with this movement, and regarded as occupying fissures produced by it, may be expected to give information about the nature of the forces involved. Measurements of these directions and of the directions of very steeply-dipping joints in the intrusive rock have been made, chiefly at Rangiawhia. Both kinds of measurement show the same direction-frequencies and the two sets combined have been plotted as a direction-frequency diagram (Pl. 49). This diagram shows equal maximum concentrations in the azimuth-groups N40-45°W and N25-30°W. Two other equal concentrations lie between N85°W and W and N5°E and N. A pair of much less marked concentrations occurs at N50-55°E and N60-65°E, that is at 95° and 90° to the N40-45°W and N25-30°W groups respectively.

These directions can, on the whole, be explained remarkably well in terms of the stress theory of the rupture of homogeneous bodies in compression, as outlined by Wilson (1947) and applied (to a problem somewhat similar to the present one) by Blyth (1950), but there remain some uncertainties in interpretation. If compression acted from north and south the northerly fractures could be explained as tension cracks, but the westerly ones remain unexplained. If compression acted from east and west, the westerly cracks can be regarded as tensional but the northerly ones cannot be explained. In the field both kinds are filled by dykes in the country rocks and in the main body of the intrusion. Those of the westerly group are perhaps more marked and it is noteworthy that east-west dykes occur over a rather wide area. There is a relatively big one at Taipa River mouth on the south shore of Doubtless Bay, which is quarried. It is 100 feet wide and can be followed eastwards for three-quarters of a mile. At Pa Island (west shore of Whangaroa Bay) there is another conspicuous one, and another at Tupou Bay to the west-north-west.

If the stress ellipsoid is orientated with maximum pressure from a shade east of north and west of south, the main north-west shear directions fit slightly better the theoretical locus of stress shear planes, than if maximum pressure from just north of east and south of west be assumed.

What may decide the issue is the sinistral sense of the movement on the faults along the Rangiawhia coast. Sinistral movement on a north-west-striking transcurrent fault apparently implies east-west compression. If the pressure were from north and south the movement would be dextral. This seems to be a rather rigid requirement of the theory. For this reason we are apparently compelled to assume east-west compression. If we could postulate more or less north-south compression we should be able to explain the folds already described, and the subsequent tear faulting, as due to the one system of compressive forces. As it is, it seems necessary to assume first a north-north-east—south-south-west compression to produce the folds, followed by compression from east and west to explain the tear faults.

This demand is not a new one, for Lillie (1951, pp. 236-8) has recently postulated a similar abrupt change in the directions of compression to explain the way in which folds in the Tertiary strata run almost at right angles to those in the Cretaceous rocks in the Waiapu area, and has found evidence of similar happenings in the south of the South Island. His hyphothesis may prove to have rather wide application.

It may be remarked in connexion with the Rangiawhia fault pattern that a fault striking about N55°E runs along the south-east coast of the Peninsula between tide marks. It is older than the north-west faults and is shifted by them. Nothing definite is known of the type of displacement along it, but its direction may suggest that it is a conjugate fracture of the same stress system as produced the north-west-striking tear faults.

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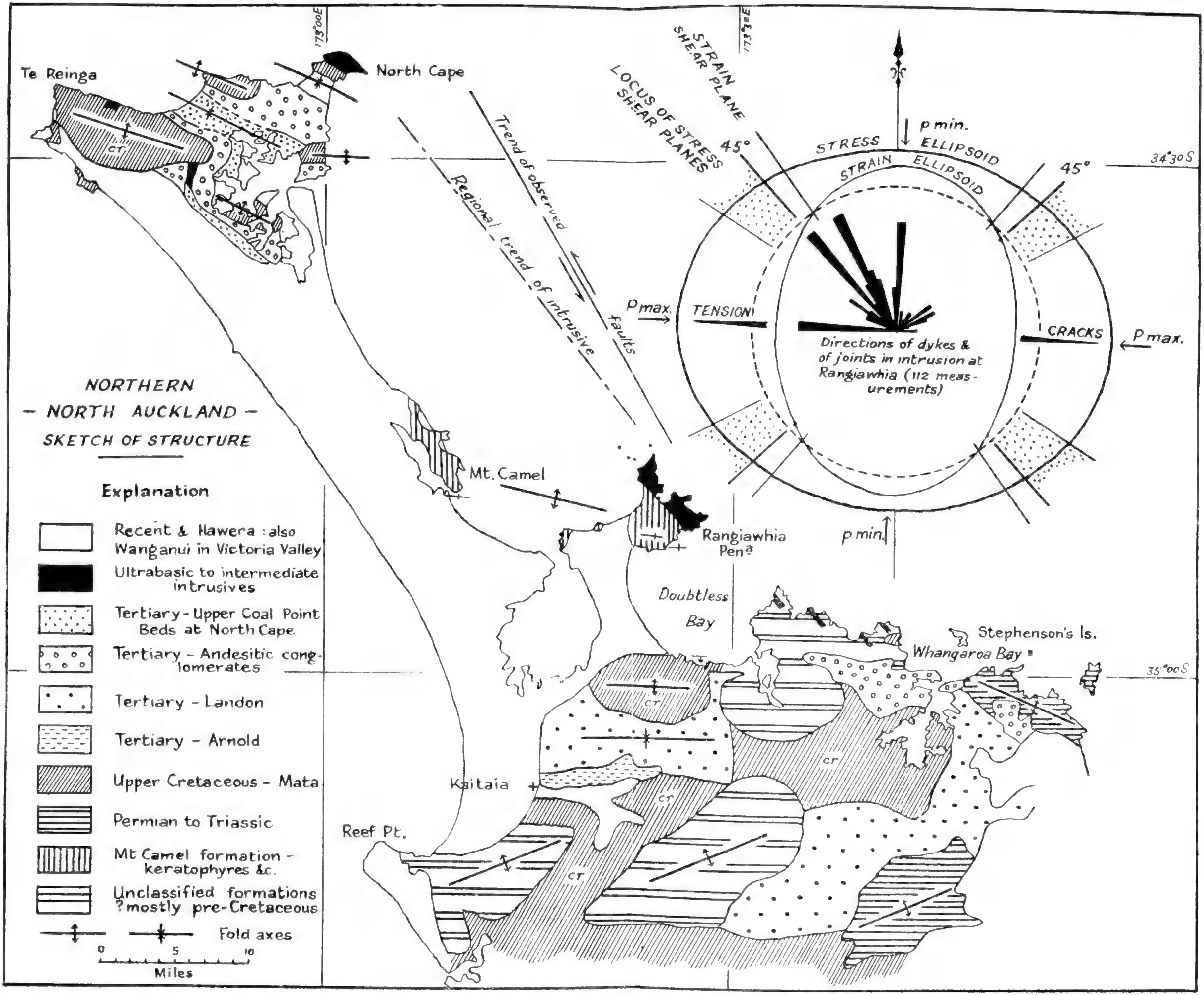

NORTHERN
- NORTH AUCKLAND -
SKETCH OF STRUCTURE
Explanation
Recent & Hawera : also Wanganui in Victoria Valley
Ultrabasic to intermediate intrusives
Tertiary - Upper Coal Point Beds at North Cape
Tertiary - Andesitic conglomerates
Tertiary - Landon
Tertiary - Arnold
Upper Cretaceous - Mata
Permian to Triassic
Mt Camel formation - keratophyres &c.
Unclassified formations ?mostly pre-Cretaceous
Fold axes
0 5 10
Miles
Te Reinga
North Cape
173°00'E
173°30'E
34°30'S
35°00'S
Trend of observed faults
Regional trend of intrusive
LOCUS OF STRESS SHEAR PLANES
STRAIN SHEAR PLANE
45°
45°
p min.
p min.
STRESS ELLIPSOID
STRAIN ELLIPSOID
p max.
p max.
TENSION
CRACKS
Directions of dykes & of joints in intrusion at Rangiawhia (112 measurements)
Mt. Camel
Rangiawhia Pen^a
Doubtless Bay
Stephenson's Is.
Whangaroa Bay
Kaitaia
Reef Pt.
CT

Some Coleoptera from The Noises Islands, Hauraki Gulf

By J. C. WATT, Papatoetoe.

During late August, 1954, a limited amount of collecting was done, chiefly during a fortnight spent on Otata Island, the inhabited island of the Noises Group. The David Rocks (or Four Brothers), islets to the south-east of Otata, and the other main island, Motuhurakia, to the north of Otata, were also visited. One of the David Rocks was revisited on 3rd March, 1956.

The Noises group lies 15 miles to the north-east of Auckland in the Hauraki Gulf. Otata, a few acres in extent, is covered chiefly by low regenerating *Leptospermum* scrub and tussock dominated by *Phormium tenax*, a large portion of the island having been fairly recently burnt; the remainder is covered by typical Auckland coastal forest. Motuhurakia, slightly smaller, is completely covered by coastal forest in a fairly advanced stage of regeneration, while the remainder of the Noises group are little more than rocks, bearing a scanty, wind-swept vegetation of hardy coastal shrubs.

Family CARABIDAE.

Ctenognathus sp.

One specimen was recorded from Motuhurakia but the specimen was later unfortunately mislaid.

Family TROGOSITIDAE.

Leperina brounii Pasc.

Two specimens under bark of pohutukawa (*Metrosideros excelsa*), Motuhurakia.

Phycosecis discoidea Pasc.

Common on sandy beach above H.W.M., Otata.

Family TENEBRIONIDAE.

Cilibe humeralis Bates.

Very common on the David Rocks under stones; also found on Otata and Motuhurakia. More active on second visit to the David Rocks, probably due to the season.

Lorelus sp.

Beaten from a shrub, Motuhurakia, two specimens.

Leiopeplus expolitus Br.

Very common in rotten wood on Otata and Motuhurakia and under fallen branches and stones on the David Rocks.

Family CERAMBYCIDAE.

Navomorpha sulcatum Fabr.

One specimen beaten from flowering shrub, Motuhurakia.

Xyloteles lynceus Fabr.

Two specimens beaten from flowering shrubs, Motuhurakia.

Xyloteles griseus Fabr.

One specimen as above.

Xyloteles nanus Bates.

Four specimens as above; also two specimens from the David Rocks, March, 1956.

Xyloteles sp.

One specimen as above.

Family CURCULIONIDAE

Sub-family EUGNOMINAE

? Hoplocneme sp.

One specimen beaten from flowering shrub, Motuhurakia.

DISCUSSION.

It will be noted that two species, *Cilibe humeralis* and *Leiopeplus expolitus*, are very common. Hudson ("New Zealand Beetles and Their Larvae," 1934) states that *C. humeralis* is "common under stones above high water mark on all the beaches around Wellington." My records indicate that it is also common on or near the sea shore in the vicinity of Auckland, especially on islands. *L. expolitus* also appears to be a coastal insect but not as exclusively as *C. humeralis*. Situations for this species according to my observations, besides those above, are under bark of dead karaka (*Corynocarpus laevigata*) and live puriri (*Vitex lucens*) trees, so it is obviously a more versatile insect than *C. humeralis*, which only occurs under stones. Both species are probably scavengers, feeding on decaying animal and vegetable matter. It would be interesting to study the feeding habits of the adults on the David Rocks, where vegetation is scanty and little soil is present and much competition for food appears probable. *Phycosecis discoidea* is common on most sandy beaches, feeding on decaying animal matter. The several species of *Xyloteles* are probably quite common on the Noises; they are phytophagous insects.

No doubt intensive collecting would yield many more species, but the majority of the common ones that are normally adults in early spring are probably contained in the species list above.

ACKNOWLEDGEMENTS.

I have greatly appreciated the opportunity to examine material of the above species in the Auckland Museum. A series of duplicates has been placed in the Museum collection.

APPENDIX.

Horuhoru, a small island just to the north of the eastern end of Waiheke Island, and E.S.E. of the David Rocks, was visited on 3rd March, 1956. This islet is only a little larger than the western islet of the David Rocks, but the vegetation has been modified by a large gannet colony, and consists mainly of stunted taupata (*Coprosma repens*). The following species were taken:

Family HISTERIDAE.

Abraeus sp.

Four specimens beaten from taupata.

Family TROGOSITIDAE.

Leperina brounii Pasc.

One specimen cut from dead taupata.

Family CRYPTOPHAGIDAE.

? Cryptophagus sp.

Eight specimens beaten from taupata. There are eleven specimens of this species in the C. E. Clarke Collection, Auckland Museum, from various localities near Auckland.

Family TENEBRIONIDAE.

Cilibe humeralis Bates.

Common under rocks. This species is often found with *Anisolabis littorea* (White), the large coastal earwig which is common on islands in the Hauraki Gulf.

Family CURCULIONIDAE.

Sub-family CRYPTORRHYNCHINAE.

Two species belonging to *Acalles* or a related genus beaten from taupata, one species very common.

Aquatic Insects of Little Barrier Island

By K. A. J. WISE, Plant Diseases Division, Department of Scientific and Industrial Research, Auckland.

In November, 1954, a collection of aquatic insects was made on Little Barrier Island. This island lies at the entrance to the Hauraki Gulf, 14 miles from the mainland. The island, which is approximately 7,000 acres in area, is more or less circular and has a central mountain group with a consequent radiating topography. It is a sanctuary and is covered with native forest.

The aquatic fauna of the island is of a restricted type, as the streams are ephemeral. Watersheds are steep and the run-off is rapid. Hamilton (1935) stated, "Except after heavy rains, many of the streams carry little or no run of water during the drier seasons of the year." None of the streams investigated was flowing; pools and stream beds yielded the specimens recorded below.

Collecting was confined to the south-western sector of the island. The Te Wairere stream bed was the most western investigated and there nymphs of *Ameletopsis perscitus* (Eaton) and *Atalophlebia dentata* (Eaton) were found amongst damp fine gravel and vegetable debris under stones as well as in pools. In the Ngamanauraru stream bed, hanging above Ngamanauraru Bay, only one pool was examined. Waipawa, Turner's (opening out on to Marae Roa), Te Waikohare, and Awaroa stream beds were also investigated. In the last-named a larva of *Archichauliodes diversus* (Walker) was seen amongst stones in the dry bed. Specimens taken at light were collected on the "the flat" (Marae Roa).

In addition to specimens collected on this expedition a specimen in the Auckland War Memorial Museum collection is included in these records. Some duplicates from the material collected are lodged in the Museum collection, the rest are in the Plant Diseases Division collection. Unless otherwise stated, all specimens were collected by the author.

PLECOPTERA

Family Gripopterygidae

Nesoperla trivacuata Tillyard

1923—*Nesoperla trivacuata* Tillyard, *Trans. N.Z. Inst.*, *54* : 211.

1 ♀. Running on stone in rain, Awaroa Stream bed, 25/11/1954.

EPHEMEROPTERA

Family Siphlonuridae

Ameletopsis perscitus (Eaton)

1899—*Ameletus perscitus* Eaton, *Trans. Ent. Soc. Lond.*, *47* : 291.

2 Nymphs. ex pools, Te Wairere Stream bed, 24/11/1954.

Family Leptophlebiidae

Atalophlebia dentata (Eaton)

1871—*Leptophlebia dentata* Eaton, *Trans. Ent. Soc. Lond.*, 19: 80, Pl. 4, fig. 18.

1 Imago. ex Tirikakawa Stream bed, 20/11/1947 (J. Dingley). (Auckland Museum collection).

1 Imago. On surface of pool, Te Wairere Stream bed, 24/11/1954.

11 Nymphs. ex pools, Te Wairere Stream bed, 24/11/1954 (5, Auckland Museum collection).

1 Nymph. ex pool, Waipawa Stream bed, 28/11/1954.

ODONATA

Anisoptera

Family Corduliidae

Procordulia smithii (White)

1845—*Cordulia smithii* White, *Zool. Erebus and Terror, Insects.* Pl. 6, fig. 2.

1 Nymph. ex pool, Te Wairere Stream bed, 24/11/1954.

This nymph fits the description of *Procordulia smithii* by Hudson (1904) but it could possibly be *Somatochlora braueri* (de Selys) the nymph of which is as yet undescribed.

Zygoptera

Family Coenagriidae

Xanthocnemis zealandica (McLachlan)

1873—*Telebasis zealandica* McLachlan, *Ann. Mag. Nat. Hist.* (4), 12: 35.

1 ♂, 1 ♀. Flying above pool, Turner's Stream bed, 29/11/1954.

Eggs in leaf tissue. ex pool, Turner's Stream bed, 29/11/1954 (3, Auckland Museum collection).

The egg has not previously been described. A description is given below.

Length: .84 mm. Width: .18 mm. Elongate-oval, pedicel pointed. Cream (in alcohol), pedicel brown. Chorion thin, colourless.

Eggs were inserted, at random, into the soft tissues of half-rotten plant debris just below the surface of the water.

HEMIPTERA

Heteroptera

Family Veliidae

Sub-family Microveliinae

Microvelia sp.

1 apterous ♀; 7 Nymphs. On surface of pool, Te Wairere Stream bed, 24/11/1954.

1 apterous ♂ ; 1 apterous ♀ ; 2 Nymphs. On surface of pool, Ngamanauraru Stream bed, 24/11/1954.

Dr. T. E. Woodward has advised that these specimens are not *Microvelia halei* Esaki but probably *M. macgregori* Kirkaldy, although they differ somewhat from the description of that species.

NEUROPTERA

Megaloptera

Family Corydalidae

Sub-family Chauliodinae

Archichauliodes diversus (Walker)

1853—*Hermes diversus* Walker, *List Specimens, Neur. Ins. Brit. Mus., 2*: 206.

1 Pupa. Under stone, Awaroa Stream bed, 25/11/1954 (J. T. Salmon).

TRICHOPTERA

Inaequipalpia

Family Sericostomatidae

Oeconesus maori McLachlan

1862—*Oeconesus maori* McLachlan, *Trans. Ent. Soc. Lond. (3), 1* : 303.

1 ♀. ex Awaroa Stream bed, 28/11/1954.

Olinga feredayi (McLachlan)

1868—*Olinx feredayi* McLachlan, *Journ. Linn. Soc. Lond. Zool., 10* : 198.

1 Pupa in case, 2 Larvae in cases. ex pool, Te Wairere Stream bed, 24/11/1954.

The larval case is figured in Plate 50.

Helicopsyche sp.

1 Larva in case. ex pool, Te Wairere Stream bed, 24/11/1954.

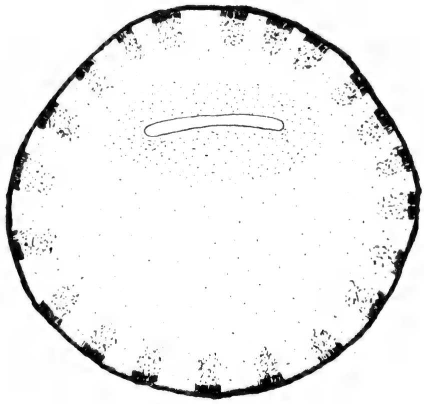
The helicoid case is figured in Plate 50.

? **Pycnocentria** sp.

1 Larval case. ex pool, Waipawa Stream bed, 28/11/1954.

This case (Plate 50) is similar to that of *Pycnocentria evecta* McLachlan described and figured by Hudson (1904). Probably belongs to a species of *Pycnocentria* or an allied genus. Family determination was made from larval and pupal skins which it contained.

The case is 6 mm. in length, formed of sand grains on a horny base. Slightly tapered and curved. The anterior sieve membrane (text-fig. 1) is 1 mm. in diameter. It is quite substantial, made entirely of a secretion, and shaped like a pill-box lid. The single opening is a slightly curved slit.



Text-figure 1. ? *Pycnocentria* sp. Anterior sieve membrane.

Aequipalpia

Family Philanisidae

Philanisus plebeius Walker

1852—*Philanisus plebeius* Walker, *List Specimens Neur. Ins. Brit. Mus.*, *1*: 116.

1 ♂. Swept ex boulder beach, 24/11/1954 (R. A. Harrison).

1 ♀. Swept ex boulder beach, 24/11/1954.

1 ♂. At light, 26/11/1954.

3 ♂ ♂, 1 ♀. At light, 27/11/1954 (2 ♂ ♂, 1 ♀, Auckland Museum collection).

Family Leptoceridae

Sub-family Triplectidinae

Triplectides obsoleta (McLachlan)

1862—*Pseudonema obsoleta* McLachlan, *Trans. Ent. Soc. Lond.* (3), *1* : 305.

2 Larval cases. ex pool, Te Wairere Stream bed, 24/11/1954.

Each case (Plate 50) is a hollowed out piece of twig. One end of the tube is blocked by small stones.

Family Polycentropodidae

Polyplectropus sp.

1 ♂, 1 ♀. At light, 26/11/1954.

1 ♀. At light, 28/11/1954.

2 Larvae. ex pool, Waipawa Stream bed, 28/11/1954.

2 Larvae. On debris in pool, Turner's Stream bed, 29/11/1954.

1 Pupal case. ex pool, Te Wairere Stream bed, 24/11/1954.

1 Pupal case. ex pool, Waipawa Stream bed, 28/11/1954.

Adult specimens belong to an undescribed species of this genus, but, as specimens representing at least two undescribed species are known in other collections, description of a new species is deferred.

Larvae and imagines cannot definitely be assigned to the same species.

The pupal cases are made of small stones tied together loosely with silk (Plate 50).

Pupal cases have been associated with the larvae by means of cast larval skins remaining in the cases.

Family Philopotamidae

Hydrobiosella stenocerca Tillyard

1924—*Hydrobiosella stenocerca* Tillyard, *Trans. N.Z. Inst.*, *55* : 289.
1 ♀. On surface of pool, Te Wairere Stream bed, 24/11/1954.

DIPTERA

Nematocera

Family Culicidae

Sub-family Culicinae

Aëdes antipodeus (Edwards)

1920—*Ochlerotatus antipodeus* Edwards, *Bull. Ent. Res.*, *10* : 132.

1 ♀. Swept at bush margin, Te Titoki Point, 25/11/1954 (R. A. Harrison).

2 ♀ ♀. ex Waipawa Stream bed, 25/11/1954 (R. A. Harrison).

1 ♂. ex Waipawa Stream bed, 28/11/1954 (R. A. Harrison).

1 ♀. ex Turner's Stream bed, 29/11/1954 (R. A. Harrison).

Culex fatigans Wiedemann

1828—*Culex fatigans* Wiedemann, *Assereur. zweifl. Ins.*, *1* : 10.

1 Pupa; 3 Larvae. ex pool, Ngamanauraru Stream bed, 24/11/1954.

1 ♂; 16 Larvae. ex pool, Te Waikohare Stream bed, 26/11/1954.

Family Dixidae

Dixa (Paradixa) sp.

1 Larva. ex pool, Te Wairere Stream bed, 24/11/1954.

Description of Larva

Length: 10 mm. Body colour (in alcohol) white with darker segmental patches on dorsum. Abdominal segments without dorsal crown of setae. Ambulacral combs on segments 5, 6, 7. Structure of end of abdomen as shown in text-figure 2. Gut somewhat extruded from anus. Sloping anterior wall of saucer-shaped spiracular depression bears small bifid chitinised plate. Lip of wall above plate bears two pairs of many branched setae, outer pair double-tufted. Caudal appendage pubescent;

ACKNOWLEDGEMENTS

The author is grateful to Mr. E. G. Turbott, of the Auckland Museum, for the loan of a specimen from the museum collection. Dr. T. E. Woodward, of The University of Queensland, Brisbane, Australia, has kindly given his opinion on the identification of the Microveliids in this collection.

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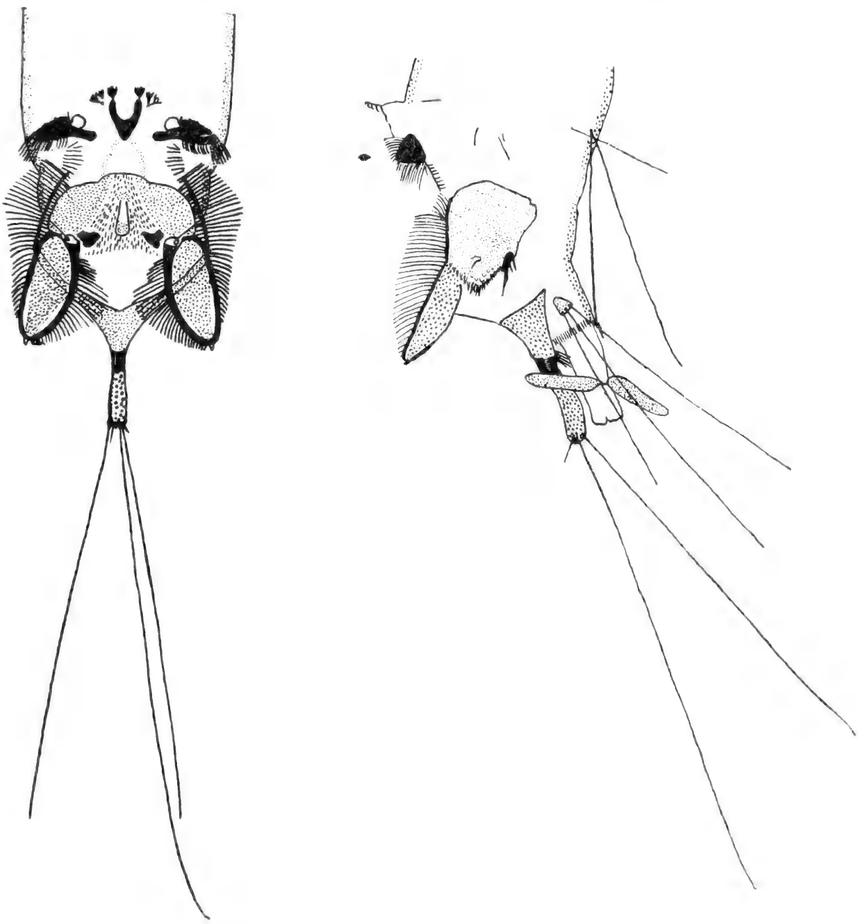
TONNOIR, A. L. 1924. New Zealand Dixidae (Dipt.). *Rec. Cant. Mus. 2 (4)* : 221-33.

long caudal setae inconspicuously plumose, two most dorsal and one of middle pair missing. Lobe of lateral plate with outer strongly chitinised opaque ring and inner transparent portion with light and dark areas, dark area filling basal half and narrowing distally. At peak of dark area a short tooth-like process arises from ventral surface of lobe and projects posteriorly. Side of lateral plate setose on posterior margin, postero-ventral angle bears three heavily chitinised teeth, one long and finely produced, two short and stubby.



A B

Text-figure 2. *Dixa (Paradixa)* sp. Larva.
End of abdomen, A. Dorsal B. Lateral.

This specimen belongs to the subgenus *Paradixa* which was erected by Tonnoir (1924) for two New Zealand species, *D. neozelandica* Tonn. and *D. fuscinervis* Tonn. Tonnoir described the larvae of both species. They can be separated by the form of the basal part of the lateral plates. Two teeth present at the postero-ventral angle in *D. neozelandica* are absent in *D. fuscinervis*. The larva from Little Barrier Island bears, at that point, three teeth, and there are other differences from Tonnoir's species in the structures at the end of the abdomen. It seems, therefore, that this larva represents a third, and as yet undescribed, species of the subgenus *Paradixa*.

Caddis cases from Little Barrier Island.

Top: *Polyplectropus* sp. Pupal case.

Centre: ? *Pycnocentria* sp. Larval case.

Bottom left: *Olinga feredayi.* Larval case.

Bottom middle: *Helicopsyche* sp. Larval case.

Bottom right: *Triplectides obsoleta.* Larval case.

Spiders from the Three Kings Islands

By B. J. MARPLES, University of Otago.

The Three Kings Islands form a group lying about 35 miles to the north-west of Cape Maria van Diemen, the extreme northern tip of New Zealand. I am indebted to Mr. E. G. Turbott, of the Auckland Museum, and to Dr. G. Archey, its Director, for the opportunity of examining this collection of spiders. Most of the specimens were collected by Mr. Turbott on Great Island, but a few are from South West Island, and one from Stella Rock. Great Island is irregular in shape with greatest diameters of about 1½ miles and rising to a height of some 1,000ft.; South West Island is oval, about a ½-mile long and 500ft. high.

In attempting to describe any general collection of New Zealand spiders at the present time, great difficulties are immediately encountered. Although over 300 species have been described, the great majority of the descriptions are worthless, and sometimes to identify even a common spider would necessitate a revision of the group to which it belongs. Accordingly, some of the following identifications are tentative, and in some cases identification has not been attempted. Little is known of the distribution of spiders in New Zealand, and more tends to be known of the faunae of small adjacent islands where special collecting has been done than of the main islands themeslves.

The measurements were made by means of a micrometer eyepiece and are given in millimetres. The sizes and distances apart of the eyes are given in direct scale readings and so are comparative only. The different legs are denoted by Roman numerals and the leg indices are obtained by dividing the length of the leg by the length of the carapace. The tibial index, which gives a measure of the stoutness of the leg, is obtained by dividing the combined lengths of the patella and tibia by the diameter of the proximal end of the patella.

Two new genera and five new species are described, and the males of two already known species are described for the first time. Twenty-six species are represented in the collection, but identification is not attempted in five cases either because of immaturity or because of the difficulties already mentioned. The following is the list of species:

DIPLEURIDAE

Aparua bipectinata Todd

MIGIDAE

Migas paradoxus L. Koch

PSECHRIDAE

Matachia ramulicola Dalmas

DICTYNIDAE

? *Epimecinus* sp.

DYSDERIDAE

Ariadna bellatoria Dalmas

DRASSIDAE

Scotophaeus pretiosus (L. Koch)

CLUBIONIDAE

Clubiona peculiaris L. Koch

Chiracanthium insulare n. sp.

THOMISIDAE

Diaea albolimbata L. Koch

SALTICIDAE
Trite auricoma (Urquhart)
Trite bimaculata (Urquhart)
Two other species

OXYOPIDAE
Oxyopes gregarius (Urquhart)

LYCOSIDAE
Lycosa hilaris L. Koch
Lycosa sp.

AGELENIDAE
Cambridgea antipodiana (White)
Gasparia nebulosa gen. et sp. nov.

THERIDIIDAE
Armigera turbotti gen. et sp. nov.
Moneta conifera (Urquhart)
Lithyphantes regius n. sp.
Theridion veruculatum Urquhart
Theridion longicrure n. sp.

TETRAGNATHIDAE
Tetragnatha flavida Urquhart

EPEIRIDAE
Argiope protensa L. Koch
Epeira sp.

DIPLEURIDAE

Aparua bipectinata Todd

1 ♂, 11 ♀. Recorded from the camp and depot area, Tasman Valley, Castaway Valley, N.W. Cliffs, and in Maori Cave, important in the soil.

This species was described from Wanganui. The average length of the carapace of 12 females, the type and paratypes, is 4.7 mm., the limits being 3.6 and 6.0 mm. The specimens from Great Island are considerably larger, the average of 10 specimens being 6.7 mm., with limits 6.0 and 8.3 mm. In my own collection are four specimens from Cambridge, average length 6.1 mm. and one from Houhora, in the North Auckland peninsula, length 6.1 mm. The numbers are too small for certainty, but the suggestion of an increase in size on passing towards the north is interesting.

MIGIDAE

Migas paradoxus L. Koch

3 ♀. In litter in the camp area. The species has been recorded from Auckland, New Plymouth and Wellington.

PSECHRIDAE

Matachia ramulicola Dalmas. Text fig. 1.

4 ♂ and 1 imm., 1 ♀ and 1 imm. Collected in Maori Cave, in the tent at night and by beating kanuka. The species was described from specimens from Nelson and seems to be widespread, but the male has not previously been described.

Male.—Length, 6.72 mm. Carapace pale yellowish brown, slightly darker between the eyes and the thoracic groove, dark brown along the anterior margin and with faint radiating pale streaks. Appendages and sternum pale yellowish brown. Abdomen pale with brown markings. Mid-dorsally are two parallel streaks, and posterior to these three large and three very small chevrons with apices directed anteriorly. Anterolaterally are spots which become streaks along the sides and merge into a dark area on each side close to the spinnerets. Under side very lightly spotted. All specimens similarly coloured.

Carapace: Length 3.04 mm, breadth 1.96 mm. Low and smooth, truncated abruptly in front. Thoracic groove longitudinal.

Eyes: 8, all pale. From above the anterior row is very slightly recurved and the posterior row very slightly procurved. From in front the anterior row is straight, the posterior row procurved. Ratio of the sizes of the eyes and their distances apart: AM, 56; AL, 63; PM, 64; PL, 68; AM-AM, 40; AM-AL, 101; AM-PM, 62; PM-PM, 94; PM-PL, 108; L-L, 19; clypeus, 66.

Chelicerae: With boss. Long and tapering, the fang long and the groove very oblique. Two minute teeth on the retromargin of the groove and 4 on the promargin. Of these the next-but-one to the proximal end is about three times the size of the others. The groove is very slightly developed. A row of bristles parallel to each row of teeth, the prolateral being much the larger. Anterior surface of chelicerae with few or no bristles.

Maxillae: Long, with parallel sides, rounded anteriorly with the median corner truncated obliquely.

Lip: Rectangular, the anterior border slightly concave. A little more than half the length of the maxillae.

Sternum: Length 1.52 mm., breadth 1.16 mm. Rebordered, straight anteriorly and ending posteriorly in a point between the hind coxae. Lateral margins slightly indented opposite the coxae.

Palp: As in figure (text fig. 1). Tibia with bifurcated retrolateral apophysis. One distal dorsal spine on the patella, 2 on the femur, also a single one near the middle. Four trichobothria on the tibia.

Legs:	I	II	IV	III	Palp
	4.95	4.01	2.78	2.59	1.38

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	1.62	0.96	——	1.62	4.20
I	3.36	5.32	4.69	1.71	15.08
II	3.16	4.33	3.44	1.26	12.19
III	2.33	2.75	2.26	0.53	7.87
IV	2.42	3.11	2.04	0.90	8.47

Tibial Index I 7.5. Tibial Index IV 9.5.

Three claws, the paired ones with 10 pectinations, the median one with 2 curved ones. The majority of the bristles on the legs and on the body also are clothed with fine setules throughout their length. Tarsi with spurious articulations. Very small tarsal organ distally situated. Trichobothria: 6 in a row decreasing in size proximally on tarsi I and II, 2 on III, 4 on IV. Similar rows occur on the metatarsi and tibiae. Spines: all legs similar. Metatarsus, 2 pairs and 1 ventral at the distal end, proximal half with 5 pro and 4 retro. Tibia, 1 distal dorsal, 2 pro and 4 retro, 1 ventral. Femur, 3 distal, 2 dorsal. The tibia and femur have rows of long hooked hairs. No calamistrum, only about half a dozen straggly hairs.

Abdomen: Length 3.84 mm., breadth 1.79 mm. Numbers of hooked hairs similar to those on the legs. Anterior median spinnerets large and triangular, touching at the base. Posterior spinnerets largest, end joint conical. Median spinnerets and anal tubercle small. Cribellum undivided.

DICTYNIDAE

One immature Dictynid was collected under stones at the summit of South West Island. From consideration of its cheliceral teeth it clearly does not belong to the genus *Ixeuticus*, which is found throughout New Zealand, but possibly to *Epimecinus*, which occurs in Australia and New Caledonia. A revision of the Dictynids of New Zealand at present being carried out has already shown that some similar species occur in the Auckland district, so no description of the present specimen is given here.

DYSDERIDAE

Ariadna bellatoria Dalmas

2 ♀ and 1 imm. From under stones and bark. This species was described by Dalmas from a female from Taumarunui. Its clearest distinction from *A. barbigera* Simon is the greater number of spines on the anterior legs. The immature specimen, which may be a male, has fewer spines, but this is insufficient evidence for the presence of both species, especially as the male of neither has been described.

DRASSIDAE

Scotophoeus pretiosus (L. Koch)

1 ♂ and 1 imm., 2 ♀. In dry cave, Stella Rock and at the camp area, Great Island.

CLUBIONIDAE

Clubiona peculiaris L. Koch

1 ♂, 3 ♀ and 4 imm. In camp area and collected by beating kanuka in lower Tasman Valley.

Chiracanthium insulare n. sp. Text fig. 2.

1 ♂. Great Island.

Male.—Length 10.57 mm. Chelicerae, maxillae and lip chestnut brown. Carapace chestnut brown anteriorly shading to paler brown posteriorly. Sternum pale brown with chestnut margin, legs pale brown. Abdomen pale greyish brown with two pale patches side by side anteriorly, followed by 5 chevrons. Anterior end and posterior dorsal patch pale brown similar to carapace.

Carapace: Length 4.49 mm., breadth 3.58 mm. Smoothly domed above with longitudinal groove, sides curved and an indentation above the waist.

Eyes: 8, all pale. From above anterior row recurved, posterior row straight. Width of eyegroup 1.57 mm. Ratio of eyes and their distances apart: AM, 114; AL, 97; PM, 92; PL, 106; AM-AM, 70; AM-AL, 58; AM-PM, 94; PM-PM, 162; PM-PL, 145; L-L, 71; clypeus, 54.

Chelicerae: Stout and inclined anteriorly, the anterior surface somewhat geniculate and with bristles on the antero-median aspect. Groove very oblique with 2 promarginal teeth at the proximal end and 2 retromarginal teeth, one proximal and the other near the base of the fang. A very pronounced swelling on the prolateral side close to the base of the fang, from which a row of bristles extends along the promargin of the groove.

Maxillae: Long, constricted in the middle, median anterior corner truncated obliquely.

Lip: Long with sides converging. Truncated anteriorly with a concave margin.

Sternum: Length 2.51 mm., breadth 1.78 mm. Oval and flat. Margin with points opposite and between the coxae.

Palp: As in figure (text fig. 2). Tarsus not swollen, no backwardly directed process, tibial apophysis small.

Legs: Leg IV is missing on both sides of this specimen.

I	II	III	IV	Palp
3.24	2.73	2.32	——	0.93

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	1.69	1.55	——	1.01	4.52
I	3.96	5.18	3.28	2.83	15.25
II	3.41	5.00	2.85	1.25	12.51
III	3.56	3.84	2.56	1.04	11.00
IV	——	——	——	——	——

Tibial Index I 10.0.

Two claws apparently not pectinated. Claw tuft. Narrow scopula on tarsi and metatarsi I and II and on tarsus III. Spines: I and II, metatarsus, 2 proximal ventral; tibia 1 median ventro-prolateral; femur 1 distal prolateral, 1 median dorsal. III, metatarsus 3 pairs ventral; tibia 3 pairs ventral, 2 retrolateral; femur 2 dorsal, 2 dorsal prolateral, 1 dorso-retrolateral.

Abdomen: Length 5.60 mm., breadth 2.57 mm. Cylindrical, anterior end chitinised and with long bristles, double row of bristles down the dorsal side and others ventro-lateral. Six spinnerets, long and cylindrical, terminal joints of the dorsal ones very short. Tracheal spiracle appears to be close to the spinnerets.

This species is doubtfully put into the genus *Chiracanthium*. It does not have the usual backwardly directed process of the cymbium and it has a thoracic groove, but there are other members of the genus exceptional in these respects. It differs from *Chiracanthium stratioticum* L. Koch in the absence of the process of the cymbium.

THOMISIDAE

Diaea albolimbata L. Koch

4 ♀ and 2 imm. Great Island, beaten from kanuka at the Saddle, Tasman Valley and the east end. These specimens all show the pattern of reddish markings lateral to white ones, as figured by Dalmas but not by Koch.

SALTICIDAE

Trite auricoma (Urquhart)

1 ♀. Maori Burial Cave area, Great Island.

Trite bimaculata (Urquhart)

2 ♂. Great Island.

The taxonomy of this family is in a most unsatisfactory condition, some 47 species having been described. It seems undesirable to add to this list until it has been revised. Two other species seem to be represented, each having 2 promarginal and 1 retromarginal teeth. One is represented by 1 ♀ from the camp on Great Island, the other by 3 ♂, 2 ♀ and 1 imm. collected by beating kanuka on Great Island. This resembles *Jotus ravus* (Urquhart) in general and in having a large lobe on the bulb of the male palp which extends proximally for about the length of the tibia. It differs, however, in the absence of a dorsal scutum on the abdomen mentioned by Bryant (1935, p. 67) but not by Urquhart (1892, p. 186), and in the presence of dark scales on the ventral side of the tibia and patella of leg I.

OXYOPIDAE

Oxyopes gregarius (Urquhart)

1 ♀. Beaten from kanuka in lower Tasman Valley, Great Island.

LYCOSIDAE

Lycosa hilaris L. Koch

1 ♀ and 1 imm. Great Island.

Lycosa sp.

1 imm. Great Island. This clearly does not belong to the previous species, but is very immature.

AGELENIDAE

Cambridgea antipodiana (White)

1 ♀. Great Island, from under stone on Quadrat 1. In this specimen the median and lateral dark stripes on the carapace and the annulations on the legs are very well marked, while the abdomen shows only vague markings.

Gasparia gen. nov.

Size small. Chelicerae with teeth on both margins of the groove. None of the spinnerets enlarged.

Gasparia nebulosa n. sp. **Text fig. 3.**

1 ♀. Under stone under litter. Quadrat I, Great Island.

Female.—Length 3.84 mm. Carapace pale brown with dark lateral bands about one-third the distance from the edge to the centre formed of 4 or 5 coalescing marks. Dark round the eyes and a streak at the fovea. Appendages brown, the legs with dark bands on the femora, tibiae and metatarsi, most marked on IV scarcely visible on I. Sternum pale brown. Abdomen pale with dark pattern. Mid-dorsally and anterior band followed by two small spots, followed by three chevrons. A dark band on each side expanding posteriorly into a mottled area reaching the chevrons. Ventral side pale with no marks.

Carapace: Length 1.49 mm., breadth 1.09 mm. Low and smooth, anterior and posterior margins straight.

Eyes: 8, AME dark. From above, anterior row slightly recurved, posterior row straight. Ratio of the sizes of the eyes and their distances apart: AM, 76; AL, 114; PM, 107; PL, 123; AM-AM, 58; AM-AL, 27; AM-PM, 116; PM-PM, 82; PM-PL, 72; L-L, 48; clypeus, 65. Breadth of eyegroup 0.44 mm.

Chelicerae: Groove oblique, 1 tooth on the promargin, 3 on the retromargin, the one nearest the fang being the largest.

Maxillae: More or less parallel, anterior median corner truncated.

Lip: Free, slightly longer than broad. Anterior margin slightly concave.

Sternum: Length 0.84 mm., breadth 0.71 mm. Smoothly rounded, with blunt projection between coxae IV.

Palp: Claw without pectinations. On the tibia 1 dorsal and 3 dorso-retrolateral trichobothria.

Legs:	I	IV	II	III	Palp
	2.55	2.50	2.29	2.00	0.94

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	0.49	0.50	——	0.41	1.40
I	1.09	1.37	0.83	0.49	3.78
II	1.01	1.20	0.69	0.51	3.41
III	0.81	1.04	0.60	0.51	2.96
IV	1.10	1.31	0.80	0.51	3.72

Tibial Index I 7.9. Tibial Index IV 8.5.

Three claws, the dorsal with 8 pectinations, the ventral with 2 which are long, slender and curved. Trichobothria: tarsus with a row of 4 increasing in size distally; metatarsi I and II with 2, III and IV with 3; tibiae I and II with 3, III and IV with 5. Spines or stout bristles; metatarsus and tibia I and II each with 3 pairs, III and IV irregularly arranged; 1 dorsal on each femur. Tarsal organ small, on I 15% of the length of the tarsus from the distal end.

Abdomen: Length 2.24 mm., breadth 1.52 mm. Spinnerets normal, posterior slightly the largest. Anterior separated by less than their diameter. Tuft of bristles in place of colulus. Anal tubercle small. Epigynum as in figure, a slight elevation in the centre and the brown spermathecae showing through the surface.

THERIDIIDAE

Armigera gen. nov.

Male with dorsal and epigastric sclerites, and a less hardened one surrounding the spinnerets. Stridulating organ at the waist. Cheliceral groove with teeth on both margins. Colulus present. One pair of book lungs, and an unbranched pair of abdominal tracheae opening together posteriorly. Female not known.

Armigera turbotti n. sp. Text fig. 4.

2 ♂. Under stones, Quadrat I, Great Island.

Male.—Length 1.56 mm. Dark chestnut brown, appendages slightly lighter.

Carapace: Length 0.87 mm., breadth 0.67 mm. High, with vertical clypeus. Slightly concave posterior surface where overhung by the abdomen. Carapace, sternum and the hard sclerities on the abdomen with a uniform granular surface.

Eyes: 8, AME dark. From above, anterior row strongly recurved, posterior row straight. Ratio of the diameters of the eyes and their distances apart: AM, 105; AL, 94; PM, 105; PL, 103; AM-AM, 57; AM-AL, 32; AM-PM, 70; PM-PM, 108; PM-PL, 66; L-L, 0: clypeus, 225. Breadth of eyegroup 0.37 mm.

Chelicerae: Small and vertical.

Maxillae: Broad, truncated anteriorly, with black serrula. Outer margins parallel, inner margin converging but not meeting.

Lip: Free, more or less semicircular.

Sternum: Length 0.41 mm., breadth 0.43 mm. Heart-shaped with a blunt posterior end widely separating coxae IV and joined to the carapace behind them.

Palp: Slender, with large palpal organ, as in figure. The embolus is long. On the prolateral side it is bent into a circle then turns back on itself, passes between the bulb and the cymbium and turns again as in the figure.

Legs:	I	II	IV	III	Palp
	3.02	2.28	1.84	1.40	1.05

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	0.34	0.18	——	0.34	0.95
I	0.89	0.91	0.53	0.33	2.66
II	0.62	0.68	0.38	0.29	1.97
III	0.39	0.36	0.25	0.21	1.21
IV	0.51	0.47	0.34	0.28	1.60

Tibial Index I 9.9. Tibial Index IV 13.4.

Three claws with few pectinations. Few pectinated bristles, no more on IV. No spines. Trichobothria: 1 on metatarsi, 2 on tibiae. Tarsal organ present, on I 63% of the length of the tarsus from the distal end.

Abdomen: Length 1.12 mm., breadth 0.90 mm. The whole dorsal surface covered by a single smoothly-domed sclerite. An epigastric sclerite covers the anterior two-thirds of the ventral surface, lateral to it on each side is a very small sclerite, and an annular one surrounds the spinnerets. In the cuticle covering the remainder are small thickenings forming longitudinal ridges, three of which pass dorsal to the spinnerets.

The skin of the other specimen was prepared by boiling in potash, when further details were visible. The promargin of the cheliceral groove has 2 teeth at the ventral end, the retromargin 3 smaller ones about the middle. There is a well-developed stridulating organ, consisting of the posterior slope of the carapace where it is overhung by the abdomen. This is covered with fine transverse striations. Rubbing upon it is a pair of small projections on the abdomen, each provided with a dorsal bristle, arising on the part of the epigastric sclerite which passes dorsal to the waist. The respiratory system consists of a pair of book-lungs and a pair of unbranched tracheae arising close to the spinnerets and confined to the abdomen. A small colulus is present bearing two bristles. The sclerite surrounding the spinnerets, which in the intact animal resembles the others, in the cleared skin is seen to be much thinner.

It seems that this species may belong to the sub-family Pholcommatinae of the Theridiidae. Several genera formerly placed here have been removed because they were found not to possess lungs, but more study seems necessary to clear up the relationships. In the meantime the present species is placed in a new genus.

Lithyphantes regius n. sp. **Text fig. 5.**

1 ♀. Great Island.

Female.—Length 3.90 mm. Carapace, chelicerae and sternum chestnut brown, palps and legs brown. Abdomen reddish brown with irregular more or less interrupted mottled white bands round the edge of the dorsal surface and in the mid-dorsal line. The mid-dorsal band is continuous with the marginal one anteriorly and posteriorly.

Carapace: Length 1.66 mm., breadth 1.30 mm. Heart-shaped. Thoracic groove, shallow, transverse, recurved.

Eyes: 8, all pale. From above anterior row strongly recurved, posterior row straight, from in front anterior row straight, posterior row procurved. Ratio of eyes and their distances apart: AM, 98; AL, 137; PM, 117; PL, 119; AM-AM, 96; AM-AL, 107; AM-PM, 128; PM-PM, 115; PM-PL, 105; L-L, 32; clypeus, 200.

Chelicerae: Vertical. Fang stout. No groove, but one blunt tooth prolaterally placed.

Maxillae: Converging but not meeting over the lip.

Lip: Free, rounded anteriorly, broader than long.

Sternum: Length 0.82 mm., breadth 0.79 mm. Heart-shaped with finely grooved surface.

Palp: Claw with 5 pectinations. Pectinated bristles present and 1 trichobothrium on the tibia.

Legs:	I	IV	II	III	Palp
	2.94	2.92	2.49	2.15	0.89

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	0.51	0.47	——	0.49	1.47
I	1.39	1.71	1.06	0.71	4.87
II	1.22	1.43	0.91	0.57	4.13
III	1.06	1.21	0.76	0.53	3.56
IV	1.39	1.75	1.03	0.69	4.86

Tibial Index I 8.3. Tibial Index IV 8.1.

Three claws, the paired ones with 10 pectinations on I and 5 on IV. Tarsal organ small, situated 29% of the length from the distal end in I. Pectinated bristles along the length of tarsus IV, a few only on the other legs. No spines. Trichobothria: tibiae 3, metatarsi 1.

Abdomen: Length 3.16 mm., breadth 2.42 mm. Oval, overhanging the carapace to about its middle. Spinnerets small. Colulus slender, about half the length of the anterior spinnerets. Epigynum anterior to the furrow. It has a pale transparent projection arising from a pale ridged area through which was visible the dark spermathecae. The ridges encircle the projection and its base, run transversely anterior and posterior to it and form a whorl on each side.

This species differs from *Lithyphantes lepidus* in its smaller size and general reddish instead of blackish colour, though the white markings on the abdomen are similar. The epigynum of *L. lepidus,* figured by Dalmas, has a smaller projection, ridges arranged concentrically and a median V-shaped chitinised structure. *L. lepidus* has only been recorded from the South Island.

Moneta conifera (Urquhart). Text fig. 6.

1 ♂ and 1 imm., 7 ♀. Great Island, collected by beating kanuka. Described from Waiwera, Te Karaka, Auckland Province, this species is widespread. The male has not previously been described.

Male.—Length 3.30 mm. Carapace, sternum and appendages brown, abdomen pale mottled above and on the sides, grey below. Some reddish brown streaks on the sides, especially posteriorly.

Carapace: Length 1.18 mm., breadth 0.96 mm. Heart-shaped, depressed above. In side view the outline is highest posteriorly and slightly concave, rising again towards the eyes. Clypeus projecting forward.

Eyes: 8, all pale, situated on reddish tubercles. From above anterior row strongly recurved, posterior row straight. Ratio of eyes and their distances apart: AM, 100; AL, 105; PM, 95; PL, 102; AM-AM, 94; AM-AL, 59; AM-PM, 63; PM-PM, 103; PM-PL, 73; L-L, 0; clypeus, 200.

Chelicerae: Small, apparently no teeth on the margins of the groove.

Lip: As long as broad.

Maxillae: Strongly curved inwards and almost meeting above the lip.

Sternum: Length 0.81 mm., breadth 0.50 mm. Flat, slightly rough surface. Extends between the bases of the legs, and broadly between coxae IV.

Palp: As in figure (text fig. 6). 1 trichobothrium on tibia.

Legs:	I	IV	II	III	Palp
	5.59	4.35	2.88	1.65	1.81

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	0.71	0.51	——	0.93	2.15
I	2.22	2.10	2.03	0.29	6.64
II	1.13	1.22	0.85	0.21	3.41
III	0.54	0.70	0.48	0.23	1.95
IV	1.71	1.53	1.62	0.63	5.49

Tibial Index I 13.3. Tibial Index IV 11.3.

Three claws on an onychium, dorsal claws with 2 or 3 pectinations, apparently 1 small one on the ventral claw. Tarsal organ one-third the length of the tarsus from the proximal end. Tarsus IV with pectinated bristles along its whole length, the distal ones on the metatarsus also pectinated. Trichobothria: none on the tarsi, metatarsi I, II and III with a very large one, almost as long as the tarsus, at the distal end, tibiae I, II and III with 3, tibia IV with 4.

Abdomen: Length 2.16 mm., breadth 0.95 mm. Bluntly pointed behind, indented above the waist. No dorsal protuberance in this specimen. 6 spinnerets subterminal, together with the anal tubercle forming a rounded group. No colulus.

Theridion veruculatum Urquhart

3 ♂ and 2 imm., 3 ♀ and 4 imm. Beaten from kanuka on Great Island. Said by Dalmas to be common in both North and South Islands.

Theridion longicrure n. sp. Text fig. 7.

1 ♂. Great Island.

Male.—Length 2.78 mm. Pale greyish brown, area between and behind the eyes as far as the fovea, brown, margin of carapace, grey. Abdomen thickly mottled with white.

Carapace: Length 1.29 mm., breadth 1.06 mm. Low, rounded in outline but slightly constricted behind the bases of the chelicerae.

Eyes: 8, AME dark. From above, anterior row strongly recurved, posterior row slightly procurved. Ratios of the diameters of the eyes and their distances apart: AM, 108; AL, 97; PM, 100; PL, 113; AM-AM, 131; AM-AL, 85; AM-PM, 107; PM-PM, 108; PM-PL, 140; L-L, 0; clypeus, 170. Breadth of eyegroup, 0.48 mm.

Chelicerae: Promargin of the groove with a large tooth having a small one at its base.

Maxillae: Twice as long as lip, margins more or less straight so that the anterior angles are sharp. Wider distally, converging but not meeting.

Lip: As wide as long.

Sternum: Length 0.69 mm., breadth 0.76 mm. Truncated where it meets the lip with a well-marked indentation on each side at the base of each maxilla. Extends between coxae IV to touch the carapace, whose edge passes ventral to the waist.

Palp: Slender, with small palpal organ, as in figure (text fig. 7). Two trichobothria on tibia.

Legs:	I	II	IV	III	Palp
	5.72	3.75	3.43	2.34	0.92

	Femur.	Pat. & Tib.	Metatarsus.	Tarsus.	Total.
Palp	0.48	0.38	——	0.33	1.19
I	2.30	2.34	2.03	0.71	7.38
II	1.51	1.57	1.24	0.52	4.84
III	0.96	0.92	0.84	0.36	3.08
IV	1.49	1.40	1.16	0.38	4.43

Tibial Index I 7.6. Tibial Index IV 9.9.

Three claws. On I the proclaw has a single large pectination near the tip, the retroclaw has six large pectinations and the median claw has one small one near its centre. Below the base of the median claw is a stout, blunt, upcurved projection. Few pectinated bristles except on IV, where they are very lightly pectinated and extend along the tarsus and on to the distal end of the metatarsus. No spines, but some stout bristles on tibiae and patellae. Two trichobothria on tibiae I and II, 3 on tibiae III and IV. On I the tarsal organ is 53% of the length of the tarsus from the distal end.

Abdomen: Length 1.78 mm., breadth 1.09 mm. Ovoid with the spinnerets postero-ventral. These are conical, the anterior being the stoutest. A colulus appears to be present but very small. A stridulating organ is present at the waist, consisting of a striated area on the posterior surface of the carapace and several small projections on the anterior end of the abdomen.

A large number of species of *Theridion* were described by Urquhart, the majority without figures or differential characters. The present specimen does not seem to correspond with any of the descriptions. It is provisionally placed in the genus *Theridion,* though it does seem to have a minute colulus. It is notable for the disproportionate length of the first pair of legs.

TETRAGNATHIDAE

Tetragnatha flavida Urquhart

1 ♂, 4 ♀. Great Island. Beaten from kanuka. One female is much larger than the rest, but the details of the chelicerae resemble this species and Dalmas says that its size is very variable.

EPEIRIDAE

Argiope protensa L. Koch

1 ♂, 1 ♀. Great Island, beaten from kanuka.

Epeira sp. Text fig. 8.

Some 53 species of *Epeira* have been described from New Zealand, the great majority on the basis of coloration, which is very variable, but the actual number of species is clearly much less than this. Many of the species described are unrecognisable, and, with some exceptions, it is impossible to identify members of this genus until a revision has been undertaken.

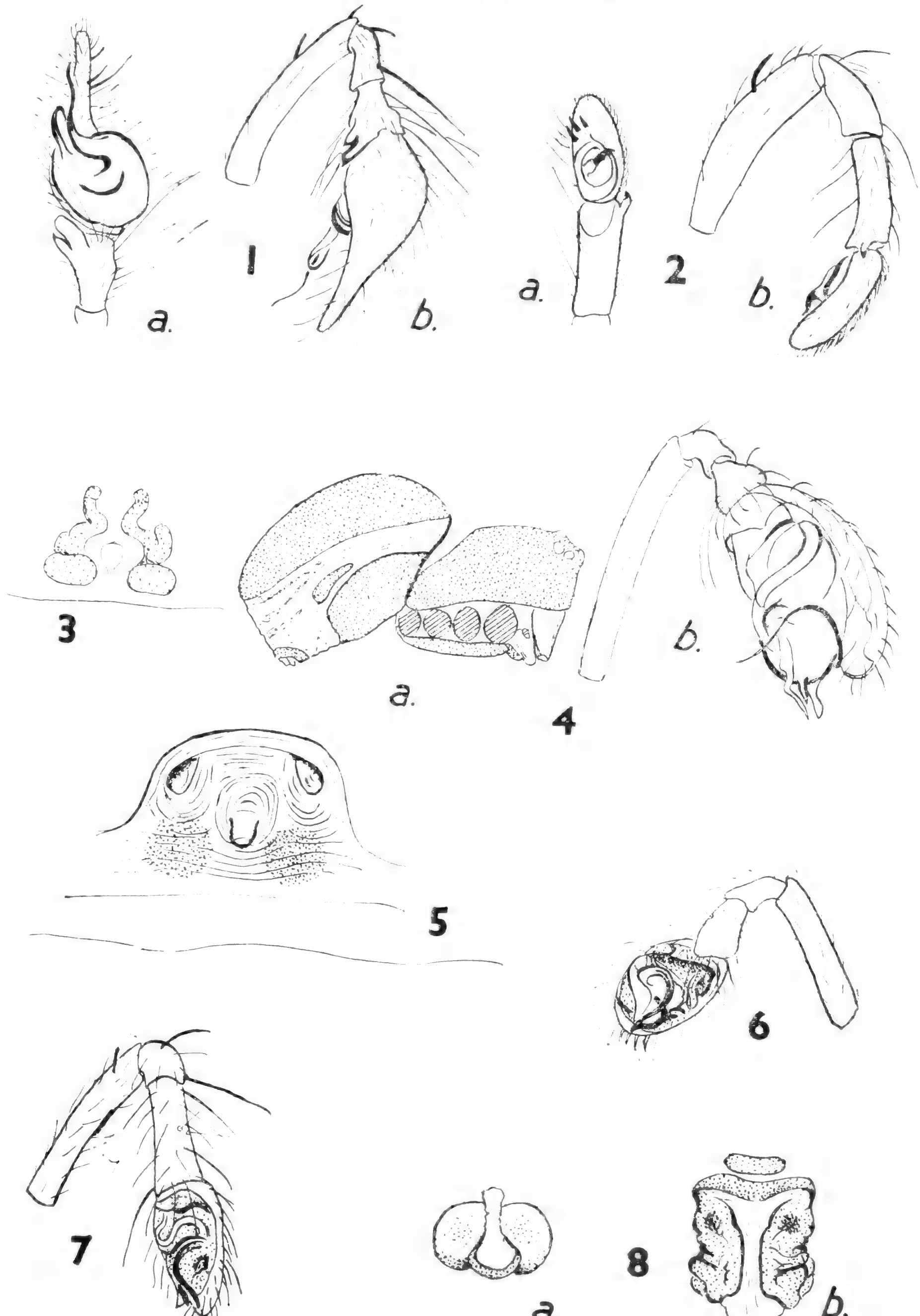


Fig. 1. *Matachia ramulicola.* (a) Ventral view, and (b) retrolateral view of the right palp of the male.

Fig. 2. *Chiracanthium insulare.* (a) Ventral view of the left palp of the male. (b) Retrolateral view of the right palp of the male.

Fig. 3. *Gasparia nebulosa.* Ventral view of epigynum.

Fig. 4. *Armigera turbotti.* (a) View of the right side of the male with legs removed, the sclerites shown stippled. (b) Retrolateral view of the right palp of the male.

Fig. 5. *Lithyphantes regius.* Ventral view of epigynum.

Fig. 6. *Moneta conifera.* Retrolateral view of left palp of male.

Fig. 7. *Theridion longicrure.* Retrolateral view of right palp of the male.

Fig. 8. *Epeira* sp. (a) Ventral view of epigynum. (b) View at right angles to "a" with the whole epigynum turned forward. The posterior end of the scape is seen above.

1 ♂, 19 ♀ and 6 imm. Great Island. This species appears to be the common if not the only Epeirid on the island. The total length is about 8 mm. and the colour pattern variable, but mostly grey and brown. The epigynum as seen in the figure consists of a smooth rounded structure with a short spoon-shaped scape, which may be turned freely forward. If the whole hard structure is turned more forcibly forward it is seen to be somewhat cylindrical and to appear as in the figure. This view is at right angles to the previous one and the posterior end of the scape appears at the top of the figure. The central part consists of soft white membrane, on each side of which is a tough sclerite with dark wrinkled edges. This epigynum resembles Dalmas' figure (fig. 53, p. 387), which he tentatively attributes to *E. venustulus* Urquhart, though his figure does not very closely resemble that of Urquhart himself (1890, plate 21, fig. 12). Dalmas states, however, that in *E. venustulus* the antero-lateral tubercles of the abdomen are very striking, while in the present specimens they are only slightly developed.

Three immature specimens from South West Island differ from the previous ones in having much more clearly annulated legs. Their abdominal colour pattern is, however, not unlike and they are probably of the same species.

SUMMARY.

The collection consists of 26 species of spiders from the Three Kings Islands, which lie about 35 miles north-west of the extreme northern tip of New Zealand. Two new genera and five new species are proposed as follows: Clubionidae, *Chiracanthium insulare;* Agelenidae, *Gasparia nebulosa;* Theridiidae, *Armigera turbotti; Lithyphantes regius, Theridion longicrure.* The males of the following species are also described: *Matachia ramulicola* Dalmas; *Moneta conifera* (Urquhart).

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Notes on the Plumages and Breeding Cycle of the Spotted Shag, Phalacrocorax (Stictocarbo) punctatus punctatus (Sparrman, 1786).

By E. G. TURBOTT, Auckland Museum.

The spotted shag, *Phalacrocorax (Stictocarbo) punctatus punctatus* (Sparrman, 1786), breeds in the Auckland area (Hauraki Gulf and west coast), Cook Strait, south-west Nelson, Banks Peninsula and Otago Peninsula. It is probably this form which breeds on islands off the coast of South Westland, although the identity of these birds is not yet certain. There were colonies formerly to the north of Auckland (Bay of Islands) and at Cape Kidnappers.

The representative form in the Stewart Island area, and apparently also in Foveaux Strait, is *P. punctatus steadi* (Oliver, 1930) (blue shag), and at the Chatham group *P. punctatus featherstoni* Buller, 1873 (Pitt Island shag). Oliver (1955) regards *Stictocarbo* as worthy of generic rank, and at the same time allots full specific rank to *P. punctatus featherstoni*, because of the absence of the white line on the side of the head and neck found in the other two. However, the relationship of *P. punctatus featherstoni* to these geographically separated forms is evidently so close that the present arrangement into three subspecies is a more satisfactory means of expressing their relationship.

P. punctatus is considered to be related elsewhere only to the red-footed cormorant, *P. gaimardi* (Lesson, 1828), of South America (Oliver, 1930a; Falla, 1932; Murphy, 1936). Oliver (1955) differs from this view, as he considers that *P. punctatus* and *P. gaimardi* show certain well-marked differences and are more likely to be derived separately from the pan-antarctic subgenus *Leucocarbo*. Thus, if Oliver's view is correct, similarities between *P. punctatus* and *P. gaimardi* are due to convergence.

All three forms keep entirely to coastal waters, and the breeding colonies are characteristically situated either on coastal cliffs providing ledges, often with overhanging rock faces, or in the interior of caves.

Information on the breeding and plumage sequences of the spotted shag is given by Falla (1932), based mainly upon material in the Auckland Museum collection from the Hauraki Gulf. It is now possible to modify Falla's descriptions in some particulars on the basis of additional field information and material added to the collections from the Auckland area. Stead (1932) also includes in his general account observations on plumages made at colonies on Banks Peninsula.

An earlier and valuable description is that of Potts (1873), whose detailed observations on breeding habits and plumages were made at Banks Peninsula colonies. A general account by Oliver (1930a; 1955, 2nd ed.) includes further field notes. In the present account, no attempt has been made to include information from the colonies other than those

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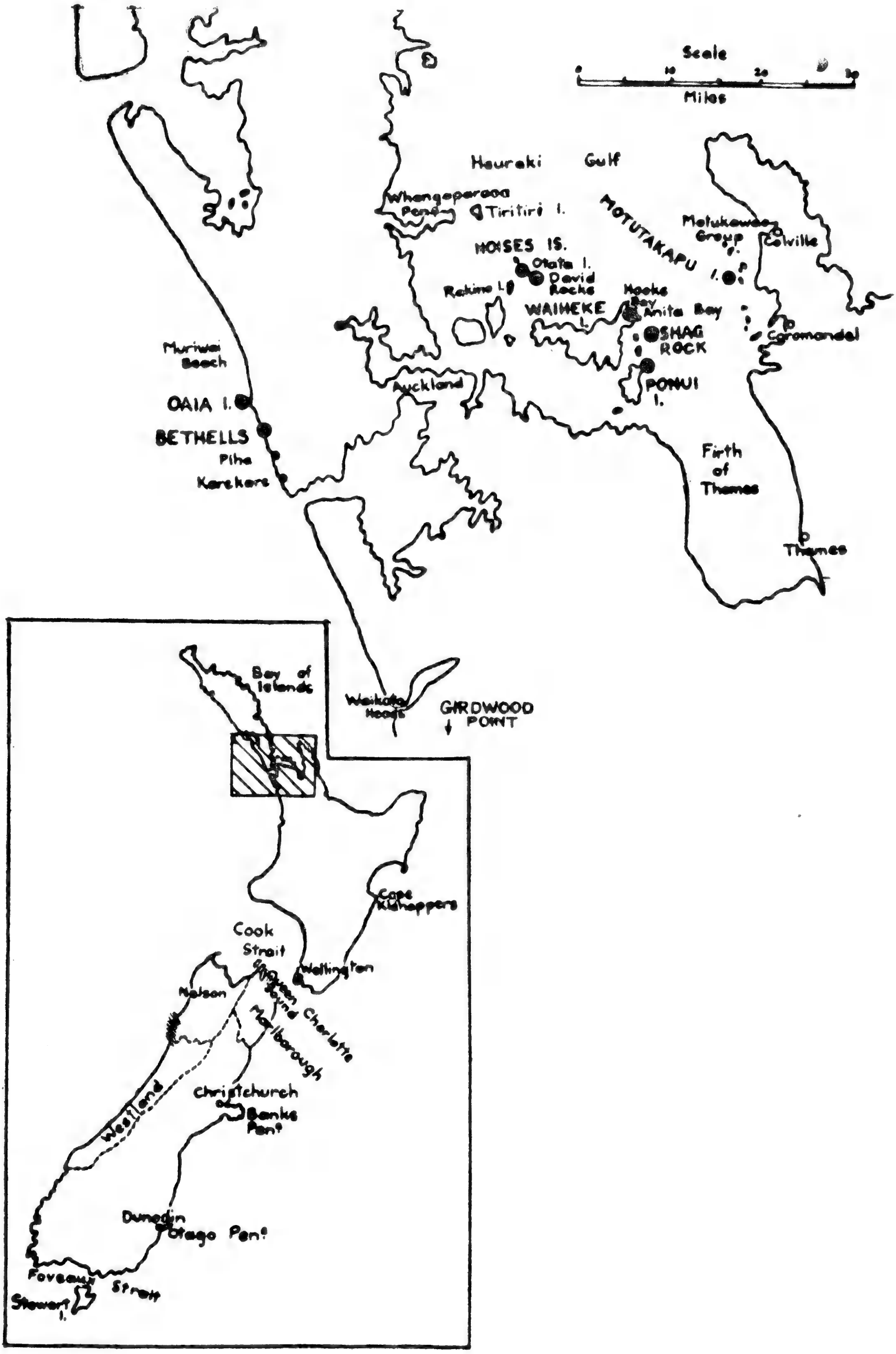

Text Fig. 1.
Location of breeding stations of the spotted shag.

in the Auckland area, except for a specimen from Banks Peninsula in the Dominion Museum, and one from Queen Charlotte Sound in the Auckland Museum collection, mentioned below.

I wish to express my thanks to Mr. O. Petersen and Mr. P. A. S. Stein for permission to incorporate their invaluable field records which form the basis of much of this paper. The fine series of photographs of several different pairs at successive stages taken by Mr. Petersen has enabled the plumage sequences to be very greatly clarified, and I am particularly indebted to him for permission to include them here.

Others who have kindly provided field notes are Miss N. Macdonald, Dr. R. A. Falla, Dr. W. R. B. Oliver, Mr. A. N. Breckon, Mr. J. C. Davenport and Mr. R. Moynihan.

NOTES ON COLONIES IN THE AUCKLAND AREA.

a. East Coast Colonies.

In 1910, according to Falla (1932), the spotted shag had an extensive distribution in the Hauraki Gulf, colonies being present at the following points: islands off Tiritiri, the Noises, Rakino Island, Waiheke Island, Shag Rock, and off Coromandel. After this date the colonies suffered severely from shooting, until in 1932 Falla had evidence of only one colony remaining on the western side of the Gulf. Buddle (1951) refers to the destruction of spotted shags which he saw practised some forty years earlier by shooting parties in the Hauraki Gulf. In a further comment, Falla (1940) states that "for many years the species suffered constant persecution in common with all other species." He adds: "If anything, it suffered more, for its habits are such that it showed no ability to move from an area of persecution and establish itself elsewhere." Measures for halting the process of extermination were taken in January, 1931, when an Order-in-Council giving total protection to the spotted shag came into force.

Falla (1932) considered that by 1932 only one colony remained. This colony, situated in a cave passing through the western shoulder of one of the islets known as the David Rocks, in the Noises group, is a well-established one at present. It has probably increased in numbers since the above date, and nests now extend on to the rocky slopes of the islet round the cave entrance.

A further colony can now be recorded on the Noises Islands. At least within recent years, spotted shags have also bred on cliffs on the north-eastern coast of the main island of the group, Otata Island. An attempt to breed here is believed to have been made in the 1934 season, but the birds suffered from shooting in spite of protection (pers. comm. R. A. Falla). Sibson (1948) reported nesting on 1st December, 1946, and found the colony "firmly established" on 21st December, 1948 (Sibson, 1950). According to Davenport (1951), on 2nd April, 1950, the colony consisted of approximately 40 birds, some on nests. It was occupied on 4th April, 1954, and in late August, 1954, according to notes from N. Macdonald and R. Moynihan respectively. Whether this colony has been regularly occupied since 1934 is thus uncertain, but it is of interest that none were present on 24th March, 1956, although the birds had roosted in the area fairly recently (Turbott).

Records kept by Stein since about 1919, show that Falla was incorrect in his belief that only the David Rocks colony remained at the height of persecution in 1931. Throughout the period of Stein's observations portion of the present colony situated near the eastern point of Waiheke Island was recorded. This colony has at different times consisted of three distinct groups close together on the same rocky headland, although only two of these sites are at present being used. The oldest portion occupies a cave at the northern end, and has been observed since *c.* 1919 by Stein. In a second cave to the south breeding was observed each season in the period 1924-1927, but not afterwards until 1951 and 1954, when attempts at nesting were unsuccessful. Situated roughly between these two, a third group breeds in a relatively conspicuous position on a cliff face (the "Terraces" in Stein's records). According to information from W. R. B. Oliver it was in occupation in 1916, and a photograph published by Oliver (1930a) was taken there. Stein records that in 1927, after the southern cave was abandoned, a few nests were built on the "Terraces." This group gradually increased, and has been present every year, with the exception of 1952; the greatest number recorded has been 90 birds. References to recent observations at this colony are given below in the section on breeding cycle in the Auckland area. It is located on the rocky point between Hooks Bay and Anita Bay.

Apparently the largest of the early colonies was on Shag Rock (Tarakihi Island), which lies a little over two miles to the south-east of the east point of Waiheke Island. According to Stein's observations it consisted in August, 1914, of four separate groups on the north-eastern cliffs of the island, and one additional group on the north-west corner. Stein's information continues that the birds suffered an attack in 1919, resulting in almost complete annihilation. Small numbers continued to breed until 1930, but the colony was then entirely deserted. In December, 1923, breeding was first observed some three miles to the south at the north-eastern end of Ponui Island, and it was Stein's impression that the stage of near extermination on Shag Rock was followed by a period when breeding was being attempted at both localities. The colony on Ponui Island appears to have increased gradually. Stein counted 90 in nuptial plumage on a visit in August, 1949.

On Shag Rock attempts were made at nesting in the mid-1940s*, and again at a new site in 1952, but all attempts were doubtfully successful until December, 1955, when Stein observed about 40 nests on three of the original cliff-sites. On a visit on 10th January, 1956, well-grown chicks were seen.

Observations by Cox (1946) are of interest in showing continued disturbance of the spotted shag in recent years in spite of protection since 1931. Some twenty newly constructed nests were observed on the north-east coast of Shag Rock on 11th September, 1945, but a month later the nests contained egg fragments, and no birds were seen. Buddle (1951) refers to the shooting of spotted shags at a colony in the Hauraki Gulf as recently as 1950.

A habitat group of spotted shags in the Auckland Museum was constructed by L. T. Griffin, using specimens obtained at Rakino Island

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* Roberts (1943, 1944) reported breeding 1942-44, and Cox (1946) in the 1945 season, as mentioned later.

and Shag Rock in 1914: the background by the well-known landscape artist Kennett Watkins represents the early colony on Shag Rock.

On the eastern side of the Hauraki Gulf, there has apparently been a colony continuously during the above period on Motutakapu Island, one of the islands off Coromandel Peninsula to the south of Colville (Motukawao group). A. N. Breckon observed the colony on this island during the period 1920-30, and Stein has made regular observations since 1952. During recent years at least, this has been a small colony, according to Stein never containing more than 30 birds. Chicks were seen in the nests on 9th April, 1955. The colony is situated near the south-western point of the island, which is approximately 12 miles distant from the nearest colonies in the western Gulf on Shag Rock and Waiheke Island.

b. West Coast Colonies.

Three colonies are known, in an area which is somewhat different from the Hauraki Gulf ecologically, the coast being exposed, with generally a considerable swell and much heavy surf from the Tasman Sea.

The largest colony is that on Ihumoana cliff at Bethells (or Te Henga), 25 miles by road west of Auckland. The colony was first mentioned by Falla (1932), and has recently been observed regularly by Petersen as described in the present paper.

Judged by telescope and binocular views from the mainland coast, it has seemed probable that a colony existed on Oaia Island, which lies nearly a mile offshore at the south end of Muriwai Beach, and about 3½ miles north of Bethells. G. and A. T. Wightman have made landings during the past five years, and according to their observations (Wightman, 1953, and Wightman, 1956) the colony, situated low down on the north side of the island, contained nests with eggs on 11th November, 1951, and on 29th November, 1953, a nest with well-grown chicks. However, there is still some doubt as to the numbers contained in the breeding colony. The island is generally encircled by surf, often extending to the mainland, and landing earlier in the breeding season is likely to be difficult.

Spotted shags which are washed up fairly often on the west coast beaches from Muriwai to Karekare are evidently from either the Bethells or Oaia colonies (*cf.* Sibson, 1946).

The third colony on the west coast is about 50 miles to the south, and is included here as it is the only other colony on the west coast of the North Island. This is at Girdwood Point, a short distance to the south of Kaawa Creek and about nine miles south of Waikato Heads. The colony is situated both on the mainland cliff and on a tall basalt stack (Cylinder Rock) separated from the mainland by a narrow cleft. E. S. Richardson, the first to describe this colony, observed small naked chicks on 20th April, 1946 (Turbott, 1947). Sibson (1952) gave an account of a visit on 19th October, 1951, when the colony contained at least 175 pairs of breeding birds, most of which had nests with eggs.

BREEDING CYCLE AND PLUMAGE SEQUENCES.

The spotted shag has a relatively long breeding season, and most of the birds probably remain in the neighbourhood and return to the colony to roost for a great part of the year. However, it has been observed, or collected, at a considerable distance from any of the breeding stations, and movements from the breeding areas are at present mainly unknown. According to Stead (1932), parties of adults and young go on journeys up or down the coast after the breeding season, and they reach Motunau Island, some 50 miles north of the Banks Peninsula colonies.

There may also be a considerable lag in breeding at any one colony, with differences of some weeks between laying, and possibly more than one breeding peak.

The plumage sequences include the seasonal assumption of crests, decorative plumes and a distinctive head pattern. The terminology used is that adopted by Murphy (1936), whose discussion has greatly clarified the plumage changes in other southern hemisphere shags—*Phalacrocorax atriceps, Phalacrocorax albiventer, Phalacrocorax magellanicus*—in the South American region. According to Murphy, in *P. atriceps* the pre-nuptial moult occurs in the late southern summer, so that "breeding" plumage is at its height by the end of June. At this time (June-July) the gonads also begin to enlarge. With actual mating and egg-laying, a prominent feature of this plumage, the crest, is lost and the birds enter upon a distinctive stage, nuptial plumage proper. In *P. atriceps* a feature of the latter plumage is the appearance of a white alar bar. Murphy (p. 885) states that "the height of plumage should not be called a 'breeding' garb, but rather a pre-nuptial plumage, at its best during the early part of the rather lengthy courtship which precedes the nesting season," while the later stage, when the eggs are laid, is more appropriately termed nuptial plumage.

The next phase, according to Murphy, comes at the annual (or post-nuptial) moult, which results in the replacement of both the quills and body plumage, accompanied in *P. atriceps* by the appearance of a distinctive patch of white feathers on the back. This stage should be termed the post-nuptial, for as Murphy points out (p. 884) it "begins early during the nesting period as with most other cormorants": it is thus misleading to use the term "winter plumage" for this stage, which appears in the late spring and summer. The term "non-breeding plumage" must also be avoided, as the plumage is assumed while the nesting season is still in progress.

The use of the terms *pre-nuptial*, *nuptial* and *post-nuptial* suggested by Murphy for the seasonal plumages of the adult is most helpful, and has been adopted in the following account. Table 1 shows the phases of the breeding cycle and adult plumages, derived mainly from Petersen's notes and photographs of the spotted shag at Bethells. The information obtained by this observer is the most complete so far available, but differences in the annual cycle at other breeding stations are discussed later in this account.

Table 1. Spotted Shag: Breeding Cycle and Adult Plumage at Bethells.

Season	Decorative plumes	Crests	White head and neck line	Plumage is termed:
Pre-nuptial (begins April-May)	present	maximum	present	PRE-NUPTIAL
Egg-laying (begins August)	absent	abraded and partly moulted	present	NUPTIAL
Rearing of young (begins September)	absent	lost	obscured	POST-NUPTIAL

The above sequence is similar to that described by Murphy (p. 884) for *P. atriceps,* which is given in Table 2 for comparison (plumage terms have been added).

Table 2. *Phalacrocorax atriceps:* Breeding Cycle and Adult Plumage, according to Murphy.

Season	Crest	Alar bar	Dorsal patch	Plumage is termed:
Pre-nuptial	maximum	absent	absent	PRE-NUPTIAL
Egg-laying	abraded	present	incipient	NUPTIAL
Rearing of young	lost	maximum	maximum	POST-NUPTIAL

Note.—Of the two other South American species referred to earlier, *P. albiventer* is characterised in nuptial plumage by an alar bar, but in post-nuptial plumage this species has no white dorsal patch. In *P. magellanicus* the whole of the chin, throat and foreneck is black in pre-nuptial and nuptial plumage, but becomes white in post-nuptial. The crest is lost in both species before the post-nuptial plumage is assumed.

The following is an outline of the details of the breeding cycle, and corresponding plumages, observed at the Bethells colony by Petersen during 1952 to 1955. According to these observations, pre-nuptial plumage is assumed as early as the last week in April, and many birds have been observed in full plumage in May. There may evidently be some lag in breeding activity, as birds wearing their decorative plumes, and apparently mated, have been seen as late as 1st September. In the same part of the colony nests may contain eggs when adjacent nests have young almost ready to leave, and the last young may not be ready to fly until the end of February.*

The chief characteristics of the pre-nuptial plumage (Fig. 1) are the two fully-developed crests, the black throat and, in contrast, the wide line of white on either side of the head and neck. In addition, an often profuse decoration of narrow white plumes is scattered over the nape, back, rump and flanks.

In July, nest-building generally begins in earnest: the birds are seen carrying long sections of seaweed, or green cliff herbage, and the colony generally contains well-built but empty nests.† Until this time they sit about the colony with a certain amount of courtship.

* The seaward (western) portion of the colony is the earliest to start, according to Petersen's records, and is from three weeks to a month more advanced than the more inland (eastern) portions, occupying the inner cliffs.

† Carrying of nest material was observed in the first week in June at Bethells (Turbott, 1946).

The transition from pre-nuptial into nuptial plumage is characterised by the loss of the decorative plumes and the reduction of the crests by wear and moult. The period during which the plumes is retained is very variable, according to Petersen's observations, and apparently they are not developed at all in some birds. In many birds they are lost after only a few weeks, but they may remain for much longer and even persist very exceptionally until the eggs have been laid. The crests generally become much reduced before egg-laying, and disappear soon afterwards. There is thus a period of perhaps two months (June-July) when most birds have lost the decorative plumes, but are characterised by the black throat, white stripe on head and neck, and distinct but diminishing crests (Figs. 2-4): the nuptial plumage.

The earliest eggs observed were found in the second week in August, but laying may evidently begin even earlier, as a chick was found just hatched on 1st September. Incubation takes over four, and less than five, weeks, according to Petersen's observations. Both parents incubate, and the change over was observed on several occasions.

With the laying of their eggs the birds enter upon the post-nuptial moult, according to Petersen's observations. By the time of hatching both parents have changed into post-nuptial plumage. As mentioned above, the crests are soon lost, and brown or greyish-brown flecks appear on the white line as early as egg-laying, gradually increasing until hatching. The black throat becomes mottled with grey and white, or may even become a featureless pale grey or almost white (see below under "adult plumages"). The dark line down the mid-line of crown and hind-neck also becomes greyish brown. The effect of these changes is to reduce the tone of the striking head and neck colouration by replacing it with more or less mottled grey and white, but the rate of change varies greatly, and the degree of pattern on the head and neck varies in post-nuptial plumage (Figs. 6-10).

The fledging of several chicks took about nine weeks, at which stage the young were observed to fly. The earliest record for a newly-hatched chick was 1st September, and the latest was the third week in December. On the more open slopes, the fledglings tend to clamber about away from the nests when only six to seven weeks old, but on narrow ledges cut off from the rest of the colony the entire fledging period of individual chicks could be observed. At this stage the most notable feature of the colony is the resemblance superficially between the young in their juvenal plumage and the post-nuptial adults, especially those in the "greyer" type of plumage. The juvenals can be distinguished by the brownish lower back and flanks, white under tail-coverts and, at close range, by the pinkish facial skin. The spots on the back are much less pronounced than in the adult.

The following are notes on material in the Auckland Museum, chiefly from the Hauraki Gulf, where collections were made some years ago, and from west coast beaches, where more recently a series of storm-killed birds has been obtained. In addition to the record of plumage sequences by Petersen, information is included from my own field notes.

Juvenile Plumages: Nestling

The naked chick has a dark lead grey skin; in a chick examined at the David Rocks, Hauraki Gulf, on 11th May, 1935, the first down was just appearing as a sparse coat, dark above and whitish below (Turbott).

The first nestling down, which is described by Oliver (1955) as "dark brown above, whitish below," is shown in Petersen's photographs of the younger chicks (Fig. 9). There are several specimens, all apparently of about the same age, in the Auckland Museum collection (Nos. AV. 96.6, included in exhibition group; 96.106 and 96.107). A noteworthy feature is the brownish face and under-parts. However, in AV. 96.107 the face is white, and the head pattern in this down may well prove to vary considerably. It seems probable that the under surface gradually becomes whiter as the second down is acquired.

The second down is shown by a fledgling in the collection, AV. 96.101, found on Bethells Beach, 8th December, 1951. In this there is a very distinct demarcation between the ashy-brown of crown, hind-neck and dorsal surface, and the under surface, which is white including the face to the level of the eye and the fore-neck. Only a trace of brown appears on the breast and abdomen. The quills and scapulars are well grown. Small filoplumes are scattered through the down on the hind-neck. The bare facial skin and gular pouch, which are pinkish in life in both fledglings and juvenals (Turbott), were a faint greenish-blue in the fresh specimen. The feet appear flesh-coloured in life, but in the fresh specimen had faded to a dull yellowish grey; the tarsus, outer toe and webs with brown shading. Fig. 10 shows nestlings at this stage.

Juvenal

As already mentioned, this can be recognised fairly readily by several characters in the field, the most satisfactory being the whitish under tail-coverts only faintly shaded with brown. The under tail-coverts and lower half of the abdomen in later plumages are dark grey to deep greenish black.

A juvenal, AV. 96.102 (Bethells Beach, 8th December, 1951) has the upper parts and thighs grey brown, faintly glossed with green on the lower back, upper tail-coverts and thighs; and the wing and tail quills dark brown. The chin is white, merging with the pale brown of the sides of the head, fore-neck and upper breast. The abdomen and under tail-coverts are white lightly shaded with brown. The feathers of the mantle, scapulars and wing-coverts have greenish-brown tips, the spots so formed being relatively faint. Filoplumes are present on the hind-neck and thighs. In this specimen the coloration of the facial skin and feet was similar to the fledgling described above (AV. 96.101), but there was more brown shading on the feet. Petersen's photographs also show this plumage (Fig. 11).

Oliver (1955) gives a detailed description of the juvenal plumage under the heading "immature," but states that there is a "stripe on side of neck mottled ashy brown and white," a characteristic of sub-adult or adult post-nuptial plumage.

Sub-adult

Information at present remains inconclusive on the later immature plumages and little can be added without larger collections, or further field work based upon ringing. It is doubtful whether classification as immature on labels, based on the condition of the gonads, is reliable. The labels have thus not been followed except when confirmed by plumage characters in the following material.

According to Stead (1932) the spotted shag breeds at the end of its first year, a conclusion based on the presence of a group of birds in the colony moulting into "mating plumage" some two months later than the main colony. These birds, which occupied an area near the colony, were considered by Stead to be the young of last year's breeding season. Some individuals were still in full juvenal plumage, and according to Stead were no doubt "late-hatched ones of the previous year."

The presence of a similar group of presumably sub-adult birds towards the outskirts of the colony, moulting into pre-nuptial plumage at a late stage in the nesting season, was noted by Petersen at Bethells.

Falla (1932) stated that the juvenal plumage is followed at the next moult by a stage which, according to his description, corresponds in most characters to the adult post-nuptial plumage. The description includes the statement: "The stripe down the side of the neck remains mottled ashy brown and white until the assumption of the nuptial ornaments consisting of frontal and occipital crests, and extensive series of elongated white feathers of fine texture." However, the two specimens (AV. 96.3 and 96.72) upon which the description is based are both of the type with a fairly definite pattern on the head and throat, and show no characters to distinguish them from the strongly-patterned type of adult in post-nuptial plumage. Falla also examined two specimens moulting out of juvenal plumage (AV. 96.5, 96.71).

The series in moult described below shows that the post-juvenal moult, when the birds probably pass into a "post-juvenal" plumage, occurs not long after the breeding season. The most advanced of the specimens (AV. 96.84, 96.90, 96.108) have almost completely changed into a plumage which is indistinguishable from the "greyer" type of post-nuptial adult. However, the material is insufficient to indicate whether this coloration is constant at the post-juvenal stage, so that at present no distinction can be drawn between this stage and the corresponding adult plumage (adult post-nuptial). Stead's observations suggest that this is followed by a "first pre-nuptial plumage" which is apparently indistinguishable from adult pre-nuptial plumage.

Specimens in the Auckland Museum collection at some stage of moult out of juvenal plumage are as follows:

No. AV. 96.5 *Bay of Islands; 1896.* Throat and fore-neck lightly shaded with grey. New spotted plumage on mantle and scapulars, mixed with some faded brown feathers. Black upper tail-coverts appearing at base of tail. Flanks brown. Under tail-coverts still whitish, but a group of dark grey feathers at the vent.

AV. 96.71. *Female; Thames; 29th June, 1882.* New spotted plumage on mantle and scapulars, with some faded brown feathers. Black over base of tail, but otherwise in juvenal plumage.

AV. 96.84. *"Juv. male"; Muriwai Beach; 12th May, 1933.* Faint grey shading on throat and fore-neck. Mantle and scapulars almost completely replaced; greenish-black feathers scattered over hind-neck, lower back and rump, above base of tail, and a few on the flanks. Under tail-coverts white, with scattered dark grey feathers. Two new black middle tail quills; remaining quills much faded.

AV. 96.90. *Immature female; Muriwai Beach; 27th August, 1935.* As adult post-nuptial plumage, except for the much-faded wing-coverts where replacement is beginning, some remaining brown feathers on the flanks, and two faded tail quills. The throat and fore-neck are lightly shaded with grey, as in AV. 96.84. The lower abdomen and under tail-coverts are dark grey, darkest on the under tail-coverts. The whole remaining under-parts are suffused with pale ashy grey. It will be noted that, but for juvenal characters recorded above, this specimen might be regarded as a post-nuptial adult of the palest type quite frequently observed amongst breeding birds.

Av. 96.103. *Female; Muriwai Beach; 18th May, 1951.* Much like AV. 96.5 and 96.84, but fewer feathers replaced on the mantle and scapulars; less advanced than AV. 96.84 on lower back and flanks.

AV. 96.108. *Muriwai Beach; 21st May, 1934.* Like AV. 96.84, but all the upper-parts replaced except the faded wing-coverts (replacement beginning). A good deal of brown remaining on the flanks. Lower abdomen and under tail-coverts almost replaced by dark grey, but scattered white feathers remaining in front. In addition to the two middle tail quills, two side quills are being replaced. The under-parts suffused with pale ashy grey as in AV. 96.90.

AV. 96.110. *Piha Beach (West Coast); 12th February, 1956.* This specimen was decomposed and only a wing was kept. It was at an early stage of the post-juvenal moult, having new black-tipped feathers under the juvenal feathers on the mantle and scapulars. Wing coverts and scapulars faded to pale greyish brown.

All the above specimens show, in addition to the characters described, a faded region on the wing coverts, and, in the less advanced specimens, on the scapulars. This marking is prominent in the field and is referred to by Stead (1932) as "pale sandy yellow." When the juvenal plumage is first acquired the wing coverts have dark-brown spotted tips as noted above, but the soft feathers of this plumage tend to wear rapidly at the tips. This is accompanied by fading, especially on the scapulars and wing coverts.

In two of the above specimens (AV. 96.90 and 96.108) the lower abdomen and under tail-coverts have changed to dark grey. This coloration may be an immature character, but it should be noted that a breeding bird photographed by Petersen (Fig. 3) shows dark grey between the thighs. There is also a variable amount of dark grey, often mottled with black, on the anterior portion of this region in specimens which are otherwise in adult plumage, and in some as little as a trace of dark grey on the black. The latter include both sexes in nuptial and post-nuptial plumage.

The following specimen (the only one in the collection from this locality) is included tentatively under this heading:

AV. 96.78. *Immature; Queen Charlotte Sound; 26th August.* Plumage like the adult post-nuptial, having a white stripe on head and neck, flecked with brown; throat dark grey faintly mottled with pale grey and white; greenish-black feathers appearing on the crown and hind-neck, and well developed on the anterior mantle. Crests sprouting beneath the feathers. Filoplumes present on hind-neck and back, and abundantly on the flanks.

This is possibly a sub-adult, as the greater wing-coverts are faded, although the remaining wing-coverts and scapulars have all been replaced. In addition, it is evidently in the process of changing into pre-nuptial plumage. By this season (26th August) at Bethells, only young of the previous year would be at this stage; and at the Noises Islands, Hauraki Gulf, the pre-nuptial moult would be mainly earlier in the year. It might, however, be a post-nuptial adult from a later breeding colony (such as that on eastern Waiheke Island). Perhaps some fading occurs during the later stages of the adult post-nuptial moult.

Observations were also made on a visit to the David Rocks (Noises Islands) colony on 3th March, 1956. A bird changing out of juvenal plumage observed closely showed the much abraded juvenal feathers on the mantle and scapulars, amongst which a dozen fresh grey feathers with black tips were conspicuous. There were fresh dark feathers above the base of the tail, but otherwise the back and flanks were apparently still brown; the tail quills were partly replaced. The under tail-coverts were whitish, and the head and neck coloration like the juvenal. The bare facial skin in this sub-adult bird was chrome yellow, whereas in post-nuptial individuals observed at the same time, and presumed to be adults, the skin was yellow distinctly tinged with olive-green. The feet were mainly dark brown, slightly pinkish. (Turbott.)

Adult Plumages: Pre-nuptial and Nuptial

There is a series in various stages of pre-nuptial and nuptial plumage in the collection. The following is a brief description of the plumage at these two stages: The side of the head, throat and fore-neck are dull black, with a faint green gloss; above this a line of pure white extends down the side of the head and neck, and continues but becomes narrower between the mantle and fore-neck, until it reaches the wing. The crests, crown and a narrow line on the hind-neck are black, with a brilliant green gloss; glossy greenish black extends on to a wider zone on the anterior portion of the mantle, and there merges with the spotted dorsal plumage. The posterior mantle, scapulars and wing-coverts are ashy brown, each feather bearing a greenish black terminal spot; the wing quills are brown with a grey bloom. The lower back, rump and upper tail-coverts, continuing below to the flanks, under tail-coverts and lower abdomen, are glossy greenish black. This meets the abdomen at a distinct line across the body, linking the thighs*. The breast and upper abdomen are pale silver-grey. In pre-nuptial plumage, white decorative plumes may almost completely hide the dark mid-line of the neck, and sometimes occur on the mantle, back and rump, and on the thighs.

Notes on a specimen in nuptial plumage (AV. 96.105) state: "feet yellow, soles (under toes) dark brown; bill horn colour, brown on top of culmen" (Turbott).

* Variations in the coloration of this region are mentioned under "sub-adult."

The bare facial skin and gular pouch in pre-nuptial plumage are generally described as dark blue ("rich royal blue," according to Stead) and the ring of beads round the eye greenish blue (for the general appearance of the facial characters see Fig. 1). As already mentioned, birds in post-nuptial plumage, probably adults, observed on the David Rocks on 3rd March, 1956, had olive-green to yellow skin on the face (Turbott). Field notes are recorded by Falla (1932) for a post-nuptial in which the skin in this region was "viridine green." It thus seems probable that the bare skin changes to bluish green, and finally to greenish yellow during the transition into post-nuptial plumage, but confirmation could be obtained by field observation in the breeding season.

The following specimens in pre-nuptial and nuptial plumages are included in the series in the Auckland Museum:

No. AV. 96.1. *Male; Rakino Island; 1886.* Nuptial.

AV. 96.4. *Rakino Island, 1887.* Pre-nuptial.

AV. 96.83. *Female; Muriwai Beach, 12th June, 1933.* Moult is still in progress on the head and mantle, but this specimen is almost in full pre-nuptial plumage.

AV. 96.105. *Female; Muriwai Beach; 15th July, 1951.* Apparently in full pre-nuptial, although there are only a few scattered white plumes on hind-neck and thighs. Two side quills sprouting in the tail (*cf.* Murphy, *ibid.,* with regard to the protracted period required for the replacement of the quills in *P. atriceps,* moult still showing in some specimens as late as April).

The observations made at Bethells by Petersen show evidence of the change out of nuptial plumage soon after egg-laying. The crests have been lost and the white lateral line obscured by the time the eggs hatch. However, Petersen's photographs taken at a considerably later stage, some two months after laying, provide some evidence that the period taken to moult the black throat may be variable. By this time, the moult of these black feathers is complete, or almost complete, in some individuals (Figs. 7 and 9). However, in a number apparently mainly with the more pronounced type of head pattern (Figs. 6 and 8), there are still plentiful scattered black feathers on the throat. These appear to be wholly lost before the next pre-nuptial moult, as specimens of this strongly-patterned type changing again into pre-nuptial plumage are included in the collection, and show fresh black feathers on the throat, which is otherwise mottled dark grey and white.

It is not possible at present to distinguish between the sexes in the field. Petersen found that, of the three pairs which he photographed, one bird appeared to be smaller and was more confident at the nest. In each pair, the smaller was the duller in nuptial, and of the "greyer" type in post-nuptial, and was considered to be the female. However, the specimens in post-nuptial plumage mentioned below include both males and females with both types of pattern.

The principal changes marking the transition to post-nuptial plumage are: (a) *The appearance of brown or greyish brown feathers as flecks in the white line.* These occur along the whole length of the white line, and may even be so numerous that the line is practically obscured (Figs. 6 and 8). They are present in both sexes in the collection, and persist in specimens which are moulting again into pre-nuptial plumage. In the "greyer" type of post-nuptial individual the line is indistinct, as the greyish brown on crown and hind-neck becomes merged into almost the same shade on the side of the head and neck (Figs. 7 and 9). (b) *Mottling of the throat region,* again with considerable variation ranging from individuals with pronounced mottling to those showing the extreme "greyer" coloration. In the former, the throat is uniform dark grey, or mottled dark grey and white, in the post-nuptial plumage; black feathers may be present, but, as mentioned above, it is uncertain how long these are retained. The "greyer" type is a featureless pale grey with a white chin in extreme cases, but the chin and throat are quite commonly a darker shade of grey, mottled more or less with white. As shown by a specimen (AV. 96.89) included below, replacement of the black throat starts on the chin round the base of the bill, and Oliver (1955) has a photograph (p. 231) of a bird, wrongly stated to be "immature," which is evidently at about this stage.

The following specimens illustrate several stages of transition to post-nuptial plumage:

AV. 96.89. *Female, Muriwai Beach; 7th September, 1936.* In nuptial plumage, but with a few scattered brown flecks on the dorsal half of the white line, and dark grey feathers appearing on the black chin at the base of the bill.

AV. 96.3. *Female; Whangaparaoa; 5th September, 1896.* Brown flecks present on the white line. Grey, white and black feathers on the throat. On the crown, hind-neck and mantle there are still greenish black feathers in the new grey-brown plumage.

AV. 96.72. *Waiheke Island.* Throat dark grey, mottled with white. Crown and hind-neck greyish brown, white line indistinct and narrow. Some dark greenish black feathers on the lower hind-neck and mantle.

AV. 96.77. *Male; Noises Islands; 30th May, 1932.* Similar to AV. 96.72, but the throat is dark grey only faintly mottled with pale grey and white. Filoplumes are numerous on the head, and there are a few short decorative plumes on the hind-neck. Although collected at such an early date, this bird appears to have performed the post-nuptial moult, but breeding begins considerably earlier at the Noises Islands (David Rocks) than at Bethells (see below). It may be coming into pre-nuptial moult, although apart from the dark feathers on the hind-neck and mantle no signs of this are yet present.

Through the courtesy of Dr. R. A. Falla and Mr. C. McCann a further specimen has been received on loan from the Dominion Museum, Wellington (DM. 1837). It is a female collected off Lyttelton, 28th January, 1926, by R. H. Beck, and is of special interest as it is in the palest "greyer" type of post-nuptial plumage, and shows a sprinkling of black feathers in the grey plumage on either side of head and fore-neck. There is no evidence of moult, and, as suggested above, these black feathers have apparently persisted until a late stage, but would probably be lost before the next pre-nuptial moult.

Post-nuptial

The collection includes two specimens in the "greyer" type of post-nuptial plumage. The throat in both specimens is mottled with dark grey and white, forming an indistinct grey shadow. The crown and hind-neck are greyish brown, with a faint green gloss, darkening only slightly on the mantle. These specimens are:

AV. 96.79. *"Immature" male; Karekare Beach (West Coast); 26th February, 1933.* (Labelled "immature" but there is no basis for this on plumage characters.)

AV. 96.82. *Female; Karekare Beach; 4th April, 1933.*

In addition, the following specimens are evidently in the process of changing into pre-nuptial plumage:

AV. 96.80. *Female; Noises Islands; 28th March, 1933.* Crests well-developed, and perhaps still growing. New dark feathers growing and already abundant on crown, hind-neck and mantle. Brown feathers still sprinkled in the already distinct white line. Filoplumes on head and neck, including throat; some sho t decorative white plumes on the hind-neck and flanks. The chin and throat still show some grey and white feathers, but many new black feathers have appeared, giving a dark grey effect generally. A side tail quill sprouting and the two central quills only half grown.

AV. 96.87. *Female; Hauraki Gulf; 30th April, 1935.* Like 96.80, but more black feathers have appeared on the chin and throat, which has a generally darker appearance. The crests are not so strongly developed.

AV. 96.93. *"Immature"; Muriwai Beach; 12th April, 1942.* The white line is much less evident than in the two specimens above, being still almost obscured by brown feathers; new dark feathers are less abundant on the crown, hind-neck and upper mantle. The crests are short, but sprouting. There is only a sprinkling of black feathers on the chin and throat mixed with the grey and white. A few filoplumes on the crown and hind-neck, and scattered short white decorative plumes on the lower back and flanks. Some faded brown quills in the tail, but mainly replaced. (Labelled "immature" but see AV. 96.79.)

AV. 96.94. *Female; Muriwai Beach; 12th April, 1942.* Resembles AV. 96.93 closely, but decorative plumes almost absent on the lower back; the white line is less heavily flecked with brown.

BREEDING CYCLE IN THE AUCKLAND AREA

As Petersen's observations at Bethells show that the colony there follows a fairly regular annual cycle, in the present section this cycle is compared with the information available from other colonies in the Auckland area.

Unfortunately, there are only somewhat scattered observations on colonies at the Noises Islands, and the large amount of field work by Stein refers mainly to the eastern Waiheke Island colony, where breeding is evidently exceptionally irregular. The opportunity is taken to include in this section some additional notes on the Bethells colony.

At the Noises Islands, the colony situated for so long in and outside the entrance to a cave at the David Rocks seems to have a generally earlier breeding season than the one at Bethells. Falla (1932) found that "the cavern-dwelling colony that alone now represents the species on the western side of the Hauraki Gulf has for some years past been breeding in mid-winter." He says: "Full nuptial plumage is present in most of the birds in May, by the end of which month in 1932, about twenty new nests of green *Mesembryanthemum australe* had been built up, but no eggs laid." However, the season may be prolonged until October, eggs having been observed in this month, and the season thus extends almost as late as the Bethells colony.

Some 200 birds were counted when the colony was visited on 3rd March, 1956, but examination of the cave showed that nesting had not yet started. In addition to the juvenals mentioned earlier, several adults were seen with the white stripe already distinct on head and neck, and the position of incipient crests could be seen in one bird observed at close quarters (Turbott). It is worth noting that this is approximately one month before the first birds assume pre-nuptial plumage at Bethells according to Petersen's observations. On a visit to the latter colony only six days earlier, on 27th February, none had been seen changing plumage (Turbott).

The earliest breeding record at the David Rocks was made on 11th May, 1935, nearly three years after the account by Falla (1932). The colony was then low in numbers, only about 54 birds being present. Of these, a number were in pre-nuptial or nuptial plumage and one nest contained three young chicks in sparse down. There were also a number of empty but completed nests, substantially built of seaweed and ice-plant, *Mesembryanthemum australe* (now *Disphyma australe*). Some birds were in non-breeding plumage, and were apparently either the earliest adults in post-nuptial, or those not yet changed into pre-nuptial plumage. Further, the colonies at this season also contain sub-adults, still at the post-juvenal stage, which, as mentioned above, it is not yet possible to distinguish from the adults. (Turbott.)

The colony was examined by Stein on 31st March, 1956, but only one bird showed signs of pre-nuptial plumage: the throat was almost black and dark feathers were present on the crown. There were also incipient crests, still almost hidden.

From these observations, it is evident that the onset of breeding is irregular in this colony, or has changed since the period of Falla's observations. Further, the period between the pre-nuptial moult and egg-laying—a full three months at Bethells—may prove to be comparatively short at the David Rocks, as the earliest hatching recorded is in early May (laying approximately a month earlier), but the pre-nuptial moult was evidently just beginning on visits on 3rd and 31st March. A connected series of several years' observations are now needed on the breeding cycle in this colony.

Evidence is also given by Cox (1946) of much later breeding at this colony, as nests were being reconditioned and built on a visit on 31st July, 1946. One nest contained two eggs, apparently well incubated. Fleming (1940) visited the colony on 6th August, 1938, and found "nest building in progress, four well-grown young and three clutches of fresh-looking eggs." Fleming also reports that in October, 1939, there were "all stages of young and eggs."

Two specimens, included in the section above, may be mentioned, as they give additional information in relation to the David Rocks colony. In AV. 96.77, as already mentioned, it is likely that the post-nuptial moult is almost complete, although alternatively the specimen may be just entering into the pre-nuptial moult. In the former case, the date of collecting (30th May) would correspond to the earliest hatching at the colony. In AV. 96.80 pre-nuptial plumage is being assumed on 28th March, and laying and hatching would probably in this case be considerably later. Unfortunately, full data are not given with several earlier specimens from the Hauraki Gulf.

On Otata Island, the largest island of the Noises group, the colony may not be regularly occupied, as mentioned earlier. The few observations available on this colony are of considerable interest, as the commencement of breeding apparently corresponds to the earliest dates for the David Rocks colony. On 2nd April, 1950, Davenport (1951) found that there were some birds on nests; and on this visit (pers. comm.) saw two nests each containing a clean egg, which had apparently only recently been laid. Sibson (1948) reported approximately 10 nests in this colony, but only four birds were seen during his visit on 1st December, 1946. By this date, the breeding season was probably nearly over.

The colony on eastern Waiheke Island, near Anita Bay, has been observed more systematically by Stein. Two groups included in this colony are relatively inaccessible, as they are cave-dwelling, and Stein's detailed observations on breeding have been made mainly on the cliff nesting portion of the colony (the "Terraces"). In addition to regular visits by Stein, the following are notes on the colony made by other observers: (a) According to Oliver (1930a), eggs were found in January, and a photograph is shown (taken on 1st January, 1916, pers. comm., W. R. B. Oliver). (b) Cox (1946) examined the colony which was "nesting in a small cave, some ten or twelve nests being located on ledges within two or three feet of the cave roof." This visit was on 23rd October, 1945, and the nests that could be examined contained eggs. (c) On 29th September, 1946, according to Buddle, Sibson and Fleming (1947), there were "about 40 birds and 17-20 nests; few adults still crested; of 11 nests, three new and empty, one with three eggs, rest with young up to nine inches high." (d) McKenzie (1948) states that the colony consisted of 55 occupied nests containing eggs or young, when visited by T. M. Roberts on 28th December, 1946. About 55 young, some newly-hatched, were counted on a later visit by McKenzie on 25th January, 1947; and the nests were empty on 23rd February, 1947, although there were still many young in the colony. Finally (e) photographs taken by G. A. Buddle in 1946 of the "Terraces" portion of the colony are shown by Buddle (1951) and Oliver (1955).

A brief summary of Stein's observations gives the following information on the breeding cycle on the "Terraces." A large proportion are in *nuptial plumage* in August. In addition, beginning in 1949, it has been found that a number assume nuptial plumage by the second and third weeks of February. At three separate periods *eggs* are observed: in late August, in December and (observed from 1950) in March. The young chicks are present in early October, January and April. As shown by Stein's observations, these dates represent separate breeding peaks and were not due to disturbance followed by attempts at re-nesting. The peaks have been observed during successive years. It would be of special interest to follow up the breeding cycle in this colony by colour ringing. Although the August and March laying periods evidently correspond to the peaks of nuptial plumage in August and February respectively, there were no observations of nuptial plumage preceding the egg-laying period in December. It will be noticed further that the pre-nuptial stage is not included in the observations, but this would occur, at least before the first peak of breeding, while no visits were being made in mid-winter. Birds in pre-nuptial plumage were not observed before the later breeding peaks.

A few additional notes may be given on the Bethells colony, as these suggest some modification of the annual cycle based on Petersen's records. Fleming (1940) on 11th June, 1939, recorded "incubating, nest material carried," but his field notes (pers. comm.) show that the use of the term "incubating" was not justified as no eggs were seen. Birds sitting on well built or partly-finished nests would suggest that breeding had started some weeks earlier than found by Petersen. Macdonald (1951) notes that there were no young to be seen on 23rd September, 1950, when the landward portion of the colony was examined: it would appear from Petersen's record that young are generally present by this date. Observations on visits on 24th November and 8th December, 1951, conformed fairly closely to Petersen's: fledglings were seen in the nests on 24th November and a number were in juvenal plumage on 8th December, although on this date the least advanced were still downy chicks in the nest (Turbott)*.

On 31st March, 1956, 10 birds were observed fairly closely on the landward portion of the colony, eight clearly showing newly sprouting crests and greyish-black or black throats, as would be expected according to the cycle observed by Petersen. There were several with an almost pure white line on head and neck, but in others numerous brown flecks still present on the line were visible. Two appeared to be in post-nuptial plumage with no signs of moult. (Turbott.)

The only observations from other west coast colonies suggest that the breeding cycle is approximately the same as at the Bethells colony: well-grown chicks in late November at Oaia Island and eggs in mid-October at Girdwood Point. However, it is significant that small naked chicks were observed at Girdwood Point on 20th April, 1946, by E. S. Richardson, and there may be a particularly extended season at this colony, or there may be more than one breeding peak. In addition, there is some doubt regarding the breeding season at Oaia Island, as Fleming (1940) reports finding a "downy chick," probably from this island, washed up on Muriwai Beach on 17th June, 1939. This record suggests that breeding may also be extended here, with the beginning of egg-laying early in the year.

In Table 3 the information available on the David Rocks and eastern Waiheke Island colonies is summarised and compared with the breeding cycle at Bethells.

* Two specimens, a fledgling (AV. 96.101) and a juvenal (AV. 96.102) found on the beach at Bethells on this date are included in the material described earlier.

Table 3. Breeding Cycle of the Spotted Shag at Bethells and in the Hauraki Gulf.

	Roosting on site of colony. (Post-nuptial plumage)	Courtship, nest-building. (Pre-nuptial and nuptial plumage)	Eggs laid. (Nuptial plumage)	Young hatch. (Post-nuptial plumage)	Young leave the nest. (Post-nuptial plumage)
Bethells	Feb.-April	begins April-May	begins August	begins September	begins November
Eastern Waiheke I.	?	Nuptial plumage Aug. (pre-nuptial and nuptial suppressed?)	late Aug.	early Oct.	no records
			December	January	
		Nuptial plumage Feb. (pre-nuptial suppressed?)	March	April	
David Rocks (Noises Is.)	?	April —?	April, July, Aug., Oct. (scattered records only)	May, Aug., October (scattered records only)	no records

A major factor, which may have affected breeding times and resulted in the differences in breeding season between the Hauraki Gulf and the west coast, was the early uncontrolled destruction of the colonies in the Hauraki Gulf. However, as noted above, there is some evidence that Bethells differs from the other west coast colonies (Oaia Island and Girdwood Point), and it is not known whether there was disturbance of any of the west coast colonies. When fuller information has been obtained, a comparison of the breeding cycle at the colonies in the Auckland area may suggest other factors resulting in differences in breeding season from colony to colony.

SUMMARY

1. The past and present distribution of the spotted shag in the Auckland area is outlined. In addition to a colony previously recorded, another colony is known to have survived in the eastern Hauraki Gulf during the period of greatest destruction, 1910-1931.

2. Terminology for stages of plumage as suggested by Murphy for certain South American shags is adopted, as it conforms to data on the colony at Bethells. Field notes on the breeding cycle and corresponding plumage changes at Bethells are given, and material in the Auckland Museum discussed with reference to the field observations.

3. It was not possible to find a satisfactory means of distinguishing between the post-juvenal stage (i.e., the first plumage following the juvenal) and the corresponding adult plumage (adult post-nuptial). An investigation based on ringing would indicate whether this plumage differs from the adult. The first pre-nuptial plumage apparently does not differ from the adult pre-nuptial.

4. The observations on breeding cycle at Bethells are compared with the records available from colonies on the David Rocks and eastern Waiheke Island (Hauraki Gulf), and differences in breeding seasons are briefly discussed.

ACKNOWLEDGMENTS

I am grateful to Mr. E. E. Owen, who has kindly drawn the map showing distribution, and to Dr. R. A. Falla and Dr. C. A. Fleming for their comments on the manuscript.

I am also greatly indebted to the Marine Department and to Mr. E. W. Gilliver, District Inspector of Fisheries, Auckland, for trips to the Noises Islands and Waiheke Island in the patrol vessel M.V. "Ocean Star."

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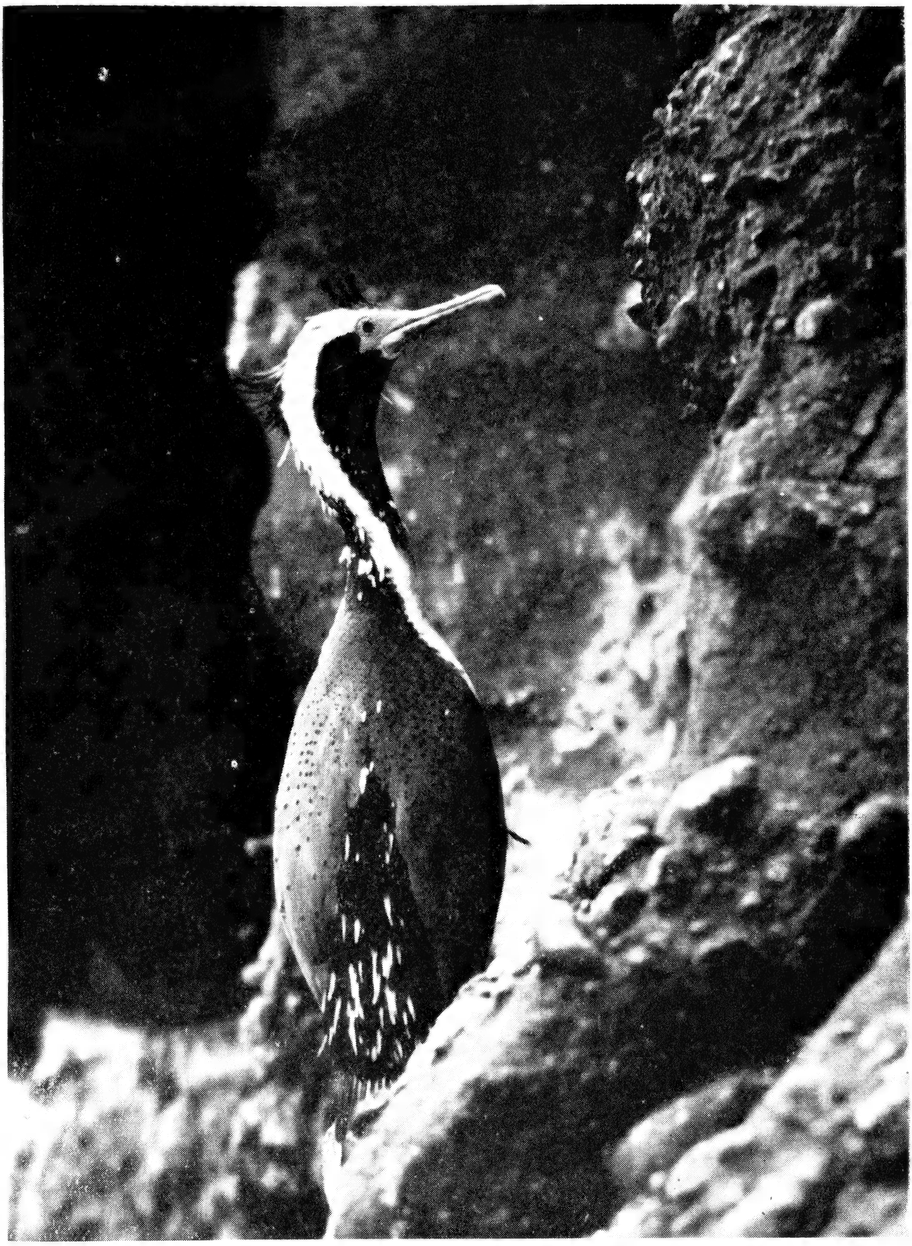


Fig. 1. Spotted shag in *pre-nuptial plumage* showing the characteristic decorative plumes on the nape, back and rump. The transition to nuptial plumage is marked by the loss of the decorative plumes and reduction of the crests by wear and moult. Bethells colony.

Photo: O. Petersen.

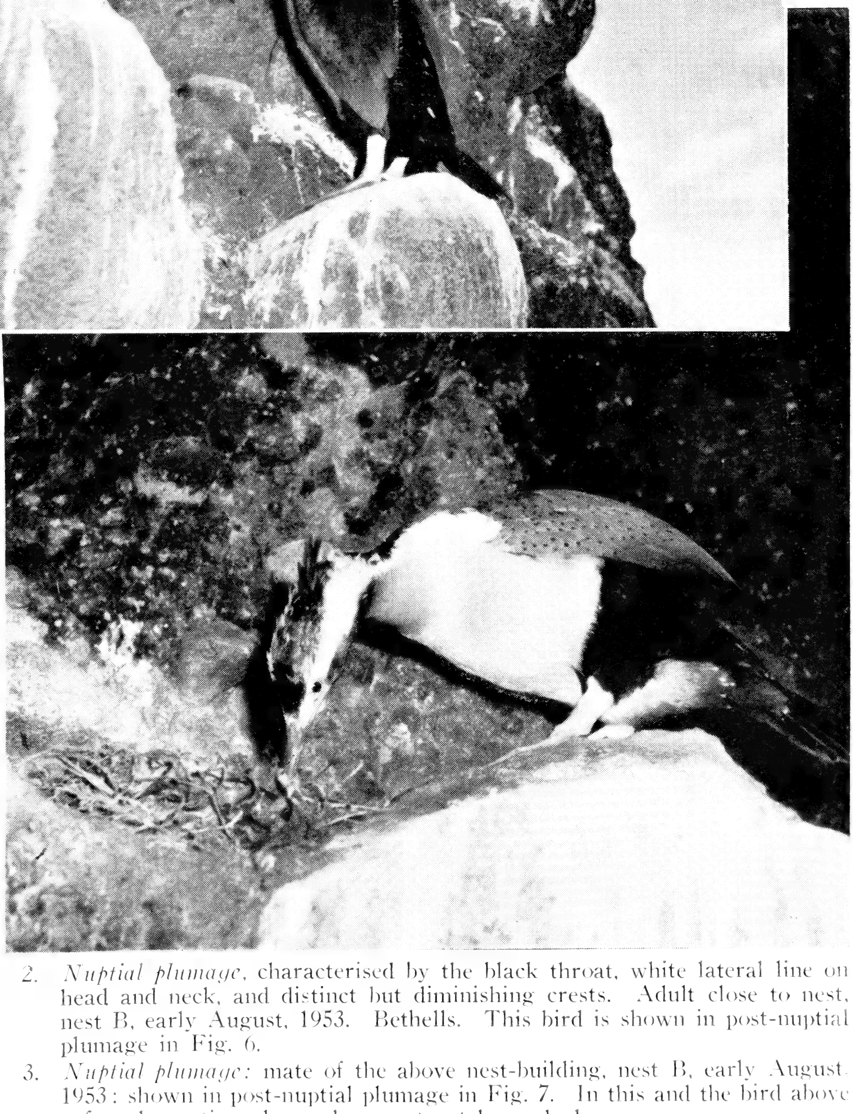


Fig. 2. *Nuptial plumage*, characterised by the black throat, white lateral line on head and neck, and distinct but diminishing crests. Adult close to nest, nest B, early August, 1953. Bethells. This bird is shown in post-nuptial plumage in Fig. 6.

Fig. 3. *Nuptial plumage:* mate of the above nest-building, nest B, early August 1953: shown in post-nuptial plumage in Fig. 7. In this and the bird above a few decorative plumes have not yet been shed.

Photos: O. Petersen.

Fig. 4. *Nuptial plumage*, showing transition to post-nuptial during incubation. The crests have been lost and brown flecks are appearing in the white line on head and neck. Nest C, September, 1954, Bethells.

Fig. 5. Newly hatched chick, nest A, October, 1952, Bethells.

Photos: O. Petersen.

Fig. 6. *Post-nuptial plumage:* both adults at nest B, October, 1953, Bethells. The bird feeding a chick shows the more pronounced type of head pattern, and there are still a number of black feathers amongst the new grey and white on the throat (shown in nuptial plumage in Fig. 2).

Fig. 7. *Post-nuptial plumage:* "greyer" type of adult with chicks approximately four weeks old, nest B, October, 1953. (Shown in nuptial plumage in Fig. 3.)

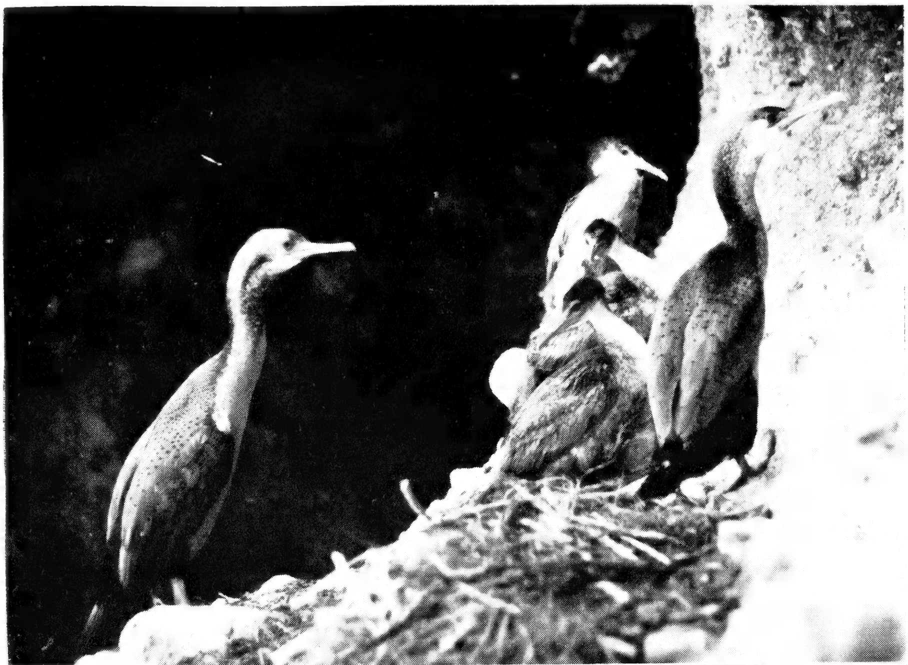
Photos: O. Petersen.

PLATE 55.

Fig. 8. *Post-nuptial plumage:* pair at nest A, November, 1952, Bethells. The single chick is partly hidden by the upper bird.

Fig. 9. *Post-nuptial plumage:* the lower bird in Fig. 8 (see above), showing the "greyer" type of plumage. The head pattern is indistinct and a few black feathers remain on the throat. Chick three to four weeks old showing first down partly replaced by the second. November, 1952.

Photos: O. Petersen.



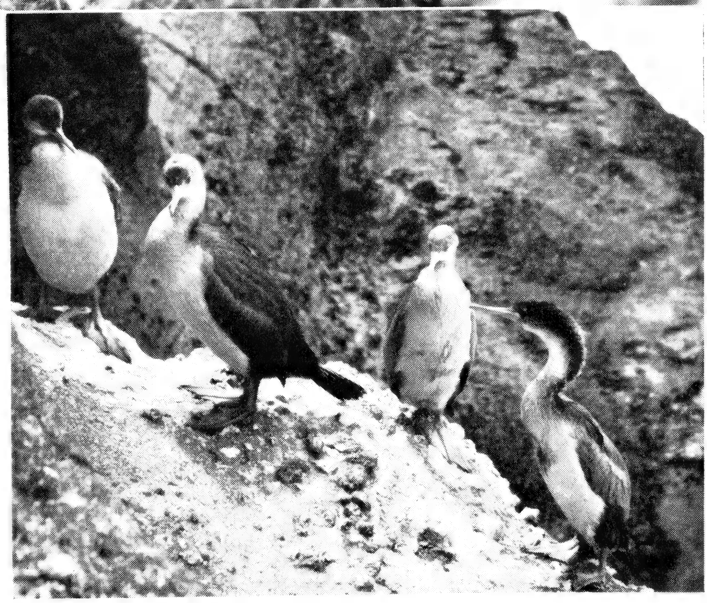


Fig. 10. Pair in post-nuptial plumage (left and right) and three fledglings (centre), still showing the second down on head and neck. The fledglings are between five and six weeks old. Nest C, November, 1954, Bethells.

Fig. 11. *Juvenal plumage:* (right) two young from nest C approximately seven weeks old on ledge near the nest, and (left) two juvenals just over nine weeks old. The young fly at nine weeks. December, 1954, Bethells

Photos: O. Petersen.

Tauihu: The Maori Canoe Prow

By GILBERT ARCHEY.

The purpose of this paper is two-fold. In the first place it records the types of canoe-prow made by the Maori in New Zealand and illustrates the various decorative designs that enhance their structure and form. Secondly it provides instances and details to amplify the observation that these several types, at first sight so different, possess important features in common, and that the differences themselves are no more than modes in which these common characteristics are presented or developed.

The photographs and drawings which follow will also reveal whatever aesthetic quality *tauihu* possess; we hope they will be found worthy of attention for this as well.

River-Canoe Prow

The plainest type of prow belonged to the fishing canoe, the small, broad dug-out with wash-strakes, used for everyday coastal work. It will be seen that this simple prow (Fig. 1), known as *tete*, is essentially a bow-cover with a transverse wash-board behind and a carved head in front. Its almost purely functional structure and its very general use in New Zealand fairly mark it as the prototype.

The bow-cover portion is fitted and lashed to the dug-out below and to the wash-strakes behind; the head is borne at the end of a neck of varying length. Apart from the typical mask details of the face the river-canoe prow was undecorated.

The stern-post of this work-a-day canoe was likewise unornamented; it was little more than the necessary rest or fulcrum for the large steering paddle to bear against. Nevertheless, it swept upward gracefully as a continuation of the curve, or sheer, of the after end of the vessel, as, at the other end, the neck of the prow carried the corresponding curve upward and forward to the figure-head.

Our next example is a prow from Doubtless Bay illustrated in text figure 3 and Plate 57, fig. 2. Although unfamiliar in general appearance, it maintains the functional structure of a bow-cover typical of the river-canoe type. The head, with its small attendant creature behind, is unusual in appearance, and both it and the vertical neck-pillar are studded with thorn-like projections. Similar spurs or spikes project from human figures and heads carved on a slab recovered from the Awanui swamp only twelve miles distant (Archey, 1933, p. 209).

The long, projecting mouth of this figure-head would suggest a bird motive, were it not for the large conical teeth (matched in human head carvings from this district) and the essentially similar though not so extreme projection of the mouth in other river-canoe prows (Text fig. 2). Indeed, the three prows here illustrated (text figures 1-3) provide a typical example of extension or decorative elaboration of an anatomical feature, in this case the mouth, that is so common a feature of Maori wood-carving.

Another unusual prow is that outlined in Figure 4 and Plate 57, fig. 1. More so than any other it is a practical bow-cover. We do not know what the canoe it belonged to looked like, but in our sketch we suggest something long, narrow and shallow, feeling that the gentle upward sweep of the prow would have been an expression or an extension of similar lines of the bow of the canoe. The prow itself is clearly another variant of the *tete*. In a way its upward and forward sweep foreshadows the outline of the leading edge of the highly decorated prow of the large war-canoe, *waka taua,* to which, as the main subject of this paper, we now turn.

The War Canoe Prow

Structurally the war-canoe prow, *tauihu* (Fig. 5), is but an elaboration of the prow of the river-canoe. It comprises the same bow-cover or lid with a transverse wash-board at the after end; but the simple projecting neck and head of the *tete* have now become a full human figure vigorously postured. The upper level of the bow-cover, instead of curving downward as a neck, continues horizontally forward beyond the transverse wash-board to reach and merge with the curved body of the leading figure. A final modification is that instead of the whole of the wood between the wash-board and the head having been cut away, there has been left a mid-line vertical panel connecting them, a panel that vies with the leading figure itself for our interest and attention.

In the first place, this panel has an obvious structural or strengthening function; it is also an escutcheon for a striking decorative design. Although the general composition of its decoration is the same for all *tauihu* in its group, it is saved from being stereotyped by an intriguing variety in its details and in the proportion of its parts. None the less, it is standardized in another way, for although it is unmistakably the pattern peculiar to *tauihu*, it also comes within an even wider convention characteristic of the greater part of Maori wood carving.

This convention I have described elsewhere (Archey, 1955, p. 12) as an alternation of *tiki* (human figures standing fullface) and *manaia* (human figures in lively attitude and with profile face), a theme that has become further developed into an alternation of figures (*tiki* or *manaia*) and double or interlocking spirals.

If the reader will turn to Plate 58 he will see, in an exceptionally fine *tauihu* from the Bay of Plenty, a clear presentation of this alternation. The elements comprise in succession: (a) the leading figure; (b) a part *manaia* facing aft; (c) a large double-spiral (*pitau*); (d) a stylized full-face figure in openwork or pierced carving; (e) another large *pitau;* (f) a forward-looking *manaia* elongated and somewhat cramped to fit the available space; and (g) a figure with its back to the wash-strake looking aft into the canoe.

The theme of alternate figures and spirals appears regularly in door-lintels and in many other carvings. The *tauihu* panel version acquires its special characteristics from the carver having taken advantage of the proportions of the panel to emphasize and expand the double-spirals so that they become the dominant element in the design. The

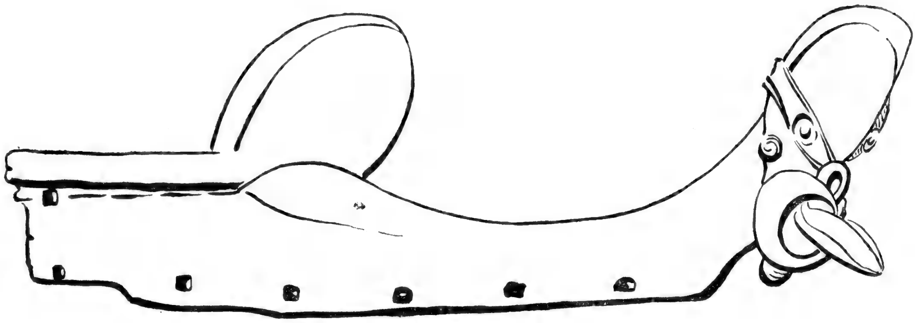


Fig. 1. River-canoe prow, *tete*. Coromandel. Auckland Museum; presented Miss Lucy Cranwell.

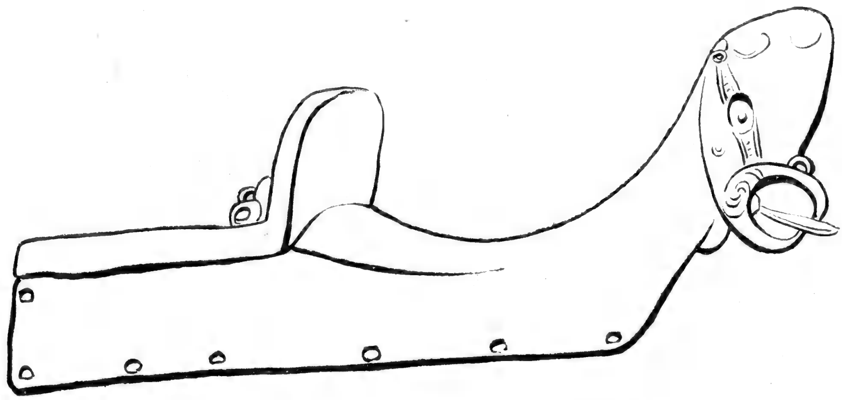


Fig. 2. River-canoe prow; no record; Auckland Museum, 6335.

Fig. 3. Prow from Doubtless Bay. Auckland Museum, 3654.

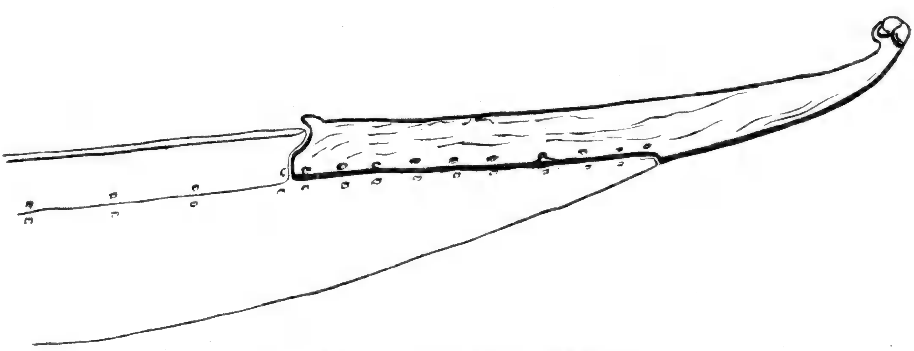


Fig. 4. Prow in Taranaki Museum.

Maori name for these elements stresses this special interest: *pitau* denotes the double spiral pattern itself; it also stands for this type of prow and as well for a canoe that bears it.

The base of the prow also has a standard composition or content in its decoration but with rather more variation. Typically the horizontal upper surface of the bow-cover bears a full-face human figure looking upward (Plate 59). It is, of course, divided into two halves by the vertical panel.

On the vertical sides of the base (Fig. 5) we again find a succession of human forms. At the after end is a human figure, full-face though

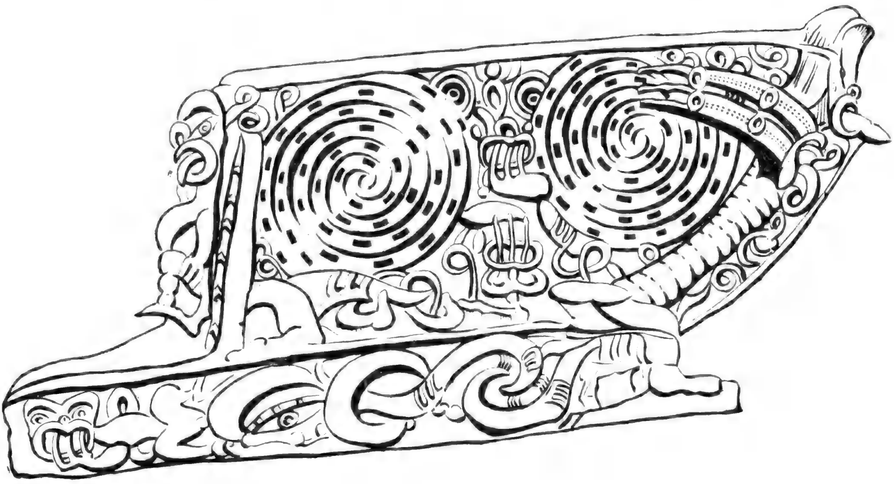


Fig. 5. *Tauihu*: carved prow of war-canoe.

in sideways stance; in front of this is a large forward-looking profile face with upper lip only, from under which projects a large curved tongue. This enloops anteriorly with another element, apparently a tongue, or a lip maybe, or even a body grasped around, as it often is, by a hand.

The prow itself is wide behind where, therefore, the two sides of the base stand separate, each abutting against the canoe wash-strake of its side. Anteriorly the base narrows, whereby the anterior portions

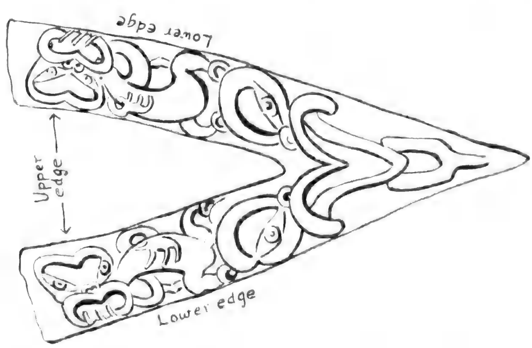
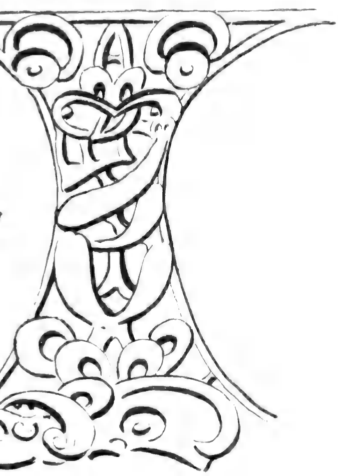


Fig. 6. Design on the vertical sides of base of *tauihu*; shown as if the sides had been splayed out horizontally.

of the lips of the large profile face meet medianly and, with a now *single* tongue and anterior loop, form a median basal support for the narrower forward portion of the prow. If one were able to slice off the horizontal flat bow-cover, and splay outwardly the vertical walls, the design on the base would appear something like the pattern outlined in figure 6.

7



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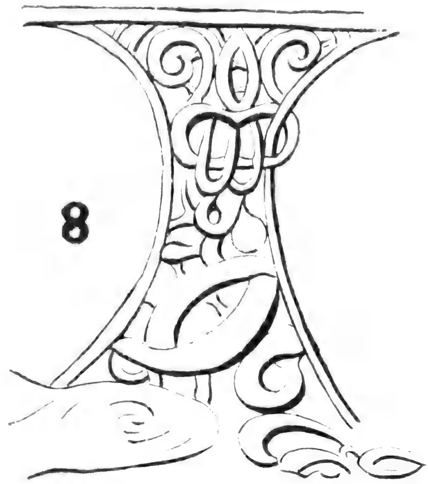

Figs. 7, Bay of Plenty, *cf.* Pl. 58; 8, Wanganui Museum, *cf.* Pl. 61, 1.

The different lengths of the base among *tauihu* offered opportunities for varying the design of the sides, either by including an extra figure or telescoping the elements together. The prow of Te Toki a Tapiri, the 82-ft. *waka taua* in this museum, is exceptionally long; the composition of its base pattern (Plate 62, fig. 2) includes no less than three figures, i.e., a full-face figure aft, a *manaia* looking forward, and next a human body with its neck joining the top and back of the customary large head profile. The interloop motive by which the design terminates is composed of limbs or bodies. In a much shortened model-canoe prow (Plate 65, fig. 3) it is the upper lip itself of the profile face that provides the first part of the interloop. Extra room for this relatively large interloop was obtained by omitting the forward horizontal part of the bow-cover: after all, it was hardly necessary in a model. Nevertheless, the same omission of bow-cover to allow for a more ample interloop, or incipient double-spiral, is a feature of a fine *tauihu* from the Wanganui district in the Dominion Museum (Plate 65).

Coming now to the design which separates the large double spirals of the central panel, we find one of the most interesting of Maori carving patterns. Its theme is simple enough, a standing figure, usually full face; but it is handled in all degrees of intricacy of open-work or tracery. Two examples, from the Royal Scottish (fig. 11) and from the Auckland Museum (fig. 7) show it in fairly simple outline; some of the ensuing elaboration is illustrated in the accompanying text figures (8 to 13) and others can be followed in the photographic illustrations. Two faces, one upside down and each with fingers in the mouth, comprise the pattern in the Ngatiawa prow of Plate 63, fig. 1; and even more intricate details of face profiles appear in Plate 63, fig. 3, where the lower portion of the pattern is a medley of face and figure profiles.

The rear-facing figure with its back to the wash-board is usually naturalistic, but even this may be patterned. The most elaborate included here is in figure 3 of plate 64; could it be that the complexity in this case ensued by way of compensation for the carver, who had somehow rendered the central panel figure more than usually naturally?

A final detail remaining for mention is the keel or band borne by the leading figure; *pitau* and *manaia* are the usual elements but often reduced or cramped together.

The foregoing description may have been somewhat tedious in its detail, though it will have served to reveal the ingenious complexity the Maori carver often indulged in. Greater interest, however, attaches to the strong sense of design appearing in parts of *tauihu* composition and to the presentation in one carved object of three or more stages of the handling of subject matter in decorative art.

Thus, referring to Plate 63, fig. 1, the vigorous leading figure and the small figure aft are hardly so far modified in the direction of applied sculpture as to remove them from the representative or realistic, and the same can be said of the relief figure that gazes steadily upward from the broad basal portion or bow-cover of the prow. Stylization appears in the large profile face of the base, and is well advanced in the intricate pierced figures between the spirals. The spirals are, of course, abstract forms of high quality, and the *pitau*, as they are named, have become an accepted form frequently used in composition, though still freely employed in all stages of stylized interlocking lips.

It is, however, in the openwork central figure of the panel that we find not merely versatility within a convention but also an originality that can fairly be rated as creative design. In figures 8 and 10, for example, we see how the features above the stylized mouth surrender their natural form to become abstract decorative detail. The limbs are handled to the same purpose even more successfully; obviously their shape as limbs was of little concern to the craftsman intent on winning a design from them.

Appreciation of the Maori carver's possession of this conscious sense both of design, and of abstraction as a means of achieving it, is of prime significance for our understanding of Maori art either aesthetically or historically. It enables us to see the carver as someone positively aware of the design possibilities of the natural forms he is using, and capable of taking hold of them and bending them to his purpose. This interest in pure pattern can hardly be seen better than in figure 14, where two bodies are first drawn out into curved parallel bands aligned with the sweep of the double spirals between which they stand and then recurved as scroll-rendered *manaia* faces to fill the upper and lower areas

An abstract design so neatly achieved is not only aesthetically acceptable; it speaks of creative art and of individual purpose as well as feeling as its source. And reverting to the natural forms that inspired it, it is not without interest to compare these two elongated abstractions with the slender undulating *manaia* that form the primary motive in the next form of *tauihu* we introduce—the trapezoid prow.

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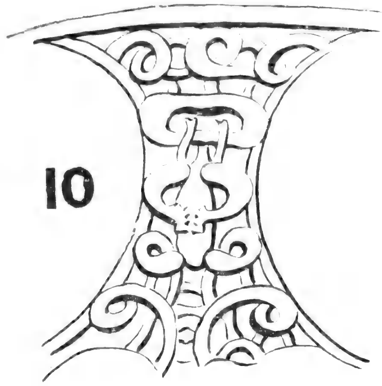

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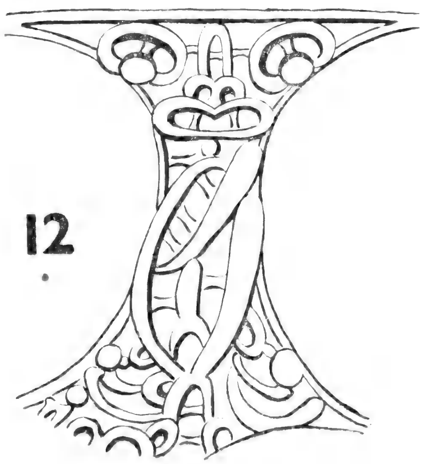

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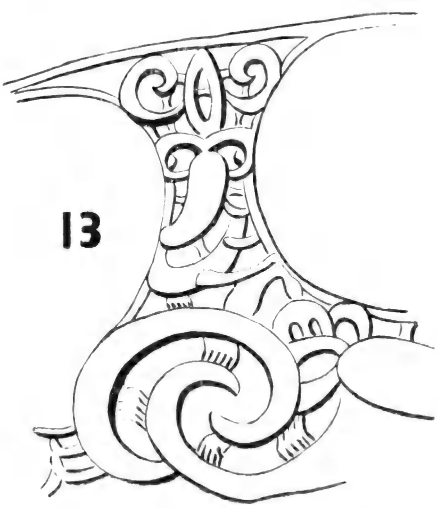

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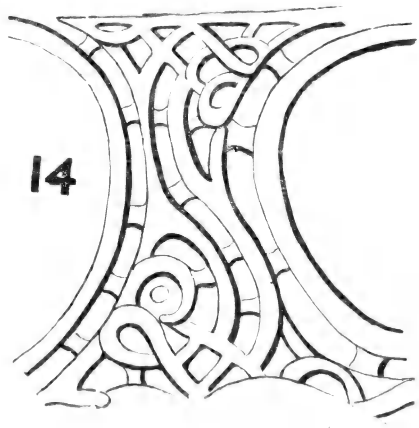


Figs. 9, Auckland Museum, *cf.* Pl. 64, 3; 10, Waitara, Bishop Museum, 1424; 11, Royal Scottish Museum, *cf.* Pl. 65, 1; 12, East Coast, *cf.* Pl. 63, 3; 13, Okehu, Wanganui, *cf.* Pl. 65, 2; 14, Hamilton, Maori Art, p. 46, Pl. 11.

The Trapezoid Prow

We turn then to the form of prow illustrated in figure 15. A name applied to it was *toiere*. At first sight it seems to stand completely apart from the *tauihu* we have been describing. It is undoubtedly different, but not entirely so, either structurally or in its decorative design.

Considering it first structurally, we observe that a panel (*toiere*) stands vertically above a flat bow-cover (*taumatua*, i.e., support) and backs against a transverse wash-board (*paretai*). The *toiere* thereby occupies the same position as the mid-line panel of the *pitau*-decorated war canoe prow; it is its homologue.

Observing it next as decoration, we soon recognize the unusual elements comprising it as no more than forms with which we are familiar handled in a different manner.

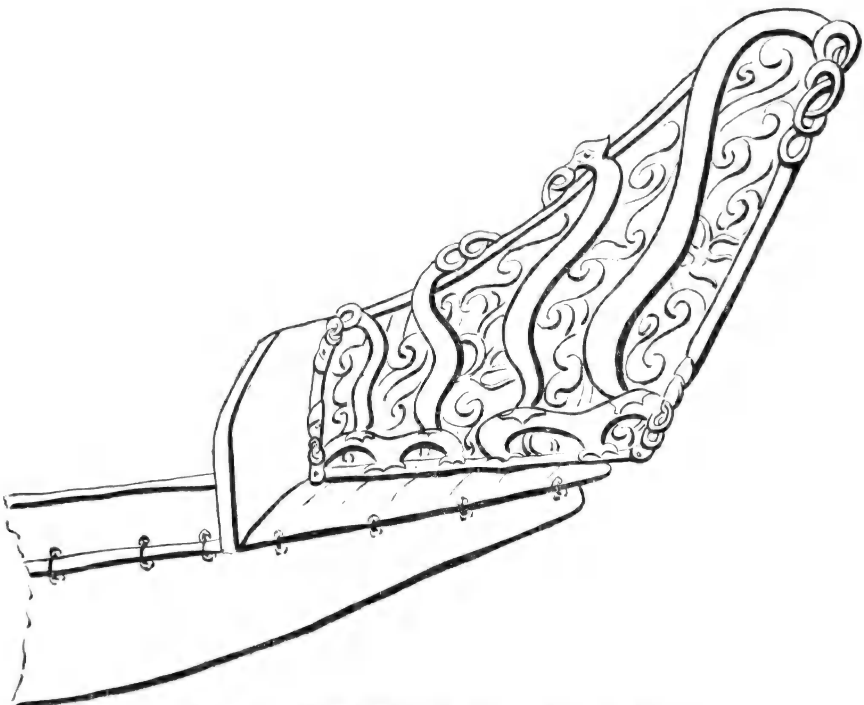


Fig. 15. The trapezoid prow; British Museum.

Fundamentally, the *composition* or content of the panel decoration is the same in both types of prow, i.e., an alternation of human figures or *manaia* with interloop (or double-spiral) tracery. It is only in the relative size of the spirals and in the treatment of the human figure that they differ. In the one we see openwork full-face figures as already described; in the other the figures are extremely elongated *manaia* of the type found in other carvings from the Northland area. What we are looking at is an art preference, wherein the fine spiral rhythm of one school stands in contrast to the rhythm of undulating figures of the other. And in the latter case the whole of the human figures, not only the enlooped mouths, have become stylized to produce the desired pattern. They are still recognizable, however, as figures in profile, not having been carried forward beyond stylization to the degree of abstract design of figure 14 discussed above.

The basal portion and the transverse wash-board were also ornamented. No satisfactory illustration is available for inclusion here, but Plate X of Hamilton's Maori Art shows naturalistic figures on the wash-board and a pattern of stylized figures on the bow-cover. An additional feature was a carved head with tattooed face (Pl. 67) carried right forward on the hull itself.

Trapezoid prows have, from time to time, been referred to as "northern"; but this is by no means a reliable allocation. One such prow is from the Waikato River; the two illustrated in Maori Art, p. 53, Plate V, are localized "Auckland," but if the city is intended they may have reached it from almost anywhere. The finest of this type, in the British Museum (Plate 66, fig. 1), is unlocalized. While, therefore, the attribution of these to "Northland" may be tentatively made on the basis of the carving style, it should be remembered that this is only conjectural.

A Connecting Link

The last prow to be mentioned is particularly interesting, not merely because it is old stone-tool work, but also for its clearly intermediate position between the two types of prow we have been considering. Like each of them, it comprises (Fig. 16) a bow-cover base and a transverse

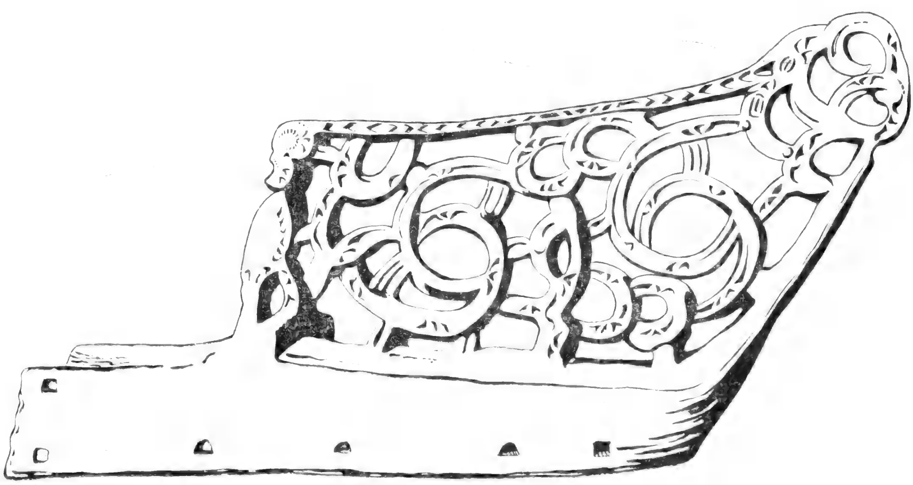
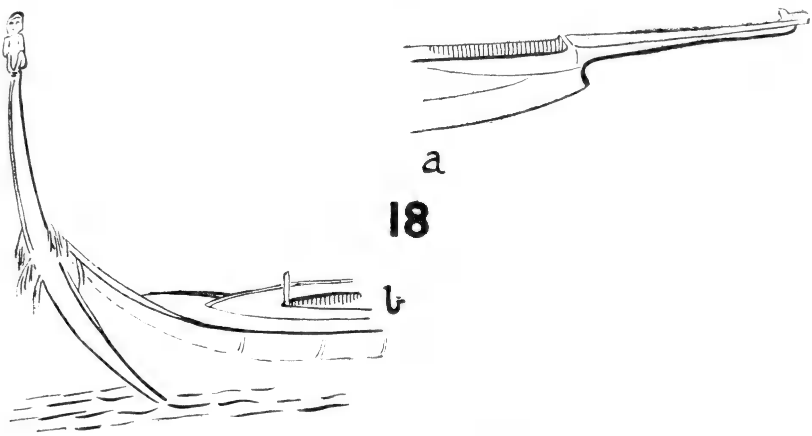


Fig. 16. North Taranaki prow.

wash-strake, though a very low one, an a median panel. The latter, though somewhat crudely carved, bears the simplest possible rendering of the alternate human figure and double spiral (or loops in this case) characteristic of the median panel in both of the others. The panel itself, moreover, is of the same form and proportion as the standard type, and its upward sweeping leading edge would require only the slightest treatment to make a man of it. Instead, the panel bears a *manaia*, much reduced, at the extremity, a figure that would only have to be lengthened to make the long *manaia* of, say, the superb British Museum prow.

The three prows comprising Plate 66 have but to be compared to enable us to realize that all three are related in functional structure, in basic form, and in the content of their decorative design. *Tauihu* thus



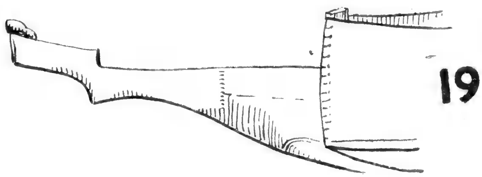


Fig. 18 a and b. Tahiti: Hornell.
Fig. 19. Nukutavake: Hornell.

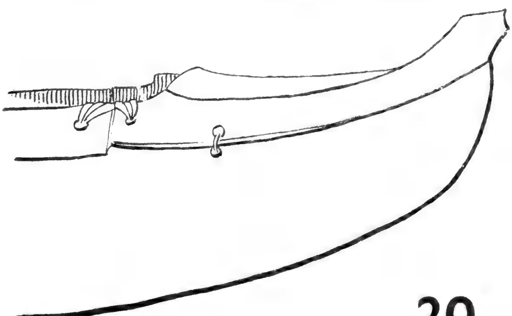


Fig. 20. Rarotonga: Auckland Museum.

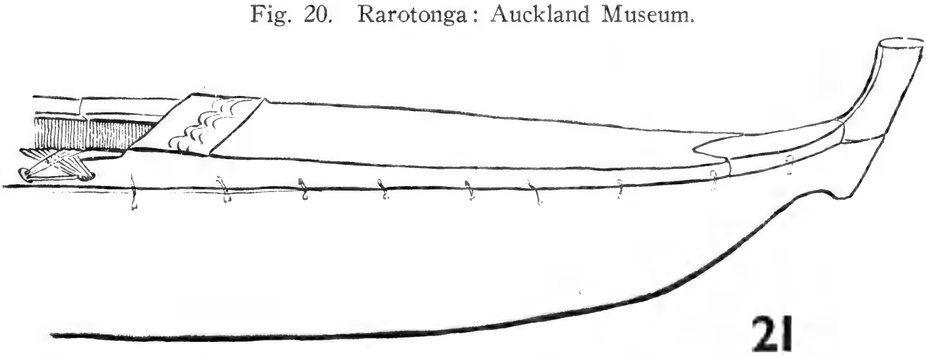


Fig. 21. Atiu: Auckland Museum.

In Rarotonga the bow-cover (Fig. 20) was perfectly plain and projected only slightly beyond the hull; but in an Atiu canoe in this museum (Fig. 21) there is a long flat fore-deck covering the anterior one-fifth of the hull, next in front is a short bow-cover and terminally a small upward projection fitted between bow-cover and hull.

stand, with *pare* or door lintels, as examples of the manner in which the Maori carver used his *tiki* and *manaia* in repetition and alternation with spirals to produce patterns basically the same but diverging in method of treatment. These styles comprise what might be called the schools of Maori art, but not of schools precisely defined either geographically or stylistically, because we already see from the relatively few examples available how varied in manner they are and how frequently and strongly the ideas and feelings of individual artists find expression in them.

Canoe Prows in Polynesia

On comparing the Maori canoe prow with those of Polynesia we again quickly realize how similar they all are, at least in basic form. Structurally, or practically, each is a bow-cover which extends the sheer of the hull upward and forward; symbolically or commemoratively each nearly always carries in front a head or a human figure. The prows in the islands exhibit this structural arrangement in varying manner, but simply and without elaboration except in the Marquesas, where additional human figures, incipiently stylized, appear. The accompanying sketches, for the most part copied from Hornell (1936), show the styles characteristic in each group.

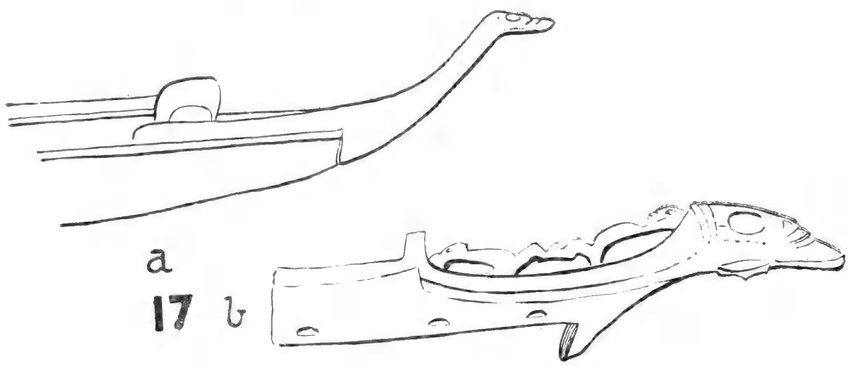


Fig. 17 a and b. Marquesas: Hornell.

The basic relationship between hull, wash-strakes and bow-cover is seen in the Marquesan prow illustrated in text-figure 17a. The slender curved forward reach, and its termination, look like a bird neck and head in profile view, but the upward-gazing face is distinctly human. The close similarity of this prow to the Taranaki Museum example outlined in figure 4 (p. 367) is readily apparent, as is its general resemblance to the standard Maori river canoe prow of figure 1, except in the style of the face or head.

In Tahiti one type of prow (Fig. 18a) is a plain plank-like projection narrowing slightly forward; another is an upwardly curved extension of the bow with a small human figure looking forward (Fig 18*b*). A second figure on this canoe looks behind from the stern, which differs from the prow only in being higher. Hornell (p. 124) thought, however, that this canoe might be Tuamotuan, or from Rurutu. A definitely localized Tuamotuan canoe described by Hornell is from Nukutavake; its prow (Fig. 19) is a solid "long and gracefully tapered blunt-ended projection."

In Tikopia (Fig. 23) the prow is carved from the dug-out hull itself, as it is in Samoa (Fig. 22); the dental decoration is also similar, though more extensive in Tikopia. In the latter a separately fitted bow-cover is lashed on above the prow.

All these prows are very simple; the one attempt at elaboration, from the Marquesas (Fig. 17*b*), has stylized human figures in mid-line between the transverse wash-board and the terminal carved face. Simple though it be, its basic form invites comparison with that of the Maori war canoe, each comprising a transverse wash-board, a horizontal base plate, a terminal face and a vertical mid-panel. Except, however, for this very tentative approach, the island canoes have no part in the extension and elaboration of structure and ornament that so strikingly characterises the *tauihu of* Aotearoa.

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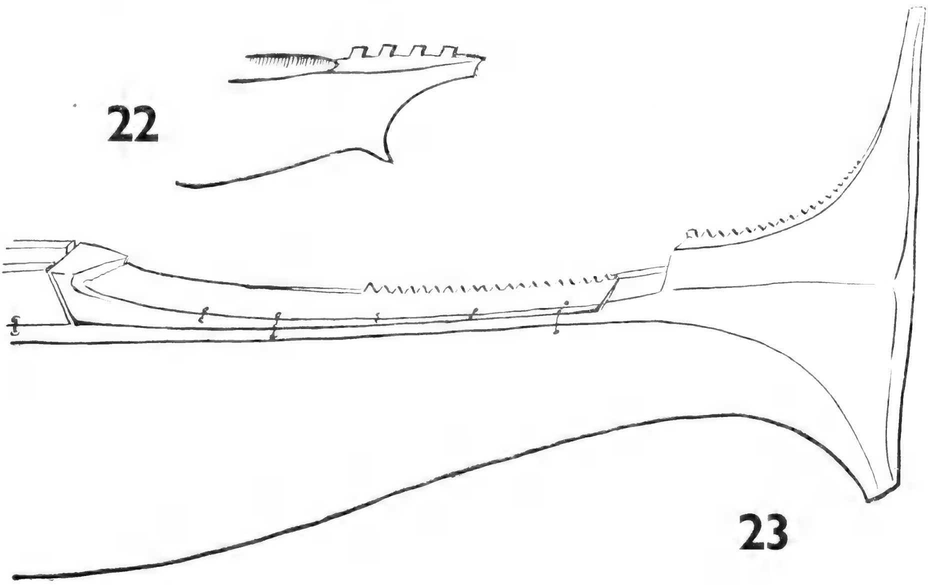

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Fig. 22. Samoa: Auckland Museum.
Fig. 23. Tikopia: Auckland Museum.

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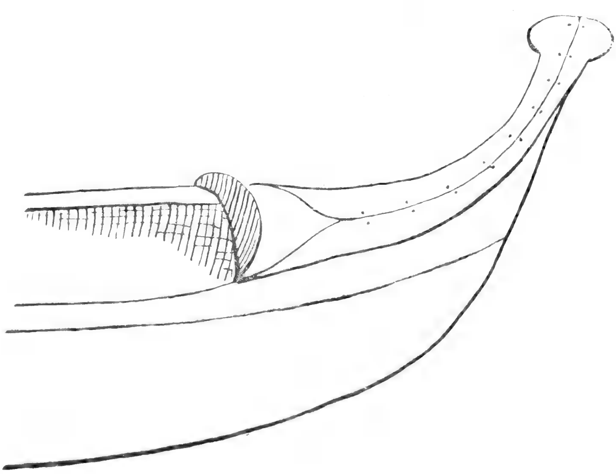

Fig. 24. Hawaii: Hornell.

Nevertheless, the fundamental structural design appears in all of them: i.e., in the bow-cover and terminal head or figure. Here, then, is the essential relationship among them. From these basic elements the Maori, and only the Maori, has developed further structural elements and decorative complexity. Not only *tauihu*, but *taurapa* also (Archey, 1938), exhibits the development or evolution from a plain practical form towards extension and elaboration, and in practically every phase of Maori wood-carving we find told a similar story of local development not only of structure but also of decorative design.

Indeed, throughout Polynesia the basic content of wood-carving is the same; the development is different in each area, though with relationships between the island arts of the Oceanic region where a rectilinear fashion prevailed. Even the simple spirals of the Marquesas, developed from insect legs and antennae, have experienced the rectilinear restriction, the outcome, I suggest, of the difficulty of carving in really hard wood.

Only the Maori, favoured with the soft wood of the totara and with sharp greenstone chisels, had launched into the complexity of free flowing patterns, with what success the *tauihu* patterns are by no means the only examples.

When, therefore, we see, in the Polynesian region from which the Maori traditionally came and to which he is culturally related, the basic structural elements alone of the *tauihu* without any decorative elaboration, and when we see in the remote and isolated colony of Aotearoa every degree of departure from them and every stage in evolution of structural and ornamental complexity, the history of the art of the Maori and of its design elements ought to be readily apparent.

The view that art motives in Maori carving have a local origin is, I submit, abundantly attested in the body of the art itself; their development accords with the principle stated by Duff (1950, p. 2), that "persistent and continuous change . . . is self-motivated or spontaneous" and "independent of . . . influx of foreign populations," though hardly, I would say, free from the effect of environment, an environment that in this case not only provided occasion in the needs of house building and transportation, and supplied means in suitable wood and effective tools, but also furnished inspiration in a stimulating climate and noble natural surroundings.

More immediately and technically, or psychologically if you prefer it, the inspiration that has developed Maori carving patterns has been the individual craftsman's direct and positive interest in form as such, and his awareness of the possibilities inherent in these forms for the creation of harmonious and well-balanced design.

Discussion: A Native Art?

Two aspects of enquiry have been appearing alternately in the foregoing: the active practice of Maori art and its manner or place of origin. They are, in my opinion, inter-related, for there is, in the range of expression of an art and the versatility and competence of the handling of all its aspects, a significance for its origin equal to that which might be sought in apparent similarities in the forms appearing in different places.

To return to the primary subject of this paper, the canoe-prow: at the time of Cook's discovery, *tauihu* were being carved in every stage of structural and decorative extension or elaboration. So were *taurapa*; so were house carvings. Carvers were producing simple, practical articles and plain naturalistic sculpture; either or both of these might be stylized or elaborated or wrought into patterns. The patterns themselves were won from whole figures or from any part—face, body or limbs; the patterns would trend in the one direction of involved curves or spirals or in the other direction towards simple, restrained abstraction. Moreover, all these details and the trends appeared even in one small composition, the central panel device we have been discussing. To repeat: the head appears full-face or profile with the fingers varyingly introduced to enhance the complexity; in most of them the limbs are stylized and set at studied angles almost in the "contemporary" manner, while in one illustrated (Fig. 14) the natural form is drawn out into a graceful, evenly flowing design that stands in accord with the spiralling of the bordering *pitau*.

We have seen elsewhere (Archey, 1933; 1955) how the *pitau* itself is almost invariably a pattern of interlocking lips in varying degrees of extension or expansion; occasionally by way of further versatility, or creative enjoyment, whole bodies or limbs are so enwhorled. In another school, Taranaki, an entwining of undulating bodies forms the pattern, while in the Kaitaia carving a simplification of limbs produces an abstraction of strangely moving power. Few arts can present so many styles. These parallels of pattern evolution are themselves evidence of local development, unless, of course, there should be, as there are not, art motives elsewhere of these several kinds from which we could fairly derive them.

Coming then to the question of origins, I am constrained to add a comment on the supposed introduction or borrowing of the New Zealand double spiral from an outside art. Does it not, in the face of such clear design competence as Maori art displays, appear altogether unnecessary, or even trivial, to introduce one such borrowed element when, within the art, not only this one but so many others are so freely created and used?

If there were real evidence of spiral forms in Central Polynesia we should, of course, have to accept the possibility or even the probability of their having been brought here; but where are they? It is precisely here that the theory of introduced spirals encounters its main ethnological difficulty, i.e.: in the need to find a satisfactory or convincing place of origin and route to New Zealand. Skinner (1924, 233) recognized this need and postulated a curvilinear art style formerly dominating Polynesia and later lost in the centre through a "strong new rectilinear fashion" from which Maori art and to a less extent Marquesan were "preserved by isolation."

Barrow has recently (1955, 17) dismissed this argument as "lacking evidence," and in even briefer terms; I myself have never found it acceptable, nor indeed more than an unsupported supposition. It is quoted approvingly, however, by Duff (1950, p. 5), who sees in it support for his own theory that marginal distribution of an item of culture is evidence of its former existence at the centre of the area. It should, however, be commented here that the evidence for Duff's theory is the existence of *identical* adzes at no less than ten marginal localities, whereas there are only two by no means similar arts for consideration, Marquesan and Maori, in which, moreover, the single pair of supposedly related spiral elements are obviously different both in their origins and their form.

In each of these two arts the spiral is an end product derived from a natural form, but a different form in each case. Marquesan art, like Maori, also stylizes face masks, but in a manner as near to Haida Indian as to Maori. Interestingly, one Marquesan prow (Fig. 17b) has features in common with *tauihu*, but the relationship is in basic essentials and not in the elaborations that comprise the full decorative vigour of the Maori achievement.

Not only in its unmatched variety and creative vitality, but also by the continuing existence within it of all phases of its development, Maori art is marked as a local achievement. On the other hand, the absence from areas in which one would expect to find it of evidence of outside relationship, except in simple basic components, indicates its derivation from a central art in which those as yet undifferentiated elements, mostly naturalistic human forms, were common to all.

The closest parallel to Maori carving, in both its component elements and its art form, is in the moderately stylized human figures set alternately full face and sideways in the staff gods of Rarotonga. The Cook Islands, moreover, are quite a likely area in which to find a parallel to the *basic patterning* of Maori art.

All this has, however, taken us away from *tauihu*, to which we return only to recall that it is in the basic structural features that it and the canoe-prows of Polynesia closely and clearly resemble one another. Except in Aotearoa the Polynesian canoe prow has remained in the unspecialized form; only the Maori has developed it. He has done so *structurally*, in the *composition* of its decorative theme, in the richness and diversity of its *patterning*, and most notably in his conception and achievement of *design*.

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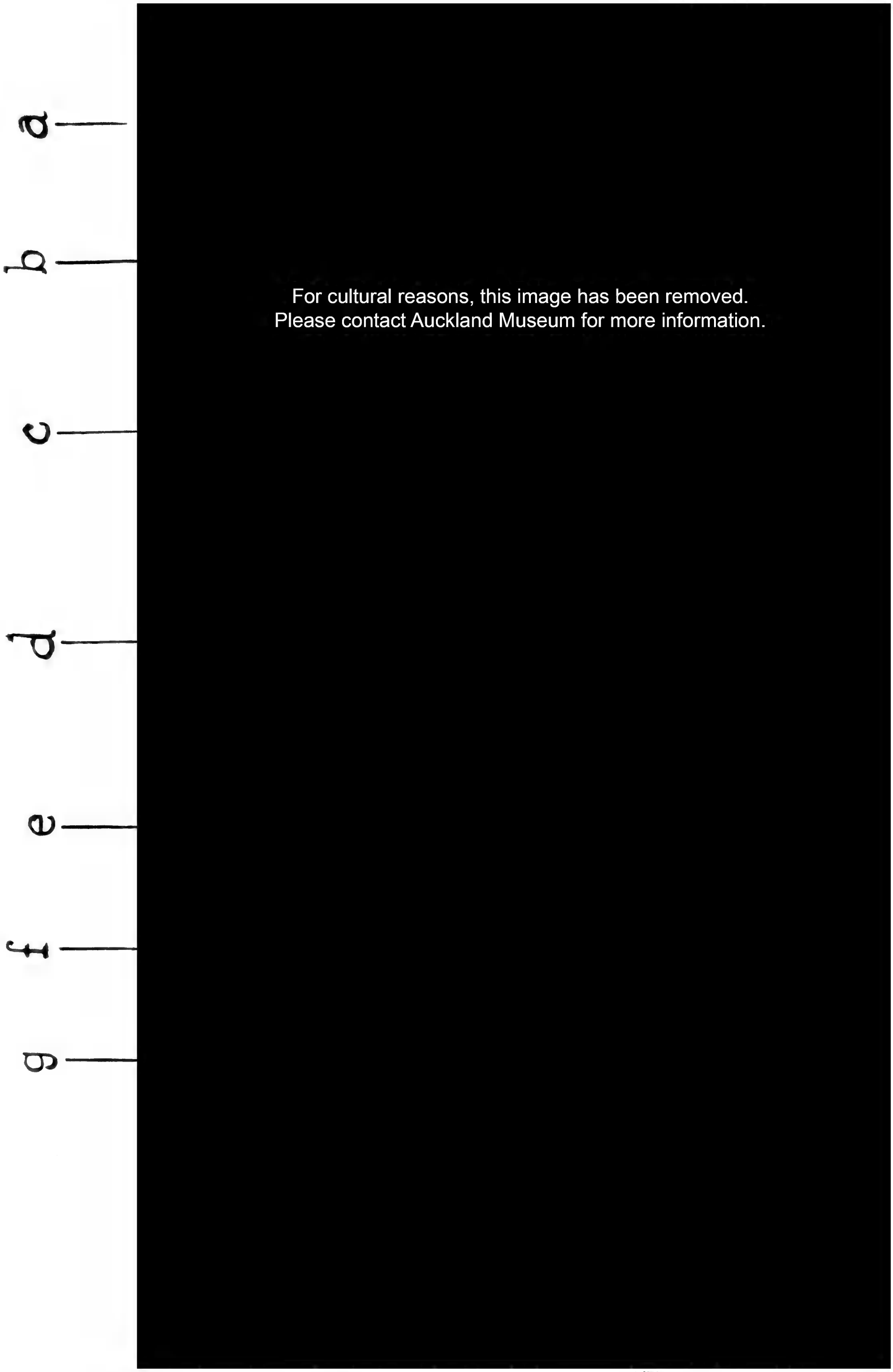
Fig. 1. Taranaki Museum.

Fig. 2. Doubtless Bay. Auckland Museum, 3654.



War-canoe prow, *tauihu;* Bay of Plenty. Auckland Museum, 171. (a) Leading figure; (b) part-*manaia* facing aft; (c) double-spiral, *pitau;* (d) stylized human figure; (e) *pitau;* (f) elongated *manaia* looking forward; (g) human figure looking aft.

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Basal portion (bow-cover) of *tauihu*, seen from above. Auckland Museum, 29722.

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Fig. 1. University of Pennsylvania Museum.

Figs. 2 and 3. *Loc.* Kapiti. Canterbury Museum, E. 141.787. (Wash-boards renewed.)

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Fig. 1. Locality and place of deposition unknown. Photo. Dominion Museum.

Fig. 2. Captured by Ngaitai of Whakatane from raiding Ngapuhi. Locality probably Bay of Islands. Auckland Museum, 197.

Fig. 3. Bay of Plenty. Auckland Museum, 171. Photo. H. Powell.

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Figs. 1 and 3. Waikanae; but "probably carved by east coast natives" (Hamilton, Maori Art, p. 46). Dominion Museum. Photo. Charles Hale.

Fig. 2. Prow of Te Toki a Tapiri, built about 1836 on East Coast (Ngati Kahungungu tribe). Auckland Museum, 150. Photo. H. Powell.

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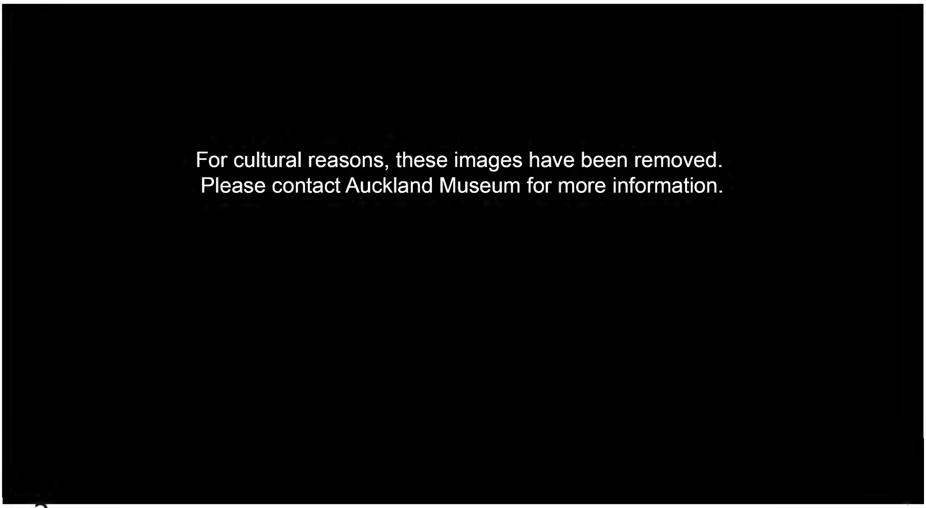

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Fig. 1. Carved by the Ngati-awa chief Wiremu Kingi. Auckland Museum, 7375.

Fig. 2. Ngatiawa: a relic of Te Rauparaha's raid to Queen Charlotte Sound. University of Pennsylvania Museum.

Fig. 3. "East Coast of North Island" (Hamilton, Maori Art, p. 44). Present location unknown. Photo, Dominion Museum.

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Fig. 1. Peabody Museum of Salem.

Fig. 2. Wanganui Museum.

Fig. 3. Purchased in England by the donor, Mr. T. H. Hopkins. Auckland Museum, *29722*.

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Fig. 1. Royal Scottish Museum.
Fig. 2. Okehu, Wanganui. Dominion Museum.
Fig. 3. On model canoe purchased in England. No record. Auckland Museum.
Photo. H. Powell.

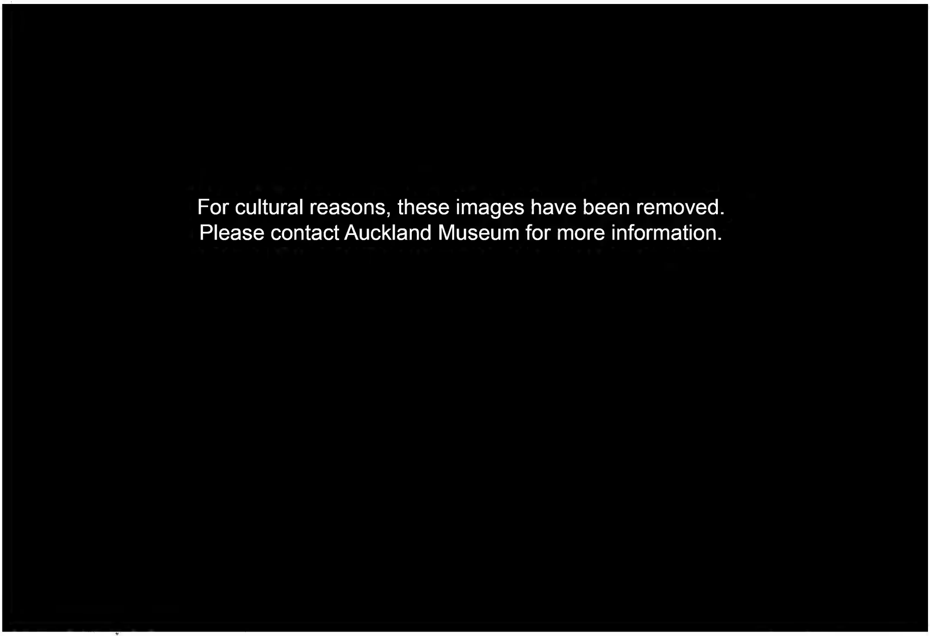

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Fig. 1. British Museum. Locality unknown.
Fig. 2. Mokau. Auckland Museum, 5676.
Fig. 3. Locality uncertain. Canterbury Museum, 141.788*

* "Locality . . . probably a little to the north of East Cape": Maori Art, p. 44. Dr. Duff comments: "I think Hamilton's reference to this as from East Cape was a guess based on style. On grounds of style and the likelihood of provenance which our records can establish, I would assign this to Cook Strait." (North Taranaki influence.)

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Fig. 1. Auckland Museum, 2711. Locality unknown.

Fig. 2. Canoe figure-head. Thames district. Auckland Museum, 5998.

The Three Kings Cabbage Tree

By W. R. B. OLIVER,

The species of *Cordyline* found in the Three Kings group has up to the present been assigned to *C. australis*. Recently I had the opportunity of examining a living plant in the grounds of the Plant Diseases Division of the Department of Scientific and Industrial Research, Auckland, and of specimens taken from this tree, as well as specimens gathered from another living tree growing in the garden of Mr. A. W. B. Powell, Auckland. Together with these I have examined specimens collected on the Three Kings islands and now in the herbaria of the Auckland Museum, the Dominion Museum and the Botany Division of the Department of Scientific and Industrial Research, Wellington. Comparing these specimens with those of *C. australis*, important differences are evident warranting the naming of the Three Kings form as a distinct species. I am indebted to Miss Joan Dingley for specimens from the tree in the grounds of the Plant Diseases Division, and to Mr. A. W. B. Powell for specimens from his living tree.

The Three Kings cabbage tree was first recorded by Cheeseman (1888) from Great Island. Three years late (1891) he recorded it from Southwest Island and from Northeast Island. The trees on Southwest Island were found above a colony of gannets and were described as short-stemmed, luxurient plants growing in sheltered places mixed with *Meryta sinclairii*. Mr. W. M. Fraser visited the Three Kings in December, 1928, and reported on the cabbage trees as follows (1929): "Cabbage trees growing to large dimensions, with many branches bearing heads of very long leaves, and flowering profusely, were found near running streams facing the east, and while resembling both the *Cordyline australis* and *C. banksii* the writer is of opinion that the Three Kings variety differs from all those found on the mainland." Collections made in 1934 and subsequently are in the Auckland and Dominion Museums. These are recorded in a paper by myself (1948).

Cordyline kaspar n. sp.

Affinis *C. australis* sed differt foliis latioribus et brevioribus; bracteis latioribus et brevoribus, basi paniculae lobatis; floribus longioribus.

A small, widely branching tree with large terminal leaf clusters and panicles. New branches arise from the base of the terminal clusters. Leaves ensiform, widest above the middle, gradually tapering to an acuminate tip and to a contracted base above an expanded sheath; midrib obscure above, more prominent below, widened towards the base, ribbed on both surfaces; laminae with fine parallel ribs diverging at an angle of about 7° from the midrib; above the sheath the leaf contracts to about half its maximum width; length 60-65 cm., width 55-70 mm., width above sheath 25-35 mm. Panicles terminating the branches, up to 80 cm. or more long, compound, the secondary axes branching once or, occasionally, twice. Bracts of the rachis broadly lanceolate, leaf-like, but the lower ones usually with a lobe on one or both sides, up to 26 cm. long and 25 mm. wide, the lobes usually short but may be 70 mm. long; upper bracts progressively shorter and proportionately broader, becoming oblong with truncate bases and acute tips; bracts subtending the tertiary axes ovate, acuminate, membranous with dark veins; there are two small bracts in each axil of the branches. Flowers rather closely placed on the tertiary branches and terminal part of the secondary. Bracteoles 3, broadly ovate, acute, hyaline with dark central line, less than half the length of the perianth segments which are narrow oblong, obtuse; margins white, centre pale yellow with 3 dark yellow ribs. Berry (unripe) 3-lobed, with 1-2 curved shining black seeds in each cell. "Fruit white" (E. G. Turbott).

Type specimen in Botany Division, Department S.I.R., No. 87645.

The specific name is that of one of the Three Kings, Kaspar, Melchior and Balthazar, after whom the group was named by Tasman, who discovered it on Twelfth Night eve, 1643.

Cordyline kaspar differs from *C. australis* in the shorter and broader leaves with veins arising at a wider angle from the midrib; in the shorter and broader bracts with one or two lobes on the lower ones; and in the longer flowers.

Distribution: Three Kings Islands: Great, Southwest and Northeast Islands.

REFERENCES.

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Three Kings Cabbage Tree growing in grounds of Plant Diseases Division, Auckland. Stick is 2 m. long.

Photo. J. W. Endt.