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A revision of the genus *Pahoroides* (Araneae: Synotaxidae)

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ABSTRACT: The genus *Pahoroides* (Araneae: Synotaxidae: Pahorinae), endemic to New Zealand, is redescribed and revised. Two known species are redescribed and six new species are described (*Pahoroides balli*, *P. kohukohu*, *P. confusa*, *P. gallina*, *P. aucklandica* and *P. forsteri*). The original description of the type species, *Pahoroides whangarei* Forster, 1990, includes illustrations of the male palp of a second, undescribed species, described here as *P. confusa*. The genus is presently known only from the northern half of the North Island.

KEYWORDS: Revision, New Zealand, spiders, Synotaxidae, Pahorinae, *Pahoroides*, *Pahora*, new species.

Introduction

In addition to the nominate subfamily, the family Synotaxidae Forster *et al.* (1990) includes the subfamilies Physogleninae Petrunkevitch, 1928, with species from Chile, Australia, Tasmania and New Zealand; and Pahorinae Forster, 1990, endemic to New Zealand, with four genera (*Pahora* Forster, 1990, *Pahoroides* Forster, 1990, *Nomaua* Forster, 1990 and *Runga* Forster, 1990). Fitzgerald & Sirvid (2009) revised the genus *Nomaua*, synonymised *Wairua* Forster, 1990 under *Nomaua*, and added another five species to the six already described. Forster *et al.* (1990) noted that *Pahora* and *Pahoroides* seem to be closely related, *Pahora* with eight species in the South Island (one of which is also found on Stewart Island/Rakiura) and one species in Taranaki, and *Pahoroides* with two species restricted to the northern half of the North Island. Recent collections of spiders from various localities in northern North Island have provided specimens of both known species and of six undescribed species of *Pahoroides*, including one that was incorrectly included in illustrations of *Pahoroides whangarei* by Forster *et al.* (1990: figs 194, 197). Here we redescribe *Pahoroides courti* and *P. whangarei* from the types and additional material, and describe the six new species.

Methods

Institutional acronyms

MONZ = Museum of New Zealand Te Papa Tongarewa,
Wellington, New Zealand

OMNZ = Otago Museum, Dunedin, New Zealand

Abbreviations for body parts

Eyes:

ALE = anterior lateral eyes

AME = anterior median eyes

PLE = posterior lateral eyes

PME = posterior median eyes

Male palp:

E = embolus

MA = median apophysis

PA = prolateral apophysis

PM = patellar macroseta

RA = retrolateral apophysis

RPT = retrolateral projection of tibia

TTA = theridioid tegular apophysis

VA = ventral apophysis

Characters that conform to the generic diagnosis are not repeated in species descriptions. We have distinguished

species of *Pahoroides* on features of the bulb of the male palp and on features of the female epigynal scape and genitalia. In describing palps, we use the terminology of Agnarsson (2003, 2004). Colour information is based on ethanol-preserved specimens. Measurements (given in millimetres) for each species were made using an eyepiece micrometer on a Zeiss Stemmi® 2000 binocular microscope. Full measurements (including total length, and eye and leg measurements) were made on one male and one female of each species (identified by their MONZ electronic database numbers with the prefix 'AS'). Total body length of all measurable specimens was taken for males and females of all species and ranges, means and sample sizes given. The strong retrodistal projection of the male palpal tibia (Forster *et al.* 1990: figs 192, 193) was not included in measurements of the tibia of the palp. For the figures, specimens were photographed using a Canon® G2 digital camera on the same microscope, and series of photographs were combined using Zerene Stacker focus-stacking software, to produce images with extended depth of field.

In locality data, two-letter entomological area codes follow Crosby *et al.* (1998). All localities are from New Zealand.

Systematics

Family Synotaxidae

Subfamily Pahorinae Forster, 1990

Pahorinae Forster, 1990 (in Forster *et al.* 1990: 36).

TYPE GENUS: *Pahora* Forster, 1990 (in Forster *et al.* 1990: 40).

DIAGNOSIS: Based on Forster *et al.* (1990). In males, the ocular area behind the AME is setose and in some species is elevated. Secretory pores are present on the clypeus and eyemound (see Forster *et al.* 1990: figs 133, 134). In males, a pick or paired picks on the posterior margin of the carapace engage with a stridulatory file on the antero-dorsal surface of the abdomen. The male palp has an excavated paracymbium on the proximal edge of the retromargin of the cymbium.

DESCRIPTION: Abdomen of males is more elongate than in females; legs long and slender, the first pair much the longest; leg formula 1243 or 1423. Eight eyes in two rows, posterior row slightly recurved. AME smallest, other eyes subequal. Secretory glands on the clypeus and eyemound open from single pores in *Pahoroides* and from multipore pits in *Pahora*, *Nomaua* and *Runga* (Forster *et al.* 1990). Chelicerae are vertical, with promarginal and retromarginal teeth and a patch of denticles in fang furrow (in contrast to the single row of denticles found in species of Physogleninae).

Labium about twice as wide as long and sternum about as wide as long; coxae IV separated by their width. Male palp has an elongate paracymbial excavation on proximal edge of retromargin of cymbium. Female palp has a strong tarsal claw bearing a single tooth (Forster *et al.* 1990). See Forster *et al.* (1990) for further information.

Genus *Pahoroides* Forster, 1990

Pahoroides Forster, 1990 (in Forster *et al.* 1990: 53). Type species: *Pahoroides whangarei* Forster, 1990.

DIFFERENTIAL DIAGNOSIS: Species of *Pahoroides* are distinguished from all other pahorines by the elongate epigynal scape of females, the distal projection on the palpal tibia of males, and elongate tegular apophyses extending beyond the distal margin of the cymbium.

DESCRIPTION:

Size: Small, total length of males 2.2–3.3 mm, females 1.7–2.3 mm; legs long.

Colour: Carapace dark grey-brown, paler down the mid-line; abdomen with pale greyish pattern along the dorsal mid-line of the abdomen and pale patches on the lateral surfaces (Fig. 1; see also Forster *et al.* 1990: figs 182–185); sternum and ventral abdomen uniform dark grey-brown. Legs orange-brown, without banding.

Cephalothorax: The eyemound of adult males is small, with four long macrosetae arranged in two pairs, the anterior pair closely spaced behind the AME, the posterior pair more widely spaced, anterior to the PME (Fig. 2) (*Pahora* has similar macrosetae, in the same arrangement). Four setae on the mid-line between the PME and the fovea, three setae in a row from the PLE to the mid-line anterior to the fovea. Fovea, relatively wide anteriorly, narrows and deepens in a V posteriorly (in *Pahora* it is a transverse furrow (Forster *et al.* 1990: fig. 130)).

Chelicerae: Promarginal and retromarginal teeth present, fang furrow with denticles (Forster *et al.* 1990: fig. 189).

Palp: Males have a long macroseta on the patella; retrolateral to it on the distal margin is a small sclerotised knob. The tibia has a strong retrodistal projection; this projection bears one or two macrosetae near the distal margin and three trichobothria, two of them with ridged bases (Forster *et al.* 1990: figs 192, 193). The TTA comprises three elements, a long ventral apophysis, a prolateral apophysis extending up or around the dorsal side of the ventral apophysis, and a broad retrolateral apophysis extending up no further than the tip of the cymbium. The embolus is straight and spiniform, originating prolaterally at the base of the bulb. The median apophysis, with a projecting tip, lies between



Fig. 1 *Pahoroides whangarei*, lateral view of female, showing abdominal colour pattern and epigynal scape.

the ventral apophysis and the distal margin of the cymbium. Paracymbial excavation is elongate.

Abdomen: Elongate in males, at least three times as long as wide; globose in females, about twice as long as high.

Colulus: With three hairs.

Legs: Formula is usually 1243, but leg 2 is only slightly longer than leg 4, and in females leg 4 is sometimes longer than leg 2, e.g. *P. balli*, *P. kohukohu*, *P. aucklandica* (Table 1) and *P. courti* (Forster *et al.* 1990).

Female genitalia: Epigynal scape is long, tapered or slender, extending at least half the length of the abdomen (Fig. 1). One pair of receptacula.

DISTRIBUTION: Known from the northern half of the North Island of New Zealand, from North Cape (34°25'S, 173°03'E) south to Maungatautari (37°57'S, 175°34'E), Lake Rotorua (38°05'S, 176°16'E) and Lake Waikaremoana (38°45'S, 177°05'E).

BIOLOGY: *Pahoroides* inhabit forest and scrub, living among ferns, low vegetation and twiggy litter. They construct a domed snare in the form of an inverted bowl with numerous threads above it (Forster *et al.* 1990: fig. 191).

DISCUSSION: Forster (1990, in Forster *et al.* 1990) established the genus *Pahoroides*, describing two species (*P. whangarei* and *P. courti*), and stating that the 'genus seems closely related to *Pahora*'. Although the pattern of four macrosetae on the eyemound of males is similar in the two genera, genitalic characters differ and indicate that the relationship might be more distant than Forster suggested. The very elongate epigynal scape of *Pahoroides* might appear to be derived from the shorter scape of *Pahora*, but the internal genitalia of *Pahoroides* differ markedly; in *Pahoroides* the



Fig. 2 *Pahoroides courti*, cephalothorax of male, showing the large palps and four macrosetae on the eyemound.

fertilisation ducts are anterior to the simple receptacula, while in *Pahora* they are posterior to the compound receptacula. Also, male *Pahoroides* have a tibial projection, with distal macroseta and three subdistal trichobothria (some with ridged bases), whereas *Pahora* lack the tibial projection but have several tibial spurs bearing trichobothria. The apophyses on the genital bulb of *Pahora* appear to be more like those of *Nomaua* than those of *Pahoroides*.

Pahoroides whangarei Forster, 1990

(Figs 1, 3, 11, 19)

Pahoroides whangarei Forster, 1990 (in Forster *et al.* 1990: 54, figs 182–186, 188–190, 192, 193, 195, 196).

TYPE MATERIAL: **Holotype** ♂, from bowl-webs on tree trunks, Coronation Park, Whangarei, ND, New Zealand, 6 Feb. 1981, R.R. Forster (OMNZ IV2962). Examined 29 Sep. 2009. **Allotype** ♀, same data as for holotype (OMNZ IV2963). Examined 29 Sep. 2009.

DIFFERENTIAL DIAGNOSIS: Males of *Pahoroides whangarei* are distinguished from males of all other species by the apically bifurcate tip of the ventral apophysis of the palp (Figs 3, 11); and females by the relatively short, broad scape (Fig. 19). (See also Forster *et al.* 1990: figs 195, 196 for male palp, and figs 186, 190 for scape.)

DESCRIPTION:

Male

Measurements: Total length 2.756; carapace length 0.906, width 0.709; sternum length 0.488, width 0.488; labium length 0.061, width 0.146 (MONZ AS.001924). Size range expressed by body length: 2.126–3.307 (mean 2.650, $n = 16$).

Table 1 Measurements of the segments of the legs and palp of *Pahoroides* species. Abbreviations for the segments are: fem. = femur, pat. = patella, tib. = tibia, met. = metatarsus, tar = tarsus.

<i>Pahoroides whangarei</i>						
Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.780	0.315	3.622	3.858	1.969	13.543
leg 2	2.520	0.236	1.890	2.283	1.181	8.110
leg 3	1.575	0.197	1.024	1.260	0.748	4.803
leg 4	2.402	0.236	1.811	1.969	0.866	7.283
palp	0.415	0.122	0.146	—	0.366	1.049
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	2.992	0.315	2.835	2.913	3.811	10.866
leg 2	2.047	0.236	1.654	1.811	1.102	6.850
leg 3	1.339	0.197	0.945	1.102	0.630	4.213
leg 4	1.890	0.236	1.496	1.417	0.787	5.827
palp	0.341	0.110	0.171	—	0.341	0.963
<i>Pahoroides courti</i>						
Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.543	0.315	3.465	3.858	1.969	13.150
leg 2	2.362	0.276	1.969	2.362	1.260	8.228
leg 3	1.575	0.236	1.181	1.496	0.787	5.276
leg 4	2.283	0.276	1.890	1.969	0.984	7.402
palp	0.463	0.134	0.171	—	0.415	1.183
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	2.677	0.315	2.520	2.598	1.496	9.606
leg 2	1.772	0.236	1.417	1.417	0.866	5.709
leg 3	1.102	0.197	0.787	0.945	0.551	3.583
leg 4	1.811	0.236	1.417	1.260	0.709	5.433
palp	0.341	0.122	0.171	—	0.268	0.902
<i>Pahoroides balli</i>						
Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.307	0.315	3.228	3.465	1.772	12.087
leg 2	1.969	0.276	1.732	1.457	1.102	6.535
leg 3	1.457	0.236	1.063	1.260	0.669	4.685
leg 4	2.047	0.236	1.654	1.654	0.787	6.378
palp	0.366	0.146	0.122	—	0.390	1.024
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	2.598	0.236	1.654	2.126	1.181	7.795
leg 2	1.654	0.236	1.220	1.417	0.866	5.394
leg 3	1.102	0.157	0.787	0.866	0.591	3.504
leg 4	1.654	0.197	1.339	1.417	0.866	5.472
palp	0.293	0.122	0.122	—	0.244	0.780

Pahoroides kohukobu

Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.228	0.315	3.386	3.937	1.811	12.677
leg 2	2.362	0.315	1.890	2.283	1.260	8.110
leg 3	1.339	0.236	1.102	1.417	0.709	4.803
leg 4	2.362	0.236	1.890	1.969	0.984	7.441
palp	0.366	0.146	0.098	—	0.366	0.976
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.307	0.315	3.110	3.228	1.811	11.772
leg 2	1.969	0.276	1.575	1.732	0.945	6.496
leg 3	1.339	0.236	0.945	1.260	0.709	4.488
leg 4	2.126	0.236	1.654	1.732	0.866	6.614
palp	0.366	0.159	0.171	—	0.463	1.159

Pahoroides confusa

Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.386	0.315	2.992	3.858	2.047	12.598
leg 2	2.047	0.276	1.732	2.205	0.866	7.126
leg 3	1.260	0.236	1.102	1.260	0.709	4.567
leg 4	2.126	0.276	1.575	1.457	0.787	6.220
palp	0.415	0.122	0.122	—	0.244	0.902
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.071	0.276	2.913	3.150	1.811	11.220
leg 2	1.969	0.236	1.575	1.811	1.102	6.693
leg 3	1.417	0.236	0.906	0.945	0.787	4.291
leg 4	1.890	0.236	1.654	1.614	0.827	6.220
palp	0.366	0.134	0.171	—	0.293	0.963

Pahoroides gallina

Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.071	0.315	2.598	3.307	1.969	11.260
leg 2	2.441	0.276	2.047	2.362	1.142	8.268
leg 3	1.654	0.236	1.024	1.614	0.709	5.236
leg 4	2.441	0.236	1.969	2.047	0.945	7.638
palp	0.317	0.122	0.122	—	0.317	0.878
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	2.441	0.315	2.283	2.756	1.575	9.370
leg 2	1.890	0.236	1.260	1.575	0.866	5.827
leg 3	1.181	0.236	0.866	1.024	0.669	3.976
leg 4	1.732	0.236	1.457	1.339	0.709	5.472
palp	0.354	0.122	0.195	—	0.341	1.012

continued on following page

Continued from previous page

<i>Pahoroides aucklandica</i>						
Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.150	0.315	3.150	3.622	1.890	12.126
leg 2	2.126	0.276	1.732	1.969	1.102	7.205
leg 3	1.496	0.236	1.260	1.339	0.787	5.118
leg 4	2.362	0.276	1.811	1.732	0.945	7.126
palp	0.463	0.146	0.171	—	0.341	1.122
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	3.071	0.315	2.677	2.913	1.575	10.551
leg 2	1.969	0.236	1.575	1.811	1.024	6.614
leg 3	1.102	0.157	0.945	1.102	0.630	3.937
leg 4	2.598	0.236	1.654	1.575	0.866	6.929
palp	0.293	0.146	0.195	—	0.305	0.939

<i>Pahoroides forsteri</i>						
Male	fem.	pat.	tib.	met.	tar.	Total
leg 1	2.953	0.276	2.598	2.835	1.535	10.197
leg 2	1.969	0.236	1.654	1.496	0.984	6.339
leg 3	1.417	0.197	1.339	1.102	0.669	4.724
leg 4	1.890	0.236	1.732	1.339	0.787	5.984
palp	0.293	0.146	0.146	—	0.341	0.927
Female	fem.	pat.	tib.	met.	tar.	Total
leg 1	2.205	0.236	1.732	2.126	1.260	7.559
leg 2	1.339	0.236	1.260	1.339	0.787	4.961
leg 3	0.866	0.197	0.787	0.866	0.472	3.189
leg 4	1.575	0.197	1.181	1.181	0.630	4.764
palp	0.317	0.110	0.171	—	0.329	0.927

Eyes: AME 0.049, ALE 0.061, PME 0.073, PLE 0.061; AME–AME 0.012, AME–ALE 0.049, PME–PME 0.061, PME–PLE 0.061, ALE–PLE 0.005.

Palp: Retrodistal projection on the tibia has a slender macroseta near the distal margin and a more slender macroseta part way down the projection. The distal end of the ventral apophysis is bifurcate and the proteral apophysis is slender and curved (Figs 3, 11).

Female

Measurements: Total length 2.047; carapace length 0.827, width 0.669; sternum length 0.463, width 0.488; labium length 0.061, width 0.134 (MONZ AS.001924). Size range expressed by body length: 1.732–2.126 (mean 1.983, $n = 11$).

Eyes: AME 0.049, ALE 0.061, PME 0.061, PLE 0.061; AME–AME 0.012, AME–ALE 0.037, PME–PME 0.061, PME–PLE 0.037, ALE–PLE 0.005.

Colour: Abdomen lateral colour pattern as in Fig. 1 (see also Forster *et al.* 1990: fig. 182).

Genitalia: Scape relatively short and broad (Fig. 19) and tip flattened dorso-ventrally.

OTHER MATERIAL EXAMINED: ND. 3♀, Kaitaia, 30 Jan. 1981, R.R. Forster (OMNZ); 1♂, 12♀, Mangamuka, 31 Jan. 1981, R.R. Forster (OMNZ); 5♂, 10♀, North Auckland, Coronation Park, Whangarei, 6 Feb. 1981, from bowl-webs on tree trunks, R.R. Forster (OMNZ IV35939); 1♂, 7♀, Matthew Reserve (Forest & Bird), 35°09.254'S, 173°17.506'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald

(MONZ AS.001738–40); 1♀, Warawara Forest Park, Kauri Plateau, 500 m, kauri forest, not logged, king fern 20 cm off ground, 35°22.75'S, 173°17.25'E, 7 Nov. 2009, D.S. Seldon (MONZ AS.001762); 2♀, Mangamuka Summit, 35°11.401'S, 173°27.366'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001713); 1♀, Mangamuka Gorge, picnic area, 35°11.600'S, 173°28.878'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001731); 1♀, Kohukohu, The Skyline, Tupuwae Forest, 35°21.311'S, 173°27.578'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001746); 9♂, 6♀, 3 penultimate ♂, Trounson Kauri Forest, 35°43.159'S, 173°38.932'E, 24 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001700–1); 7♂, 10♀, Whangarei, Coronation Park, N end (off Russell Rd), 35°42.799'S, 174°18.840'E, 25 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001698–99, AS.001924, AS.001702); 4♀, Whangarei, Coronation Park, S end (off Wilson Rd), 35°43.480'S, 174°18.461'E, 26 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001689).

DISTRIBUTION: Northland, from Kaitaia to Whangarei.

COMMENTS: We agree that the SEM images of the retrodistal projection on the palpal tibia (Forster *et al.* 1990: figs 192, 193) are of *Pahoroides whangarei* on the basis that the macroseta on the retrodistal projection is more slender than in *P. confusa*. We also agree that SEM images of the palp (Forster *et al.* 1990: figs 195, 196) represent *P. whangarei*. However, we identify two SEM images of the palp (Forster *et al.* 1990: figs 194, 197) as not belonging to *P. whangarei* but to *P. confusa* (see below).

We examined specimens held in OMNZ that were listed in Forster *et al.* (1990). Much of the material is now in poor condition and difficult to identify, so only part is listed here.

Pahoroides courti Forster, 1990

(Figs 4, 12, 20)

Pahoroides courti Forster, 1990 (in Forster *et al.* 1990: 56, figs 187, 198, 199).

TYPE MATERIAL: **Holotype** ♂, Te Tapui Scenic Reserve, Matamata, **WO**, New Zealand, 20 Aug. 1984, D.J. Court (OMNZ IV2964). Examined 29 Sep. 2009. **Allotype** ♀, rimu/tawa forest, Lake Okataina, Rotorua, **BP**, New Zealand, 20 Oct. 1984, D.J. Court (OMNZ IV2965). Examined 29 Sep. 2009.

DIFFERENTIAL DIAGNOSIS: Males of *Pahoroides courti* are distinguished from males of all other species by the broad arrowhead shape of the distal end of the prolateral apophysis (Fig. 4); and females by the very long scape of uniform

width (Fig. 20). (See also Forster *et al.* 1990: fig. 198 for male palp, and figs 187 and 199 for scape.)

DESCRIPTION:

Male

Measurements: Total length 2.520; carapace length 0.866, width 0.630; sternum length 0.488, width 0.488; labium length 0.073, width 0.146 (MONZ AS.001923). Size range expressed by body length: 2.362–3.386 (mean 2.655, $n = 7$). **Eyes:** AME 0.049, ALE 0.061, PME 0.061, PLE 0.061; AME–AME 0.012, AME–ALE 0.049, PME–PME 0.073, PME–PLE 0.061, ALE–PLE 0.005.

Palp: The tibia has a large retrodistal projection with a long macroseta near the distal margin (Figs 4, 12).

Female

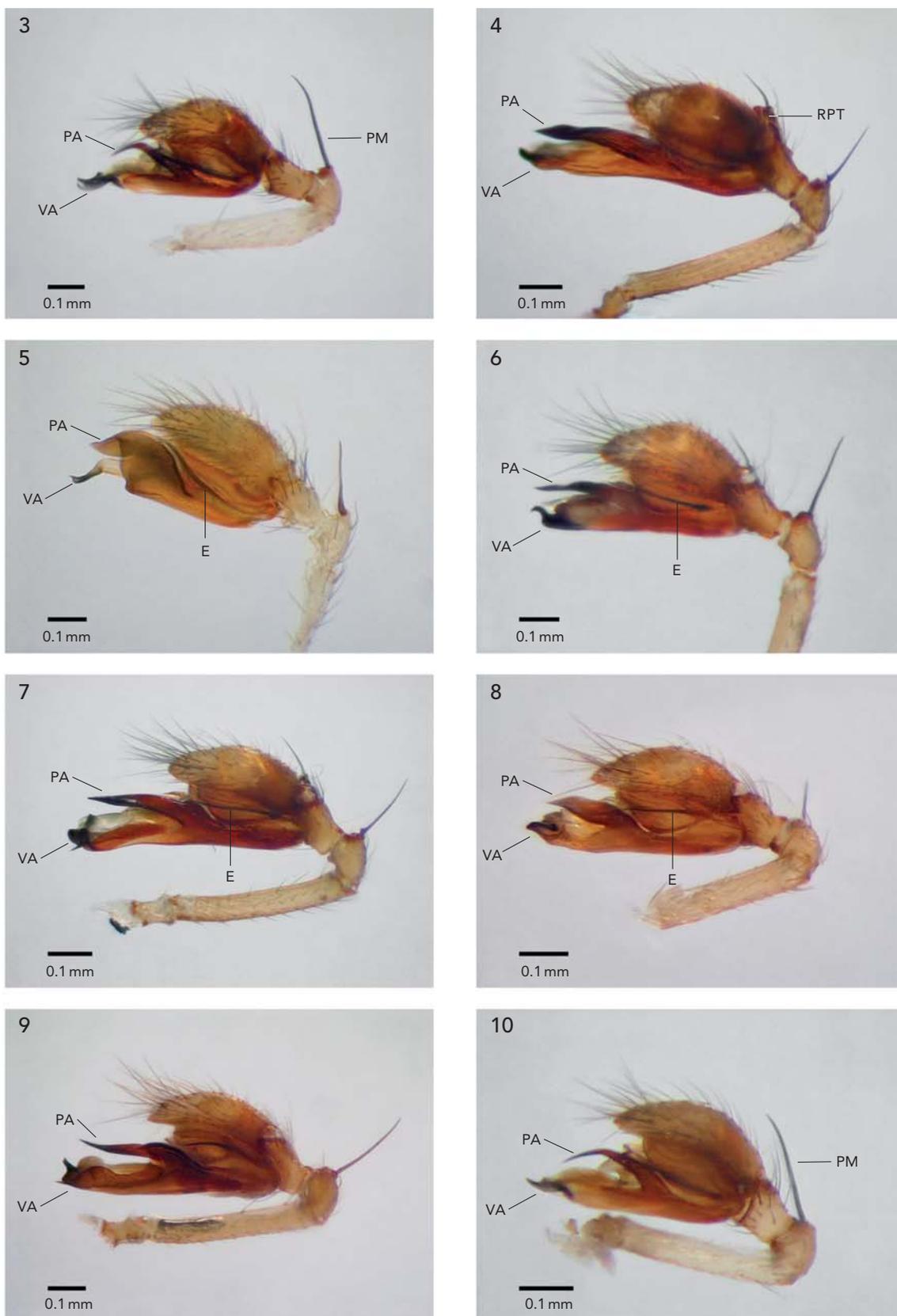
Measurements: Total length 2.126; carapace length 0.787, width 0.551; sternum length 0.463, width 0.439; labium length 0.073, width 0.146 (MONZ AS.001923). Size range expressed by body length: 1.811–2.362 (mean 2.115, $n = 14$).

Eyes: AME 0.049, ALE 0.061, PME 0.061, PLE 0.061; AME–AME 0.012, AME–ALE 0.024, PME–PME 0.073, PME–PLE 0.037, ALE–PLE 0.005.

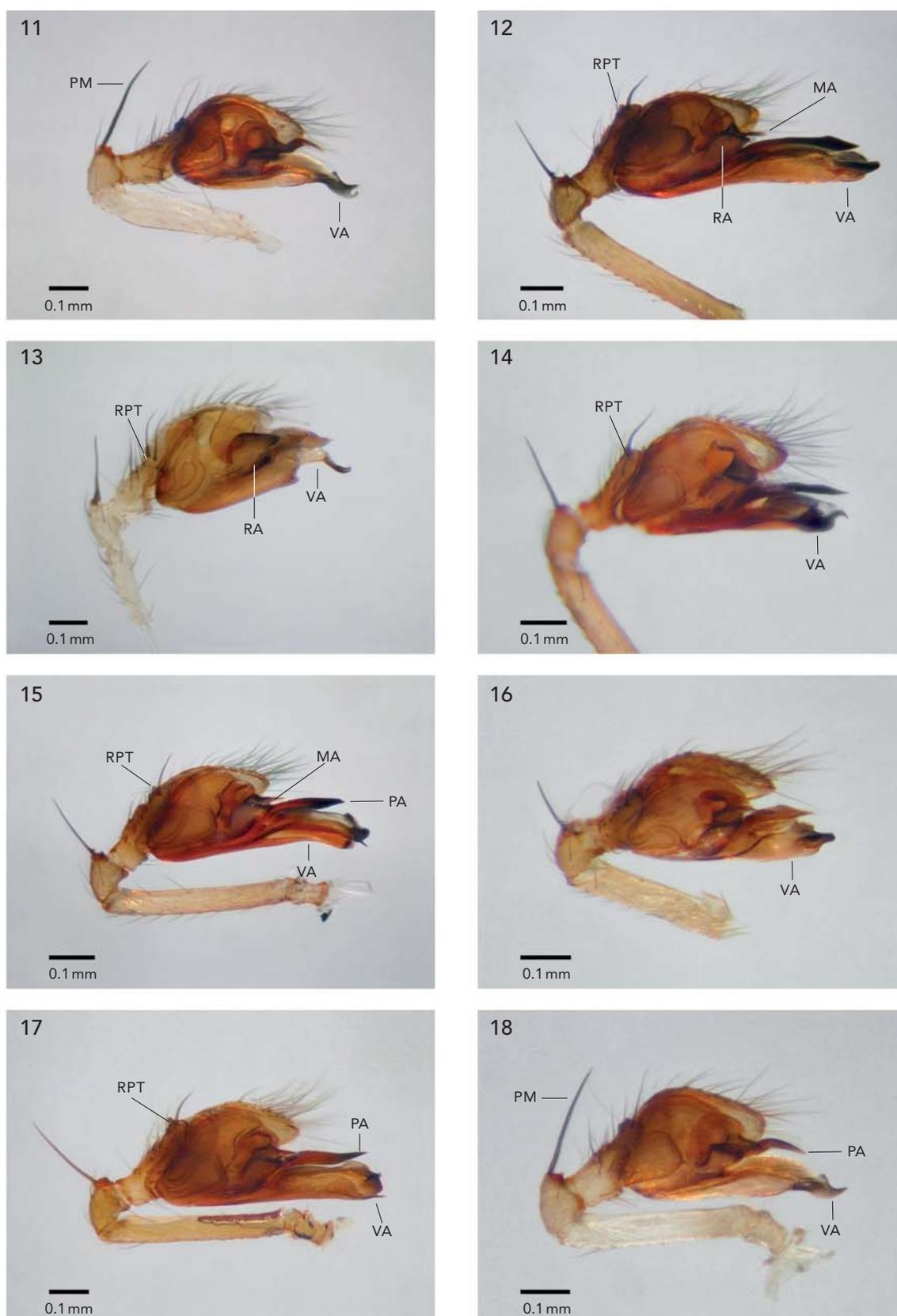
Colour: Lateral abdomen with the same basic pattern as in *Pahoroides whangarei* but the pale areas narrower.

Genitalia: Scape very long and slender (Fig. 20).

OTHER MATERIAL EXAMINED: **ND.** 1♂, Kaitaia, east Herekino, nīkau frond on ground, 35°10'S, 173°16'E, 16 Jan. 2010, D.S. Seldon (MONZ AS.001761); 1♂, Kohukohu, The Skyline, Tupuwae Forest, 35°21.311'S, 173°27.578'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001744); 1♂, 1 penultimate ♂, Waipoua Forest, kauri forest S of Tāne Mahuta, 35°37.404'S, 173°33.623'E, 24 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001722). **WO.** 1♂, Limestone Downs, native bush, pitfall trap, 22 Dec. 2009–13 Jan. 2010, C.H. Watts (MONZ, AS.001583); 1♂, Maungatautari, South cell, outside cell, transect 1 pitfall trap J, Dec. 2008–Jan. 2009, C.H. Watts (MONZ AS.001584); 1♀, Maungatautari, South cell, outside cell, transect 1 pitfall trap J, 21 Jan. 2009–24 Feb. 2009, C.H. Watts (MONZ AS.001585); 2♀, Maungatautari Mt., pitfall trap in native forest, Jan.–Feb. 2010, C.H. Watts (MONZ AS.001804). **CL.** 1♀, Tuhua (Mayor Island). Te Huinga, from litter and broken branch, 24 Feb. 2003, B.M. Fitzgerald (MONZ AS.001763). **BP.** 2♂, 1♀, 1 penultimate ♂, Mokoia Island, Lake Rotorua, under branch and litter on ground, and



Figs 3–10 Prolateral view of palps of males: 3, *Pahoroides whangarei*; 4, *Pahoroides courti*; 5, *Pahoroides balli*; 6, *Pahoroides kobukohu*; 7, *Pahoroides confusa*; 8, *Pahoroides gallina*; 9, *Pahoroides aucklandica*; 10, *Pahoroides forsteri*.



Figs 11–18 Retrolateral view of palps of males: 11, *Pahoroides whangarei*; 12, *Pahoroides courti*; 13, *Pahoroides balli*; 14, *Pahoroides kohukohu*; 15, *Pahoroides confusa*; 16, *Pahoroides gallina*; 17, *Pahoroides aucklandica*; 18, *Pahoroides forsteri*.

dead leaves, 7 and 8 Feb. 2000, B.M. Fitzgerald (MONZ AS.001764); 1 ♀, Moutohora (Whale Island), damp gully, beaten from blechnum ferns, 1 Apr. 2005, B.M. Fitzgerald (MONZ AS.001765). **GB**. 1 penultimate ♂, 1 penultimate ♀, 1 fragment, beech forest, Treatment 2, Papaotehiwera Bay, Lake Waikaremoana, Urewera National Park, ex. sifting litter/moss, 19–26 Nov. 1996, L.J. Boutin (MONZ AS.001768); 1 ♂, 4 ♀, 3 penultimate ♂, 2 penultimate ♀, 1 ♀ fragment, mixed podocarp forest, Control 1, Whakeneperu Bay, Lake Waikaremoana, Urewera National Park, under log/bark, 19–26 Nov. 1996, L.J. Boutin (MONZ AS.001767, AS.001923); 1 ♀ (damaged), beech forest, Control 2, Te Piripiri Bay, Lake Waikaremoana, Urewera National Park, pitfall trap, 14 Jan. 1997, L.J. Boutin (MONZ AS.001769); 1 ♀, Hinau Walk, Whaitiri Point, Lake Waikaremoana, Urewera National Park, beating, 11 Jun. 2008, B.M. Fitzgerald (MONZ AS.001766); 1 ♂, 3 ♀, 1 penultimate ♀, Tawa Loop portion of Ngamoko Track, Lake Waikaremoana, Urewera National Park, beating, 20 Nov. 2008, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001439); 2 ♀, 1 penultimate ♂, track from Onepoto Redoubt to Lake Kiriopukae, Urewera National Park, beating, 19 Nov. 2008, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001459).

DISTRIBUTION: From northern Northland south to Maungatautari, Lake Rotorua and Lake Waikaremoana.

COMMENTS: On the holotype male the right palp is missing, presumably having been used for the SEM photograph (Forster *et al.* 1990: fig. 198), but the left palp is present.

Pahoroides balli new species

(Figs 5, 13, 21)

TYPE MATERIAL: **Holotype** ♂, Te Pahi, Haupatoto, 34° 27.7697'S, 172°57.1582'E, ND, New Zealand, native bush, pitfall trap 6, 9 Apr.–7 May 2009, O. Ball (MONZ AS.001785). **Allotype** ♀, Te Pahi, Haupatoto, 34°27.7697'S, 172°57.1582'E, ND, New Zealand, native bush, pitfall trap 1, 9 Apr.–7 May 2009, O. Ball (MONZ AS.001786).

ETYMOLOGY: The species epithet is a patronymic in honour of Dr Olivier J.-P. Ball, who collected the specimens, and in recognition of his studies of the biodiversity of the Te Pahi Ecological District.

DIFFERENTIAL DIAGNOSIS: Males of *Pahoroides balli* are distinguished from males of all other species by the curved distal projection on the ventral apophysis of the palp (Figs 5, 13); and females by the relatively short, tapered scape (Fig. 21).

DESCRIPTION:

Male

Measurements: Total length 2.205; carapace length 0.945, width 0.551; sternum length 0.390, width 0.366; labium length 0.098, width 0.146 (MONZ AS.001802). Size range expressed by body length: 2.205–2.283 (mean 2.244, $n = 2$). **Eyes:** AME 0.061, ALE 0.061, PME 0.061, PLE 0.073; AME–AME 0.005, AME–ALE 0.024, PME–PME 0.073, PME–PLE 0.049, ALE–PLE 0.005.

Palp: The retrodistal projection of the tibia is short, with two macrosetae near the distal margin (Fig. 13). The ventral apophysis terminates in a dark, curved projection and the broad proteral apophysis extends around the ventral apophysis.

Female

Measurements: Total length 1.890; carapace length 0.709, width 0.551; sternum length 0.439, width 0.415; labium length 0.073, width 0.146 (MONZ AS.001802). Size range expressed by body length: 1.417–1.969 (mean 1.693, $n = 11$).

Eyes: AME 0.049, ALE 0.073, PME 0.061, PLE 0.073; AME–AME 0.005, AME–ALE 0.024, PME–PME 0.049, PME–PLE 0.037, ALE–PLE 0.007.

Colour: Lateral abdomen with the same basic pattern as in *Pahoroides whangarei* but the pale areas narrower.

Genitalia: Scape broad, gradually tapering to the tip. The receptacula are ovoid (Fig. 21).

OTHER MATERIAL EXAMINED: ND. 2 ♀, Te Pahi, Radar Bush, 34°28.42'S, 172°45.87'E, native bush, pitfall traps 1 and 2, 14 Aug.–14 Sep. 2006, O. J.-P. Ball (MONZ AS.001311–2); 2 ♀, Te Pahi, Radar Bush, 34°28.42'S, 172°45.87'E, native bush, pitfall traps 3 and 4, 13 Oct.–13 Nov. 2006, O. J.-P. Ball (MONZ AS.001798); 1 ♂, 3 ♀, Te Pahi, Radar Bush, 34°28.42'S, 172°45.87'E, native bush, pitfall traps 1, 3 and 8, 12 Jan.–12 Feb. 2007, O. J.-P. Ball (MONZ AS.001796–7, AS.001800–1); 1 ♂, 1 ♀, Te Pahi, Radar Bush, 34°28.42'S, 172°45.87'E, native bush, pitfall traps 3 and 8, 12 Feb.–13 Mar. 2007, O. J.-P. Ball (MONZ AS.001802); 2 ♀, Te Pahi, Radar Bush, 34°28.42'S, 172°45.87'E, native bush, pitfall traps 3 and 8, 13 Mar.–13 Apr. 2007, O. J.-P. Ball (MONZ AS.001582); 2 ♀, Te Pahi, Radar Bush, 34°28.42'S, 172°45.87'E, native bush, pitfall traps 3 and 4, 13 Apr.–14 May 2007, O. J.-P. Ball (MONZ AS.001799); 1 ♀, Te Pahi, Unuwahao Site A, 34°26.139'S, 172°53.279'E, broadleaf forest, pitfall trap 3, 14 Jul.–14 Aug. 2006,

O. J.-P. Ball (MONZ AS.001795); 1♀, 1 penultimate ♂, Te Pahi, Unuwahao Site A, 34°26.139'S, 172°53.279'E, broadleaf forest, pitfall traps 1 and 6, 13 Oct.–13 Nov. 2006, O. J.-P. Ball (MONZ AS.001794); 1♀, Te Pahi, Kohuronaki Site 1, 34°29.4658'S, 172°50.2647'E, native bush, pitfall trap 8, 14 Jul.–14 Aug. 2006, O. J.-P. Ball (MONZ AS.001793); 1♀, Te Pahi, Kohuronaki Site 1, 34°29.4658'S, 172°50.2647'E, native bush, pitfall trap 4, 13 Nov.–14 Dec. 2006, O. J.-P. Ball (MONZ AS.001789); 1♀, Te Pahi, Kohuronaki Site 1, 34°29.4658'S, 172°50.2647'E, native bush, pitfall trap 4, 13 Mar.–13 Apr. 2007, O. J.-P. Ball (MONZ AS.001791); 1♀, Te Pahi, Kohuronaki Site 1, 34°29.4658'S, 172°50.2647'E, native bush, pitfall trap 8, 14 May–12 Jun. 2007, O. J.-P. Ball (MONZ AS.001792); 1♀, Te Pahi, Darkies Ridge, 34°27.6695'S, 172°45.623'E, shrubland, pitfall trap 7, 13 Apr.–14 May 2007, O. J.-P. Ball (MONZ AS.001790); 1♀, Te Pahi, Te Huka, 34°25.8957'S, 172°55.187'E, native bush, pitfall trap 7, 22 Oct.–21 Nov. 2008, O. J.-P. Ball (MONZ AS.001788); 3♀, Te Pahi, Te Huka, 34°25.8957'S, 172°55.187'E, native bush, pitfall traps 4 and 5, 9 Apr.–7 May 2009, O. J.-P. Ball (MONZ AS.001787, AS.001821).

DISTRIBUTION: Known from the North Cape and Cape Reinga area (Te Pahi Ecological District), Northland.

Pahoroides kohukohu new species

(Figs 6, 14, 22)

TYPE MATERIAL: **Holotype** ♂, Kohukohu, The Skyline, ND, Tupuwae Forest, 35°21.311'S, 173°27.578'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001748). **Allotype** ♀, same data as holotype (MONZ AS.001747). **Paratypes** 2♀, same data as holotype (MONZ AS.001749). **ETYMOLOGY:** The species epithet is a noun in apposition taken from the type locality, north of the Hokianga Harbour, Northland.

DIFFERENTIAL DIAGNOSIS: Males of *Pahoroides kohukohu* are distinguished by the black hook across the top of the ventral apophysis of the palp (Figs 6, 14); and females by the shape of the epigynal scape, constricted at the base and widening distally (Fig. 22).

DESCRIPTION:

Male

Measurements: Total length 2.598; carapace length 0.945, width 0.630; sternum length 0.463, width 0.439; labium length 0.073, width 0.122 (MONZ AS.001715). Size range expressed by body length: 2.598–2.677 (mean 2.638, $n = 2$). **Eyes:** AME 0.061, ALE 0.061, PME 0.061, PLE 0.073;

AME–AME 0.005, AME–ALE 0.024, PME–PME 0.073, PME–PLE 0.049, ALE–PLE 0.005.

Palp: The retrodistal projection of the tibia has a strong macroseta; the TTA is relatively short, and the ventral apophysis has a sharp black hook on the tip (Fig. 6), that originates on the retrolateral side of the tip and curves across the tip, prolaterally (Fig. 14). The prolateral apophysis is broad and flattened as in *Pahoroides courti*.

Female

Measurements: Total length 1.732; carapace length 0.906, width 0.669; sternum length 0.488, width 0.488; labium length 0.073, width 0.159 (MONZ AS.001741). Size range expressed by body length: 1.732–2.205 (mean 2.000, $n = 5$). **Eyes:** AME 0.061, ALE 0.073, PME 0.061, PLE 0.073; AME–AME 0.005, AME–ALE 0.012, PME–PME 0.061, PME–PLE 0.037, ALE–PLE 0.005.

Genitalia: Scape narrow at base, wider in the distal half, and narrows to a tip that is not dorso-ventrally flattened (Fig. 22).

OTHER MATERIAL EXAMINED: ND, 2♂, 4♀, North Auckland, Kohukohu, The Skyline, 28 Aug. 1953, B.J. Marples (OMNZ IV35938); 1♂, 4♀, 1 immature ♀, Waipoua Forest, 20 Jan. 1981, R.R. Forster, (OMNZ IV35937); 1♀, Mangamuka Summit, 35°11.401'S, 173°27.366'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001712); 1♀, Waipoua Forest, kauri forest S of Tāne Mahuta, 35°36.212'S, 173°31.936'E, 24 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001741); 1♀, Waipoua Forest, kauri forest S of Tāne Mahuta, 35°37.404'S, 173°33.623'E, 24 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001723); 1♂, Kaihu Farm Hostel, forest, 35°45.738'S, 173°40.410'E, 24 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001715).

DISTRIBUTION: Western side of Northland, from Mangamuka and Kohukohu, south through Waipoua Forest to Kaihu.

COMMENTS: The specimens of *Pahoroides kohukohu* collected by Marples and Forster, listed above, are in poor condition, but identifiable. Their samples also include fragmentary material of one or more additional species that were unidentifiable.

Pahoroides confusa new species

(Figs 7, 15, 23)

Pahoroides whangarei Forster (in Forster *et al.* 1990: 54). In part: figs 194, 197.

TYPE MATERIAL: **Holotype** ♂, Whangarei, ND, Coronation

Park, S end (off Wilson Rd), 35°43.480'S, 174°18.461'E, 26 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001692). **Allotype** ♀, same data as for holotype (MONZ AS.001691). **Paratypes** 2♂, 5♀, same data as holotype (MONZ AS.001688, AS.001690, AS.002137–8).

ETYMOLOGY: The species epithet (from Latin = confused) refers to the inclusion of this species in the original description of *Pahoroides whangarei*.

DIFFERENTIAL DIAGNOSIS: Males of *Pahoroides confusa* are identifiable by the distal spine on the ventral apophysis and the shape of the proteral apophysis (Figs 7, 15); and females by the scape of medium thickness throughout its length (Fig. 23). This species may be found with *P. whangarei*, *P. courti* and *P. kohukohu*. Males may be distinguished by the form of the ventral apophysis of the TTA (bifurcated in *P. whangarei* (Fig. 3), terminating in a black hook in *P. kohukohu* (Fig. 6) or the proteral apophysis (distally arrowhead shaped in *P. courti* (Fig. 4)). Females can be separated on the basis of scape form (Figs 19, 20, 22, 23). *Pahoroides confusa* most closely resembles *P. aucklandica* but males can be separated by the form of the proteral and the ventral apophyses (PA narrower and more tapered, and VA distally lobate in *P. aucklandica* (Figs 9, 17)), while the profile of the broad basal region of the scape can be used to separate females (Fig. 23).

DESCRIPTION:

Male

Measurements: Total length 2.362; carapace length 0.866, width 0.630; sternum length 0.463, width 0.439; labium length 0.073, width 0.146 (MONZ AS.001832). Size range expressed by body length: 2.362–2.598 (mean 2.520, $n = 4$). **Eyes:** AME 0.049, ALE 0.061, PME 0.073, PLE 0.073; AME–AME 0.049, AME–ALE 0.049, PME–PME 0.073, PME–PLE 0.049, ALE–PLE 0.005.

Palp: Retrodistal projection is short and blunt, with a strong macroseta on the distal margin, about as thick as that on the patella. The ventral apophysis ends with a thickened tip and distal spine; the retrolateral apophysis is broad (Figs 7, 15).

Female

Measurements: Total length 1.811; carapace length 0.827, width 0.630; sternum length 0.463, width 0.463; labium length 0.073, width 0.171 (MONZ AS.001737). Size range expressed by body length: 1.732–2.283 (mean 1.998, $n = 8$). **Eyes:** AME 0.049, ALE 0.061, PME 0.061, PLE 0.061; AME–AME 0.012, AME–ALE 0.024, PME–PME 0.049, PME–PLE 0.049, ALE–PLE 0.005.

Colour: Lateral abdomen with same basic pattern as in *Pahoroides whangarei* but pale areas narrower.

Genitalia: The scape and genitalia are shown in Fig. 23.

OTHER MATERIAL EXAMINED: ND. 1♂, 1♀, Coronation Park, Whangarei, 6 Feb. 1981, from bowl-webs on tree trunks, R.R. Forster (OMNZ IV35939); 2♀, Kohukohu, The Skyline, Tupuwae Forest, 35°21.311'S, 173°27.578'E, 23 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001745); 1♀, Waipoua Forest, kauri forest N of Tāne Mahuta, 35°35.756'S, 173°31.634'E, 24 Mar. 2010, P.J. Sirvid and B.M. Fitzgerald (MONZ AS.001737); 2♂, Mas Olivier, 35°51.841'S, 174°10.150'E, 25 Mar. 2010, B.M. Fitzgerald and O.J.-P. Ball (MONZ AS.001751, AS.001832); 1♂, Mas Olivier, 35°51.841'S, 174°10.150'E, 26 Mar. 2010, O.J.-P. Ball (MONZ AS.001750).

DISTRIBUTION: Northland, from Kohukohu and Waipoua Forest to Whangarei district.

COMMENTS: The vial containing 1♂, 1♀ collected by R.R. Forster (OMNZ IV35939), listed above, also contains 5♂, 10♀ of *Pahoroides whangarei*. This is confirming evidence that Forster's (1990) concept of *P. whangarei* includes two different species, as discussed above.

Pahoroides confusa may require more moisture than does *P. whangarei*; we collected both *P. confusa* (3♂, 6♀) and *P. whangarei* (4♀) in the damp habitat at the south end of Coronation Park, but only *P. whangarei* (7♂, 10♀) in the dry habitat at the north end of the park.

***Pahoroides gallina* new species**

(Figs 8, 16, 24)

TYPE MATERIAL: **Holotype** ♂, Hen Island, ND, New Zealand, inside bases of fallen nikau fronds and on rock at night, 2–5 Dec. 2004, B.M. Fitzgerald (MONZ AS.001783). **Allotype** ♀, same data as holotype (MONZ AS.001784). **Paratypes** 4♂, 3♀, same data as holotype (MONZ AS.001780–2).

ETYMOLOGY: The species epithet (from Latin = chicken, hen) refers to Hen Island (Taranga Island), the type locality, and also relates to the common name of syntaxids, 'chicken-wireweb' spiders (Jocqué & Dippenaar-Schoeman 2006).

DIFFERENTIAL DIAGNOSIS: The relatively short and pointed ventral apophysis of *Pahoroides gallina* males is unique (Figs 8, 16), and the basal area of the epigynal scape tapering at about 45° and ovoid receptacula are typical of *P. gallina* females (Fig. 24).



Figs 19–26 Epigynal scapes of females: 19, *Pahoroides whangarei*; 20, *Pahoroides courti*; 21, *Pahoroides balli*; 22, *Pahoroides kohukohu*; 23, *Pahoroides confusa*; 24, *Pahoroides gallina*; 25, *Pahoroides aucklandica*; 26, *Pahoroides forsteri*.

DESCRIPTION:

Male

Measurements: Total length 3.307; carapace length 1.102, width 0.709; sternum length 0.512, width 0.524; labium length 0.098, width 0.171 (MONZ AS.001780). Size range expressed by body length: 2.047–3.386 (mean 2.874, $n = 6$).

Eyes: AME 0.061, ALE 0.073, PME 0.061, PLE 0.073; AME–AME 0.017, AME–ALE 0.037, PME–PME 0.049, PME–PLE 0.024, ALE–PLE 0.005.

Palp: The retrodistal projection of the tibia is of moderate length and has a strong macroseta near the distal margin. The ventral apophysis ends in a black lobe, narrow in side view (Fig. 8). The projection on the MA is semi-translucent and tapers to a point (Fig. 16).

Female

Measurements: Total length 2.283; carapace length 0.866, width 0.591; sternum length 0.463, width 0.463; labium length 0.073, width 0.146 (MONZ AS.001837). Size range expressed by body length: 1.811–2.362 (mean 2.189, $n = 5$).

Eyes: AME 0.049, ALE 0.073, PME 0.061, PLE 0.073; AME–AME 0.012, AME–ALE 0.024, PME–PME 0.049, PME–PLE 0.037, ALE–PLE 0.005.

Colour: Lateral abdomen with the same basic pattern as in *Pahoroides whangarei* but the pale areas narrower.

Genitalia: Base of scape broad; epigynal lobe slender, wider towards tip and ending in a sharp point; receptacula ovoid (Fig. 24).

OTHER MATERIAL EXAMINED: ND. 2♀, 2 penultimate ♂, 1 penultimate ♀, 1 immature, Bream Head, forest, in bases of fallen nikau fronds, 16 and 26 Oct. 2001, B.M. Fitzgerald (MONZ AS.001778, AS.001837); 1♂, 2♀, 2 penultimate ♂, Hen Island, in fallen dead nikau fronds and on rocks, 19–23 Oct. 2001, B.M. Fitzgerald (MONZ AS.001779).

DISTRIBUTION: Known only from Hen Island, and Bream Head, at the entrance to Whangarei Harbour.

COMMENTS: Records of 1♀ (as *Synotaxus*) from Tawhiti Rahi, Poor Knights Islands, in Court (1982), and of 4♀, 1 immature (as linyphiids) from Lady Alice Island, Chickens Islands, in Court (1984), probably belong to *Pahoroides gallina*.

***Pahoroides aucklandica* new species**

(Figs 9, 17, 25)

TYPE MATERIAL: **Holotype** ♂, Wenderholm Regional Park, Waiwera, AK, New Zealand, 36°31.80'S, 174°42.00'E, ex fallen nikau frond, 27 Nov. 2010, P.J. Sirvid (MONZ

AS.002324). **Allotype** ♀, same data as holotype (MONZ AS.002325). **Paratypes** 1♀, 1 penultimate ♂, same data as holotype (MONZ AS.002326–7).

ETYMOLOGY: The species epithet refers to the geographical distribution within the Auckland District.

DIFFERENTIAL DIAGNOSIS: The male ventral apophysis of *Pahoroides aucklandica* is distally lobate with a small spine on the tip, and the prolateral apophysis is slender and curved (Figs 9, 17). The female scape is slightly notched on the distal margin of the basal area (Fig. 25). This species most closely resembles *P. confusa* but can be separated by the outline of the basal region of the scape in females, and the form of the prolateral and ventral apophyses in males.

DESCRIPTION:

Male

Measurements: Total length 2.756; carapace length 0.945, width 0.669; sternum length 0.463, width 0.439; labium length 0.073, width 0.146 (MONZ AS.002141). Size range expressed by body length: 2.756–2.913 (mean 2.834, $n = 2$).

Eyes: AME 0.061, ALE 0.073, PME 0.073, PLE 0.073; AME–AME 0.012, AME–ALE 0.049, PME–PME 0.073, PME–PLE 0.073, ALE–PLE 0.005.

Palp: One macroseta on the tibial projection. The ventral apophysis has a small, upright spur on the distal prolateral margin. Also, the retrolateral apophysis is slender and curved (Figs 9, 17).

Female

Measurements: Total length 2.047; carapace length 0.787, width 0.630; sternum length 0.488, width 0.463; labium length 0.073, width 0.146 (MONZ AS.002142). Size range expressed by body length: 2.047–2.126 (mean 2.073, $n = 3$).

Eyes: AME 0.049, ALE 0.061, PME 0.061, PLE 0.061; AME–AME 0.012, AME–ALE 0.049, PME–PME 0.061, PME–PLE 0.061, ALE–PLE 0.005.

Genitalia: The shape of the scape is unique among the eight species, being slightly notched at the base (Fig. 25).

OTHER MATERIAL EXAMINED: AK. 1♂, Tiritiri Matangi, pitfall trap 2/9b, Sept. 1996, C.J. Green (MONZ AS.002141); 1♀, Mt Auckland, Mt Auckland Walkway, ex nikau frond, 8 Jan. 2010, D.S. Seldon. (MONZ AS.002142); 1 penultimate ♀, 129 Laingholm Drive, pitfall trap 1A–3B, 19 Jun. 2007, J.T. Pusateri (MONZ AS.002140); 1♀, 129 Laingholm Drive, pitfall trap 4A–6B, 26 Feb. 2008, J.T. Pusateri (MONZ AS.002139).

DISTRIBUTION: Auckland region, from Mt Auckland south to Laingholm, Titirangi.

Pahoroides forsteri new species

(Figs 10, 18, 26)

TYPE MATERIAL: **Holotype** ♂, East Double Island, Mercury Islands, CL, New Zealand, 36°37'S, 175°54'E, summit, beaten from plants close to ground, 1 Dec. 2000, B.M. Fitzgerald (MONZ AS.001803). **Allotype** ♀, same data as holotype (MONZ AS.001809). **Paratypes** 3♂, 3♀, 1 penultimate ♂, 2 immatures, same data as holotype (MONZ AS.001806–8).

ETYMOLOGY: The species epithet is a patronymic in honour of the late Dr R.R. Forster, who described the genus *Pahoroides* and collected specimens of *P. forsteri* on Cuvier Island (Repanga Island) in 1943.

DIFFERENTIAL DIAGNOSIS: The male palp of *Pahoroides forsteri* resembles that of *P. whangarei* but the ventral apophysis of the TTA ends in a single tapered, curved point (Figs 10, 18). The strongly curved and tapered proteral apophysis separates this species from all other *Pahoroides* males (Fig. 10). In females, the scape is uniform in width, and broad relative to its length (Fig. 26).

DESCRIPTION:**Male**

Measurements: Total length 2.520; carapace length 0.827, width 0.551; sternum length 0.463, width 0.439; labium length 0.085, width 0.171 (MONZ AS.001814). Size range expressed by body length: 1.890–2.913 (mean 2.650, $n = 20$).

Eyes: AME 0.061, ALE 0.061, PME 0.049, PLE 0.073; AME–AME 0.024, AME–ALE 0.024, PME–PME 0.049, PME–PLE 0.037, ALE–PLE 0.005.

Palp: The retrodistal projection of the tibia is relatively short, with a long, slender macroseta on the distal margin and another situated more proximally. These macrosetae are more slender than those in other species of *Pahoroides* and sometimes are difficult to distinguish from hairs (Figs 10, 18).

Female

Measurements: Total length 1.969; carapace length 0.709, width 0.512; sternum length 0.341, width 0.293; labium length 0.073, width 0.146 (MONZ AS.001814). Size range expressed by body length: 1.732–2.283 (mean 2.000, $n = 21$).

Eyes: AME 0.049, ALE 0.061, PME 0.049, PLE 0.061; AME–AME 0.024, AME–ALE 0.024, PME–PME 0.049, PME–PLE 0.037, ALE–PLE 0.007.

Colour: Lateral abdomen with the same basic pattern as in *Pahoroides whangarei* and the pale areas of similar size.

Genitalia: Epigynal scape relatively short and broad, of uniform width throughout length; tip of scape flattened dorso-ventrally. Receptacula round (Fig. 26).

OTHER MATERIAL EXAMINED: CL. 1♂, Cuvier Island, Jun. 1943, R.R. Forster (OMNZ); 5♂, 1♀, 1 penultimate ♂, Cuvier Island, Lookout Track, under rat trap covers, 23 Mar. 1994, B.M. Fitzgerald (MONZ AS.001773); 2♀, Cuvier Island, Radar Camp, under rock and fallen rotten log, 24 Mar. 1994, B.M. Fitzgerald (MONZ AS.001775); 4♀, Cuvier Island, Lookout Track, in fallen nikau fronds and flowers, 25 Mar. 1994, B.M. Fitzgerald (MONZ AS.001774); 2♀, Cuvier Island, Pumphouse Track, at stream on rocks at stream edge, 15 Dec. 1996, B.M. Fitzgerald (MONZ AS.001776); 1♂, 1 penultimate ♂, 1 penultimate ♀, Cuvier Island, West Ridge Track, at big rock under iron and rodent trap cover, 15 Dec. 1996, B.M. Fitzgerald (MONZ AS.001777); 4♂, 1♀, Stanley Island, Mercury Islands, beaten from fallen dead mānuka twigs, 30 Nov. 1997, B.M. Fitzgerald (MONZ AS.001772); 3♂, 1♀, 1 penultimate ♂, Stanley Island, Mercury Islands, beaten from dead mānuka, 30 Nov. 1999, B.M. Fitzgerald (MONZ AS.001771); 1♀, Stanley Island, Mercury Islands, on small web at base of pōhutukawa, 30 Nov. 1999, B.M. Fitzgerald (MONZ AS.001770); 1 immature ♂, West Double Island, Mercury Islands, summit, beaten from fallen dead mānuka, 1 Mar. 2000, B.M. Fitzgerald (MONZ AS.001810); 2 penultimate ♂, Ruamahua, Aldermen Islands, forest, in damp rotten log, 19 Feb. 2002, B.M. Fitzgerald (MONZ AS.001815); 1♂, 1♀, Ruamahua, Aldermen Islands, under bank at night, 7 Nov. 2002, B.M. Fitzgerald (MONZ AS.001814); 1 penultimate ♂, Ruamahuanui, Aldermen Islands, NW Bay campsite, under rocks, 19 Nov. 2003, B.M. Fitzgerald (MONZ AS.001813); 2♂, 1♀, 1 penultimate ♂, Middle Chain Island, Aldermen Islands, from webs at ground level in forest, 20 Feb. 2002, B.M. Fitzgerald (MONZ AS.001820); 1♀, Middle Chain Island, Aldermen Islands, under rock on stone wall, 5 Nov. 2002, B.M. Fitzgerald (MONZ AS.001818); 1♀, Middle Chain Island, Aldermen Islands, NE Basin, on web under rocks, 19 Nov. 2003, B.M. Fitzgerald (MONZ AS.001819); 2♀, 1 immature, Hongiora, Aldermen Islands, under rocks beneath pōhutukawa and taupata, 18 and 22 Feb. 2002, B.M. Fitzgerald (MONZ AS.001816); 1 immature, Hongiora, Aldermen Islands, beaten from dead mariscus leaves, 9 Nov. 2002, B.M. Fitzgerald (MONZ AS.001817).

DISTRIBUTION: Known from islands east of the Coromandel

Peninsula (Cuvier/Repanga, Mercury and Aldermen islands), North Island. It is probably also present on the Coromandel Peninsula.

COMMENTS: Forster *et al.* (1990: 57) listed one ♂ and one ♀ from Cuvier Island (Repanga Island) in June 1943 as *Pahoroides courti*. We examined them and identified the male as belonging to *P. forsteri* and the female as *Nomaua repanga*, for which Cuvier Island (Repanga Island) is the type locality (Fitzgerald & Sirvid 2009: 151).

Discussion

The eight species of *Pahoroides* described here include seven species of rather limited geographic range in Northland and in the Auckland/Coromandel region, and one species (*P. courti*) with a more extensive distribution from Northland to the Waikato, Bay of Plenty and the Urewera Ranges. Several species of *Pahoroides* from Northland are in part sympatric, in contrast to species of *Nomaua*, for which our records indicate largely allopatric distributions (Fitzgerald & Sirvid 2009). For example, we collected *P. whangarei*, *P. kohukohu*, *P. confusa* and *P. courti* in the same forest at Kohukohu, and *P. whangarei* and *P. confusa* in Coronation Park, Whangarei. However, *P. balli* was the only species of *Pahoroides* identified among the large number of specimens caught in pitfall traps by Olivier Ball in the Te Pahi Ecological District, an area of high endemism (Vink *et al.* 2011). That area, including Cape Reinga and North Cape, was an island until about the Middle Pleistocene and was subsequently joined to the rest of mainland Northland by a sand tombolo, 50 km in length (Brook 1999). This isolation, and the inhospitable habitat of the sand tombolo, may have prevented the southward spread of *P. balli* and the northward spread of other species of *Pahoroides*. Another isolated species, *P. forsteri*, was recorded only on Cuvier Island and the Mercury and Aldermen islands. These islands were connected to the North Island until rising sea-levels isolated Cuvier and the Aldermen Islands about 10 000 yrs BP and the Mercury Islands about 7000 yrs BP (Hayward 1986; Towns 1994). With such recent separation, we expect *P. forsteri* to be present on the adjacent Coromandel Peninsula.

Species of *Pahoroides* are common inhabitants of low vegetation and twiggy litter of the forest floor, and are probably not under threat, but the ranges of some may have been reduced and fragmented as forest has been cleared. More detailed information on their distributions in Northland would help in assessing the risk to their survival and in evaluating their conservation status.

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Archaeological investigations at Maungarei: A large Māori settlement on a volcanic cone in Auckland, New Zealand

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ABSTRACT: Salvage excavations on the volcanic cone of Maungarei between 1960 and 1972 revealed a complex history of terrace construction and use, reflecting repeated occupations in the sixteenth and seventeenth centuries AD. The crater rim was extensively modified in the eighteenth century, after which use of the site seems to have ceased. Occupation of the cone was probably prompted by the need for defence, but it appears that only the two high points of the rim were actually fortified. A major use of the terraces was for roofed storage pits for garden produce.

Artefacts are typical of what is known of Auckland area material culture, showing reliance on local rocks of the Waipapa series for adzes, although obsidian was imported from five source areas. Food remains reflect a reliance on fish and shellfish for protein. The predominant fish catch was snapper, with a remarkable size range suggesting a variety of capture methods. Charcoal and mammal and bird identifications are described in specialist appendices. The charcoal and faunal remains show that the local environment was already highly modified by Māori when the northern slopes of Maungarei were occupied.

Maungarei meets the criteria for a transient settlement. Although the Auckland volcanic cones are usually perceived as exceptionally large sites, with populations numbering in the thousands, it is argued that the population of Maungarei at any one time would have been no greater than the number that could take refuge in, and defend, the larger of the two citadel areas.

KEYWORDS: Maungarei, volcanic cone, pā, transient village, faunal remains, material culture.

Introduction

The former Māori settlements on the volcanic cones of the Auckland area are among the most spectacular archaeological sites in New Zealand. Once part of a cultural landscape, including extensive garden areas and numerous open settlements, they now appear as terraced green islands rising out of a sprawling modern metropolitan area (Fig. 1). Some former cones have been completely destroyed by quarrying; all the survivors have been modified to a greater or lesser extent by quarrying, buildings, military installations, water

reservoirs, roads and playing fields. The archaeological features on some of the main surviving cones have been mapped in considerable detail (see, for example, Fox 1977), but excavations have been relatively few and all have been salvage projects in response to threats of further degradation of the sites. The most extensive were a series of excavations carried out on Maungarei¹ between 1960 and 1972, which are the subject of this paper.

The only comparable site to have been investigated elsewhere in New Zealand is the volcanic cone of Pouerua in the inland Bay of Islands (Sutton *et al.* 2003), where



Fig. 1 Maungarei is a green island surrounded by industrial and residential developments. This May 2010 view from the south shows the old quarry face (now vegetated) with the main citadel area above it; a small old reservoir to the left of the quarry face; and, further left, a rocky protrusion at the base of the cone with traces of garden walls. The land at the top left is laid out for a new residential subdivision in the old quarry beyond Mt Wellington Domain (photo: Kevin Jones).

excavations were the culmination of a three-year research programme examining not only the cone but its intact surrounding landscape of gardens, hamlets and smaller fortified sites. In contrast to Pouerua, the excavations on Maungarei were constrained by the requirements of salvage. Even so, a considerable amount was learned about the complex history of this major archaeological site and the lives of its inhabitants.

The site and its setting

Maungarei (Site R11/12, formerly N42/4) is one of the four largest of some 30 cones in the Auckland volcanic field that were once sites of Māori settlement (Fox 1977; Bulmer 1996); it is also one of the better preserved examples. Situated in the eastern part of the Tāmaki Isthmus, not far from the western bank of the Tāmaki Estuary (Te Wai ō Taiki or, more formally, Te Wai ō Taikēhu), it is a dominant feature in this part of Auckland (Fig. 2). The summit, about

134 m above sea-level, provides one of the best panoramic views of the region.

The prominent volcanic cone of Maungarei itself is part of a more complex eruptive centre. Volcanic activity here was relatively recent, most, if not all of it dating to about 9000 years ago. First to form was the explosion crater of Te Kai ā Hiku² (the Panmure Basin), a little to the south, which is now a tidal inlet of the Tāmaki Estuary (18 on Fig. 2). Renewed volcanic activity to the north was initially also explosive, resulting in tuff rings. This was followed by the formation of a low, double-crater scoria mound, known as Tauomā³ (Purchas Hill), immediately to the north of Maungarei. Last to form was the higher and more complex cone of Maungarei itself (Searle 1964: 77–79, 1981: 117–125). Lava from the eruptions flowed to the west and southwest, forming an extensive lava field. Ash and tuff deposits survive on the north, east and south, and thinner deposits of ash extend east, to the banks of the Tāmaki Estuary, and southwest. This volcanic complex was first mapped in the

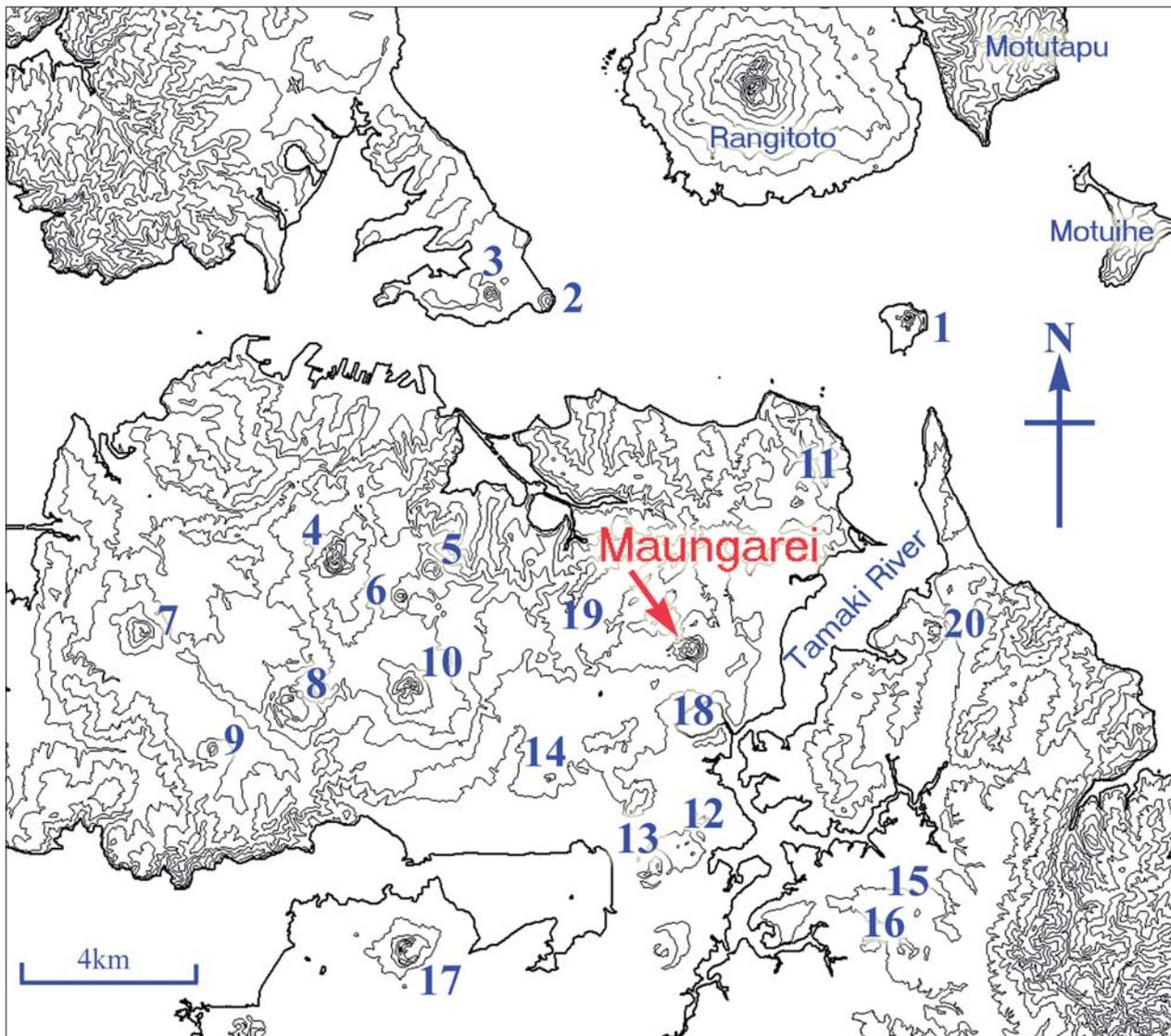


Fig. 2 The location of Maungarei (Mt Wellington) in the eastern part of the Tāmaki Isthmus, some other major scoria cone sites, and other places mentioned in the text. 1, Brown's Island/Motukōrea; 2, North Head/Maunga ā Uika (severely damaged); 3, Mt Victoria/Takarunga; 4, Mt Eden/Maungawhau; 5, Mt Hobson/Remuera; 6, Mt St John/Te Kōpuke; 7, Mt Albert (sometimes known as Ōwairaka, severely damaged); 8, Three Kings/Te Tātua (severely damaged); 9, Mt Roskill/Puketāpapa; 10, One Tree Hill/Maungakiekie; 11, Taylor's Hill/Taurere; 12, McLennan's Hills/Te Apunga ō Tainui (destroyed); 13, Mt Richmond/Ōtāhuhu; 14, Mt Smart/Rarotonga (destroyed); 15, Green Mount/Matanginui (destroyed); 16, Smale's Mount/Te Puke ō Taramainuku (destroyed); 17, Māngere Mountain/Te Pane ā Mataaho; 18, Panmure Basin/Te Kai ā Hiku; 19, Waiatarua; 20, Pigeon Mountain/Ohuiārangi (severely damaged).

nineteenth century by Hochstetter (Fig. 3), who recognised the Māori earthworks on the two cones. The radial lines on the northern tuff ring, which he did not explain, may possibly have been Māori garden boundary walls.

About 4 km to the northeast of Maungarei is the complex of small cones composing Taylor's Hill (Taurere), and a similar distance to the south were McLennan's Hills (Te Apunga ō Tainui, now quarried away), Mt Richmond

(Ōtāhuhu), and Sturges Park (also destroyed). Lava from the east side of Te Apunga ō Tainui flowed north and south, as well as east towards the Tāmaki Estuary, and extensive areas from south of Sturges Park to north of Maungarei were blanketed in ash and tuff.

When Māori arrived in the area, the cones and surviving parts of the tuff rings were surrounded on all sides by fertile soils developed on the volcanic deposits. To the north and

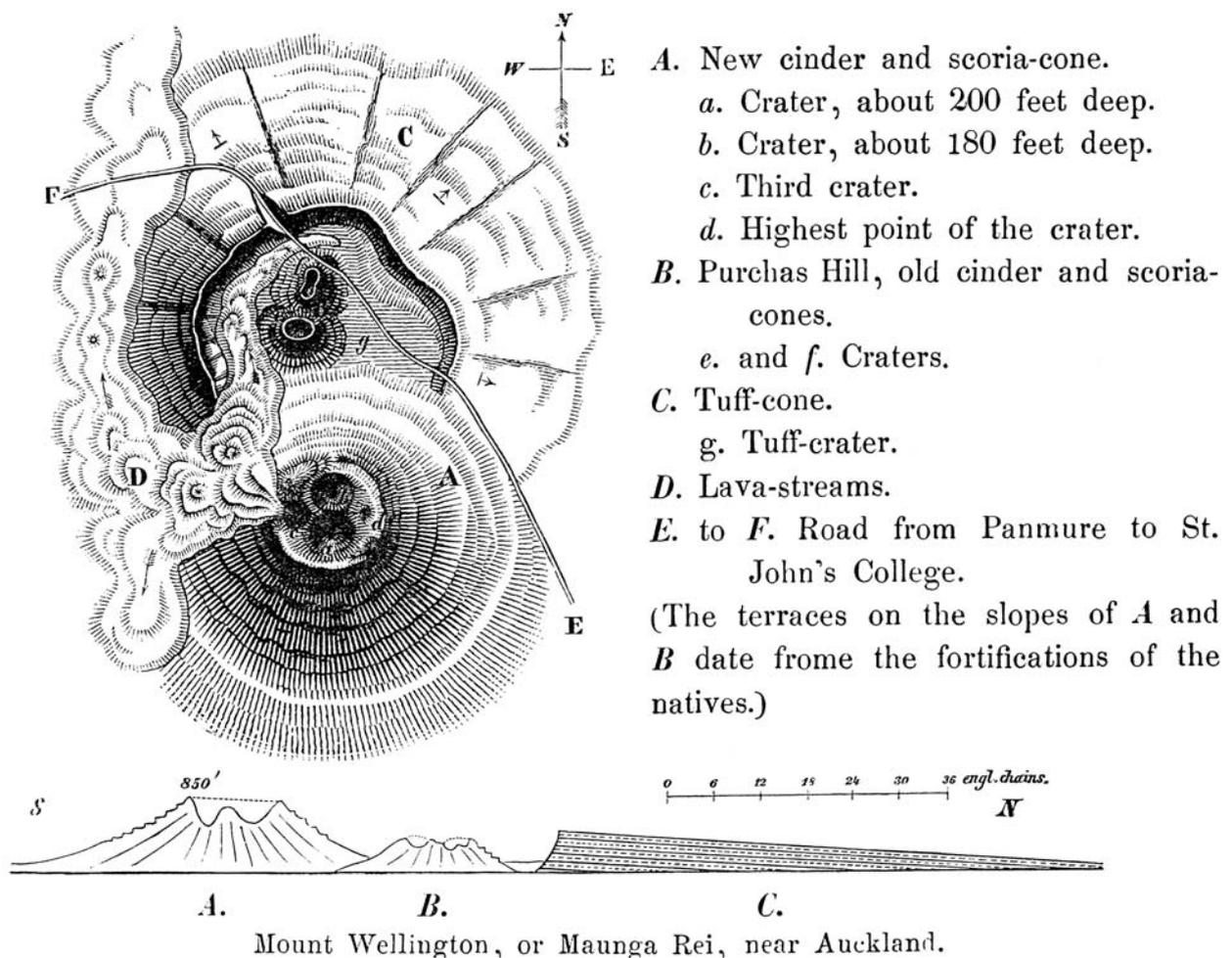


Fig. 3 Hochstetter's map of the eruptive complex of Purchas Hill (Tauomā) and Mt Wellington (Maungarei) before any damage had been done apart from the road (Hochstetter 1867: 237).

west of Maungarei, the lava flow had blocked the heads of tributary valleys, forming extensive areas of lake and swamp, notably at Waiatarua, only about 1.5 km from the western side of the mountain. The Tāmaki Estuary to the east was a source of shellfish, particularly cockles, and also fish, which entered the estuary itself. The estuary extends inland for about 15 km from its mouth. The semi-enclosed inlet of the Panmure Basin provides the nearest access to Maungarei, only about 500 m to the northwest. The entrance to the Panmure Basin is about 8 km from the estuary mouth. In pre-European times, Maungarei was strategically placed for rapid access by canoe to the Waitematā Harbour, Hauraki Gulf and North Island east coast generally. Some 4 km to the south were the portages that provided canoe access to the Manukau Harbour and the west coast. Thus the early residents of the district had easy access to potentially good garden land, swamps and lakes, and marine resources. Fresh

water is generally found only on the periphery of the Auckland lava fields, as at Waiatarua. Freshwater springs were named and greatly valued by Māori. A fast-flowing spring beside the Panmure Basin may have been the nearest to Maungarei. It was named Te Waipuna ā Rangiātea (Murdoch n.d.: 6).

A number of pollen studies in recent years have revealed a Late Quaternary and Holocene environmental record for Auckland covering some 76,000 years (Horrocks *et al.* 2007: 5). After the last glacial maximum, conifer-hardwood forest dominated by *Prumnopitys taxifolia* (mataī) became the main forest cover. After about 10 000 yrs BP, *Dacrydium cupressinum* (rimu) became dominant and taxa such as species of *Metrosideros* (pōhutukawa and rātā) expanded, suggesting a change to moister conditions. Patchy expansion of *Agathis australis* (kauri), *Libocedrus* and *Phyllocladus* after about 7000 yrs BP suggests a change to drier conditions (Horrocks

et al. 2007: 7). From this time until the arrival of humans, the nature of the vegetation appears to have been fairly constant.

A study of the small volcanic cone of Mt St John (Te Kōpuke), west of Maungarei, showed that when humans arrived a podocarp-hardwood forest dominated by *Metrosideros* grew on the rim and in the crater, with taxa such as *Elaeocarpus*, *Griselinia* and *Cyathea* also present (Horrocks *et al.* 2005: 219). It is likely that Maungarei would also have been forest-covered when Māori arrived in the vicinity.

The nearest pollen core site to Maungarei is at Waiatarua. Although the impact of human arrival could not be detected in the Waiatarua core described by Horrocks *et al.* (2002), the forest surrounding the lake during the last 3000 years was dominated by *Dacrydium*, *Prumnopitys* and *Metrosideros*, with other tall trees such as *Agathis* and *Phyllocladus* also well represented (Horrocks *et al.* 2002: 344). The range of plants found at Waiatarua is a good indication of what the vegetation in the vicinity of Maungarei was like when Māori first arrived.

A multiproxy analysis of cores from the Tāmaki Estuary found that Māori forest clearance in the estuary catchment was indicated by increased sedimentation and a sharp decline in forest taxa pollen, associated with an increase in bracken (*Pteridium esulentum*) and grass pollens (Abraham 2005). By the time of European settlement, Maungarei, like the rest of the Tāmaki Isthmus, was surrounded by fern and scrub.

Māori occupation was not confined to Maungarei itself. Tauomā and the tuff rings also bore evidence of terraces and pits. Unfortunately, no study was made of these, or of the field systems which, by analogy with evidence surviving until recently in other parts of Auckland, once extended outwards from the base of the cone. Mundy in 1847 visited Mts Wellington (Maungarei) and Halswell (now Mt Richmond or Ōtāhuhu), and noted 'hundreds of scoria walls, evidently the enclosures of former potato-gardens' under high fern extending out for half a mile (800 m) (Mundy 1855: 260). Tauomā and the tuff rings immediately to the northeast have been almost completely destroyed by quarrying, and the surrounding areas have been quarried or built on, or both. Now, almost all the surviving archaeological evidence is within the Mt Wellington Domain and that, too, has been progressively damaged over a long period. A small surviving area of former gardens has recently been identified and set aside as a stone fields reserve on the edge of the residential area to the west of the mountain.

At the time of the excavations described in this paper, the only recorded archaeological sites in the area were

Maungarei, some vestigial pits (now long destroyed) on Tauomā, the historically documented sites of Mokoia and Mauinaina to the east (shown on Brown's (1960) map of major Auckland sites), one burial site, and a pit and terrace site. Mitigation work in recent decades has revealed the remains of numerous midden and pit sites around the Panmure Basin and along the west bank of the Tāmaki Estuary to the south, suggesting that there was once a rich archaeological landscape in this part of Auckland.

History and traditions

Little has been published about the Māori history of Maungarei. Graham stated that the name means 'watchful mountain' and refers to the vigilance of the eighteenth-century Waiōhua inhabitants, who could not be taken by surprise by the invading Ngāti Whātua under Kāwharu (Graham 1980: 5; Simmons 1980: 18). According to Te Warena Taua (pers. comm. 1992), the full name is Te Maungarei ā Pōtaka, after Pōtaka, a prominent leader who lived there and is believed to have been buried there. Murdoch (n.d.: 3, 10) gives the name Te Rua ā Pōtaka specifically for the western side of the mountain. An alternative name for the mountain is Maunga ā Reipae after a Tainui ancestress, who travelled north in the form of a bird and landed on the mountain (Murdoch n.d.: 10).

Stone (2001) has relatively few references to Maungarei in his thorough review of the Māori history of Auckland. He notes that it was occupied, along with Maungawhau (Mt Eden) and Maungakiekie (One Tree Hill), at a relatively early time by Ngāti Huarere, a Te Arawa group (2001: 15). It was subsequently occupied by the Waiōhua and was sacked, along with those other two great pā, by a Ngāti Maru war party under Rautao in the latter part of the seventeenth century (2001: 25). However, it was not mentioned as one of the great pā of the region in the time of Kiwi Tāmaki in the mid-eighteenth century, when Maungakiekie, Māngere and Ihumatao (Maungataketake/Ellett's Mountain) were the leading citadels (2001: 36).

Although Taurere (Taylor's Hill) was attacked by the Te Taoū group of Ngāti Whātua during their first assault on the region in the mid-eighteenth century (Stone 2001: 40),⁴ Maungarei apparently was not. This was possibly because, as Graham claimed (1980: 5), the inhabitants were too watchful, or perhaps because these people, if there were any living there at that time, were not the prime focus of Te Taoū revenge.

Stone also discusses in some detail the Tainui tradition that Ngāti Maniapoto invaded Tāmaki and overthrew Maungakiekie and Maungarei (2001: 53–55). He argues that this attack must have taken place in the earlier half of the eighteenth century, not the beginning of the nineteenth century as argued by Kelly. A large number of those slain at Maungarei were rolled into a lava tube on the west side of the mountain, and the place was named Ruapōtaka (the pit for spinning tops) for that reason (Kelly 1949: 278). This is quite a different explanation for the name Pōtaka than that given above. A deep shaft into a lava tube on the western side of the mountain, known as Ruapōtaka or ‘the fairy hole’, was explored in 1927 and found to contain human bones. The shaft was subsequently concreted over by the Domain Board (Baker 1987: 106).

Although much of the pre-European history of Tāmaki concerns Waiōhua and Ngāti Whātua, by the end of the eighteenth century people related to the Hauraki iwi of Ngāti Paoa were established on the west bank of the Tāmaki Estuary (Stone 2001: 23), probably not far from Maungarei, which was by then unoccupied. A *tuku whenua* (gift of land), which extended as far inland as Waiatarua, was made to them by Ngāti Whātua. They never occupied Maungarei, their principal settlements being Mokoia and Mauinaina to the south and east of Maungarei, closer to the Tāmaki Estuary. These people were intimately related to Waiōhua as well (G. Murdoch, pers. comm. 2010).

In 1820, Reverend John Butler, travelling with Samuel Marsden, visited Mokoia and Mauinaina and climbed to the summit of Maungarei. He described his experience as follows:

When we arrived at the foot of the mountain, and began to ascend the side, I found, on examination, the grass and fern growing upon burnt earth and calcined cinders, which led me to conclude that it had been a volcano.

Reaching the summit, I found a large crater, and proportionately deep, but the eruption must have ceased long since, as the grass grows spontaneously at the bottom of it. The prospect from the summit is grand and nobly pleasing. I observed twenty villages in the valley below, and, with a single glance, beheld the largest portion of cultivated land I had ever met with in one place in New Zealand. Having taken a general survey, we returned by another path to the Eppah (pah), where we found Mr. Marsden enjoying a friendly chat with the people. (Butler 1927: 97–98)

From this it is clear that Maungarei had been unoccupied for some time, but that the fertile soils along the west bank of

the Tāmaki Estuary were supporting a substantial population. Captain Cruise, who visited the area in August 1820, commented on the size of the settlement of Mokoia and the extent of the hamlets and gardens stretching south towards the portages. White potatoes were well established in these gardens (Cruise 1824: 215–216).

In 1821, Mokoia and Mauinaina were attacked and taken by Hongi Hika and many of the inhabitants slain. Thereafter, the area was vacated (Stone 2001: 88–90).

The land on which Maungarei is situated was part of a very large block purchased by the Crown from the Māori owners in 1841. A pattern of subdivision laid out in 1863 included an area of 72 acres (29.14 ha) marked Government Reserve (Survey Office Plan 913B). In 1881, the present Mt Wellington Domain, covering essentially the same area, was gazetted under the Public Reserves Act 1877 and the first Domain Board was appointed. In 1909, part of the southern face of the mountain within the existing Domain was gazetted as a Quarry Reserve. The Domain was administered by Domain Boards until 1960, when the Mt Wellington Borough Council assumed the duties. With local government amalgamation in 1989, Auckland City Council became responsible for the Domain. The history of the Domain is described in more detail by Baker (1987: 105–108).

History of investigations

The archaeological values of the Auckland volcanic cones had been recognised since the early days of European settlement in Auckland (e.g. Mundy 1855: 260; Hochstetter 1867: 164). However, modern archaeological investigations began only in the 1950s. The appointment of Jack Golson as the first lecturer in prehistory at the then Auckland University College, along with the establishment of the Auckland University Archaeological Society and the New Zealand Archaeological Association, coincided with and encouraged the growth of public interest in the preservation of archaeological sites. The Auckland cones were the subject of an early campaign to secure better preservation and management of these magnificent sites (Golson 1957). The first rescue excavation on one of the cones took place at Taylor’s Hill (Taurere) between 1954 and 1956 (Leahy 1991). Although the stratigraphy and features uncovered seemed complex at the time, the excavation provided little preparation for what was to be experienced at Maungarei.

Maungarei became the focus of archaeological interest early in 1960, when it was selected for an intensive mapping



Fig. 4 Maungarei in 2010, showing the location of excavated areas and the two tihi, or citadels. The extensive terracing on the eastern slopes (right) extends through the wooded area to the boundary of the Domain (photo: Google Earth).

exercise as part of the newly established site recording scheme (Groube 1960). At this time, the cone had already been damaged by building on the slopes outside the Domain on the north side, by the quarry on the southern face, by the construction of a small reservoir low down on the southwest side, and by tracks to the small reservoir and to the summit. Little remained of Tauomā and the tuff rings, described above, and that little disappeared in the intervening years, along with almost all of the stone garden walls that in 1960 were still visible on the western side of the cone, beyond the Domain.

Shortly after the mapping project began, a major new threat to the site emerged with the Auckland City Council decision to build a reservoir in one of the craters. This would breach the rim at its lowest point and destroy a

number of Māori earthworks. The then National Historic Places Trust provided a grant that enabled the Auckland University Archaeological Society to employ two people full time and undertake a rescue excavation (A on Fig. 4) from March to late May 1960 (Golson 1960).

In 1964, the Mt Wellington Borough Council unveiled plans for a major development of the mountain, including a road to the summit, a large parking area, a revolving restaurant, and an artificial ski lane down the slopes. The Auckland University Anthropology Department carried out an excavation on the crater rim (B on Fig. 4) for one week in November 1965. A Golden Kiwi Grant for South Pacific Research to Auckland University enabled 15 people to be employed (Brown 1966: 105–106). Immediately after this excavation, the development plans were put on hold.

The proposal to build a road to the summit was revived in 1970. Three areas affected by the proposal were investigated by the New Zealand Historic Places Trust and the Auckland Museum on several occasions between August 1971 and August 1972. Financial support from the Mt Wellington Borough Council enabled two people to be employed. The excavations were on a terrace on the northeast part of the crater rim, two large terraces on the northern slopes below the reservoir, and the presumed garden on the protrusion at the foot of the western side (C, D, and E, respectively, on Fig. 4). As a result of these excavations and a collaborative approach between archaeologists, the Mt Wellington Borough Council and the Lands and Survey Department, the road proposal was modified to its present form. The terraces on the northern slope were damaged, but the other two areas remained intact.

The excavations

The underlying natural material in the various excavated areas was normally unweathered scoria – a light, porous volcanic material, essentially ‘frothed up lava’ (Searle & Davidson 1973: 2). This could be dug into relatively easily by the inhabitants of the site, and crumbled readily into rubble- and gravel-like pieces. Most of the cultural deposits encountered in the excavations consisted of cultural debris mixed with coarse or fine scoria derived from the construction of terraces and pits on the mountain.

On part of the northern slope, scoria was overlain by volcanic ash. The transition from scoria to ash was abrupt. On the lowest part of the crater rim, vesicular basalt lava was found to underlie scoria.

Area A: the lowest part of the crater rim

The 1960 excavations were directed by Jack Golson. Day-to-day supervision was by Les Groube; he and Bob Cater were employed to work full time on the excavation. Volunteers took part in some numbers at weekends and, occasionally, on weekdays. The Auckland University Archaeological Society’s Easter excavation was held at the site, with participants living at the old residential School for the Deaf on the northern toe of the mountain.

These excavations were the most complex and produced the most detailed information about earthworking on the mountain. Unfortunately, they were not completed before construction began on the reservoir and only some areas

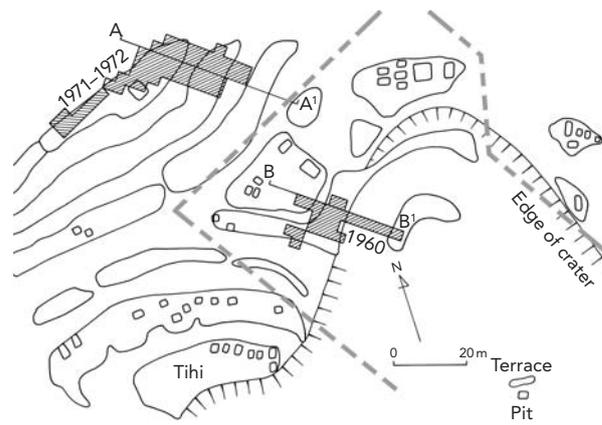


Fig. 5 The layout of excavations in Areas A (1960) and D (1971–72). The dashed line indicates the approximate extent of destruction caused by the reservoir.

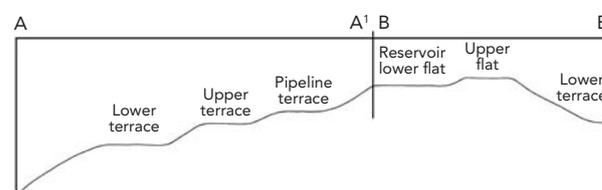


Fig. 6 Surface profile through Areas A and D (see Fig. 5 for locations).

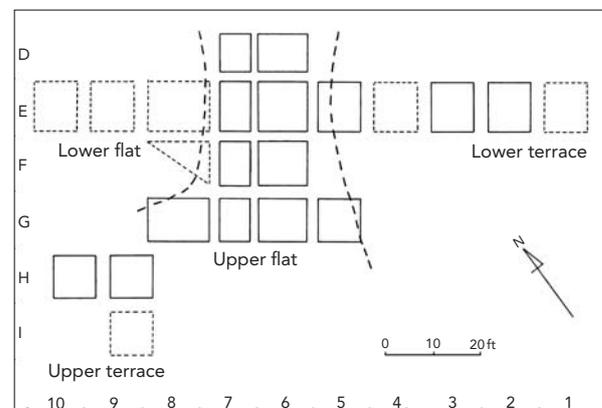


Fig. 7 Layout of the 1960 excavations.

were fully recorded. The following account has been put together from the preliminary reports (Golson 1960, 1961), surviving notes, plans and sections made available by Professor Golson, and the photographic archive in the Anthropology Department at Auckland University, augmented by photographs (mostly social) taken by people who took part in the excavation. I took part as a student volunteer and made some of the surviving notes and sections relating to the Upper Flat.



Fig. 8 A view of the Upper Flat in Area A from one of the terraces of the secondary tihi, 1961. The crater, now filled by the reservoir, is to the right (photo: Anthropology Department, University of Auckland).



Fig. 9 The Lower Flat (front) and Upper Terrace (rear) in Area A, with the edge of the Upper Flat to the left, 1961 (photo: Anthropology Department, University of Auckland).

The configuration of the northern part of the mountain before construction of the reservoir and the relationship of the 1960 excavations and those of the summer of 1971/72 are shown in Figs 5 and 6. Fig. 5 indicates the grids laid out in the two areas. Details of the squares actually excavated are given below.

The 1960 excavations were centred on a flat area or saddle, which constituted the lowest part of the crater rim and extended down to a terrace inside the crater and out on to a slightly lower flat area with several visible surface pits (B¹ to B in Fig. 6). The aim of the excavation was: 'to dig a complete section from the lower terrace, covered beneath the grass with scoria boulders, up the crater scarp, with its surface scattering of shell, over the upper flat on which no surface features were present, across the lower flat with its dispersed rectangular pits clear to the outer edge of the rim' (Golson 1960: 31). Had time and resources enabled this plan to be completed effectively, we would know a great deal more about the complex history of this part of the site.

To the southwest of the excavation, the crater rim rose steeply to a secondary tihi (citadel), most of which still survives, although its northern face has been reshaped to form the batter above the reservoir. To the northeast, the crater rim rose less steeply to a flat knoll with some large pits visible on the surface, and then curved sharply to the

southeast, rising fairly steeply towards a terrace (Area C) partly excavated in August 1971. The flattened area at the lowest point of the rim extended as a terrace to the northeast inside the crater. The approximate extent of earthworks destroyed by the reservoir construction is indicated in Fig. 5.

Fig. 7 illustrates the extent of the 1960 excavations, based on a surviving plan and augmented by photographic evidence. Several additional points should be made. This plan does not indicate that a number of baulks were removed; this will be apparent from Figs 10 and 11. Photographs show that the position of the three squares on the Upper Terrace as taken from the surviving plan is incorrect; they were fully aligned with squares E9 and E10. An unpublished report on the geology of the excavations (Kear n.d.) includes a plan that depicts square E11 on the Lower Flat as being at least partly excavated. Lastly, photographs also show that in the final stages of the excavation a trench was dug towards the eastern part of the Lower Flat to a large pit visible on the surface. This appears to have been a 3 ft-wide (90 cm) trench along the southeast side of what would have been square D9, which then turned to intersect the pit at right angles to its long edge.

Fig. 8 shows a fairly early stage of the excavation of the Upper Flat. Very little has been done as yet in squares G5 (lower right) or D6 and D7 (uppermost). Fig. 9 shows

excavations extending to the Lower Flat and Upper Terrace, with the pits on the Upper Flat more fully exposed.

Excavation was by hand trowel according to natural layers. Since the principal objective of the excavation was to understand the structural history of this part of the site, great attention was paid to stratigraphic detail. As time ran out, some fill layers were shovelled out in an attempt to complete parts of the excavation before bulldozers moved in. During excavation, artefacts, bone fragments, charcoal pieces and unusual shells and stones were collected by hand. It was not practical to sieve the deposits, containing as they did large quantities of scoria gravel and rubble.

The Upper Flat

Excavations began on the Upper Flat (Fig. 8); the area laid out initially was almost completely excavated and fairly thoroughly recorded. During the excavation, and for the purposes of the following discussion, the long line of squares from the Lower Terrace to the Lower Flat was deemed to run from south to north; in the squares on the Upper Flat, the north sections are those nearest the Lower Flat, the south sections those nearest the Lower Terrace, and the east and west sections those parallel to the long axis of the excavation.

Kear (n.d.) described the natural stratigraphy in this area as vesicular basalt lava underlying unweathered scoria. Both deposits dipped inwards towards the crater. Weathered brown clay had developed on these deposits through normal soil-forming processes, and was covered by a thin topsoil. The brown clay varied in thickness up to 45 cm in flat areas or depressions where it would have been increased by slope wash from higher ground. Digging and redeposition of these natural deposits, with the addition of greater or lesser amounts of cultural debris (shells, charcoal, etc.) produced the various other layers encountered during the excavation.

Kear (n.d.) distinguished between *slope debris*, consisting of two contrasting lithologies that were well bedded; and *man-made deposits*, in which the bedding was, 'at best, crude and chaotic'. The slope debris was a result of human activity higher up the mountain but had come to rest in its present position through natural processes, whereas the obviously man-made deposits were the result of human activity, such as pit filling and rubbish dumping, in the immediate vicinity.

Removal of turf and topsoil (layers 1 and 2) revealed a few patches of fairly fragmentary shell midden and some small hāngi (earth ovens), and patches of stones on a uniformly flat, gritty, largely sterile surface of scoria rubble and gravel (layer 3). The most significant of these features was a low mound of shell midden in square F7, which extended into F6. Layer

3 was at first thought to be natural. However, it was found to be a deliberately laid surface covering and sealing four large pits and some further patches of midden and ovens in the tops of their fills and in the intervening natural surfaces.

The pits themselves were dug partly into natural scoria (and in one place into the underlying lava), but partly into earlier cultural deposits. These included both slope debris consisting of redeposited cindery scoria containing occasional shells and charcoal fragments, and more concentrated midden or fill layers. It became apparent that the southern part of the Upper Flat had been considerably extended and built up beyond the natural surface of the crater.

The plan of the pits and scarp features is shown in Fig. 10. It indicates the probable original bases of the pit walls and the extent to which the walls have eroded or crumbled because of the loose material (whether natural or redeposited) through which they were dug.

Pit A was between 114 cm and 122 cm deep. Not shown on Fig. 10 but evident in photographs are one or two additional postholes towards the western end of the pit and the remains of a retaining wall of scoria blocks along the western edge. Fig. 11 (upper) indicates the nature of the fill layers as they appeared in the west face of squares F6 and F7. The earliest fill was a lens of fine yellowish-brown material on the south side. A layer of burnt organic material lapped down from the surface of this to cover the bottom of the pit. In this part of the pit the lower burnt layer was separated by a fine, dark soil layer from a similar but higher burnt layer. Above this on the northern side of the pit, layers of loosely packed whole shells were interspersed with layers of finer soil or scoria. The bulk of the pit fill was mixed loose material containing scoria, stones, shell and earth. On the surface of this fill on the north side was a black layer with some shell, associated with several scoop features, possibly fire scoops.

Pit B was similar in depth to *Pit A*, but smaller in plan. The excavation data suggest that it had a single central row of postholes. The two excavated were about 30 cm and 33 cm deep. To the east, this pit, like the others, was dug into natural scoria, but its western end was dug entirely through a deep series of slope debris deposits, which had built up on the natural slope of the crater before pit construction began (Fig. 11, upper and middle). Although the south and west edges of the pit were quite clear, the distinction between pit fill and earlier fill was blurred on the northern edge, where only the base of the pit wall was clearly defined. The pit fill is best described on the basis of the east face of squares G5 and G6 (Fig. 11, middle). Towards the base of the walls,

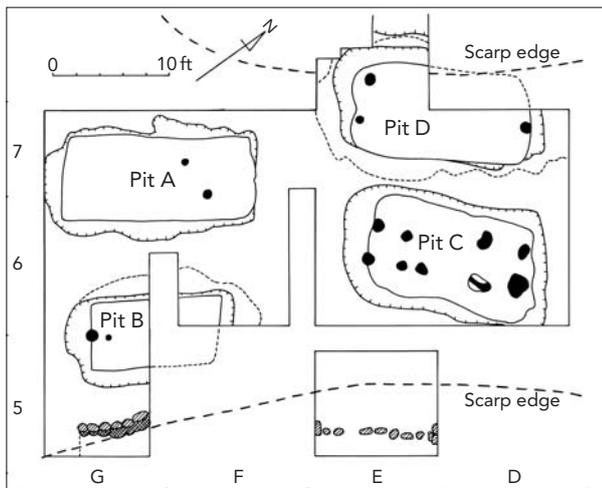


Fig. 10 Features on the Upper Flat in Area A. Postholes are shown as filled circles. Remains of scoria-block walls are shown as diagonally hatched ovals.

the fill consisted of lenses of mixed scoria gravel and finer material, while the centre contained a thick layer of burnt organic material. Above this was a largely sterile layer of scoria and earth with some large scoria blocks, and above that a finer layer of scoria with charcoal and shells scattered through. The upper part of the fill consisted of loosely packed shell with lumps of scoria. A black layer with scattered shell, similar to that on top of the fill of Pit A, was immediately below layer 3.

Pit C was similar in depth to Pits A and B. Its walls were very eroded and its floor uneven. Nine postholes were defined in the floor, ranging in depth from about 20 cm to 46 cm. There was some indication that this pit may have been redug and reduced in width at some stage. If so, most of the postholes, in two groups of four, would have belonged to the first stage. Pit C also had an extensive burnt layer just above its floor (Fig. 11, lower). The lower fill layers, particularly those on the northern side, were very loose and rubbly, and some contained considerable shell. The upper layers, on the other hand, were finer and more compacted.

Pit D was much deeper than the others (between 230 cm and 245 cm) and was largely dug into lava. Only three postholes were found in the area excavated: the one nearest the scarp to the Lower Flat was more than 75 cm deep and the other two 30 cm deep. Against the bases of the pit walls were fairly fine, compact fill layers of scoria and earth. Above these and in the centre were several loose, rubbly layers. A thin layer of loosely packed shell lensed in from the south.

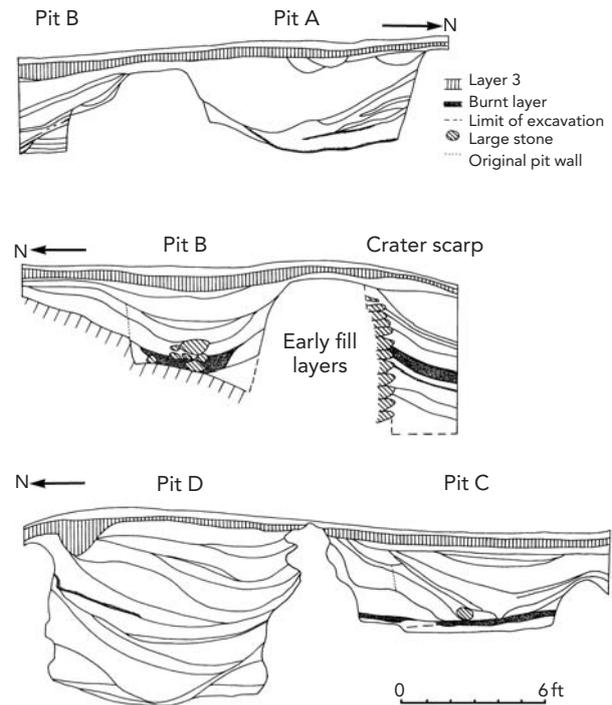


Fig. 11 Cross sections through the pits on the Upper Flat in Area A. Upper, west face of squares F6 and F7; middle, east face of squares G6 and G5; lower, east face of squares E7 and E6.

An earthy layer separated this from a layer of burnt organic material about halfway up the fill. This burnt layer was at about the same depth below the surface as the burnt layers on the floors of the other three pits. The upper fill layers were finer and more compacted, with only occasional shell and charcoal.

The general arrangement of these pits suggested that they were constructed at about the same time. However, it is possible that Pit D was abandoned first, perhaps because of construction of the Lower Flat.

The Inner Scarp and Lower Terrace

The two squares on the edge of the crater (E5 and G5) yielded vital but complicated information about the history of modification of this part of the site.

Part of an intact, well-built retaining wall of scoria blocks was exposed in square G5 (Fig. 11, middle). This wall separated early layers of slope debris and fill, contained behind it, and later deposits thrown down from the Upper Flat onto the sloping crater wall. The layers between the retaining wall and Pit B were not excavated, but were assumed to be similar to those into which the western end of Pit B had been dug. The more recent slope layers were not

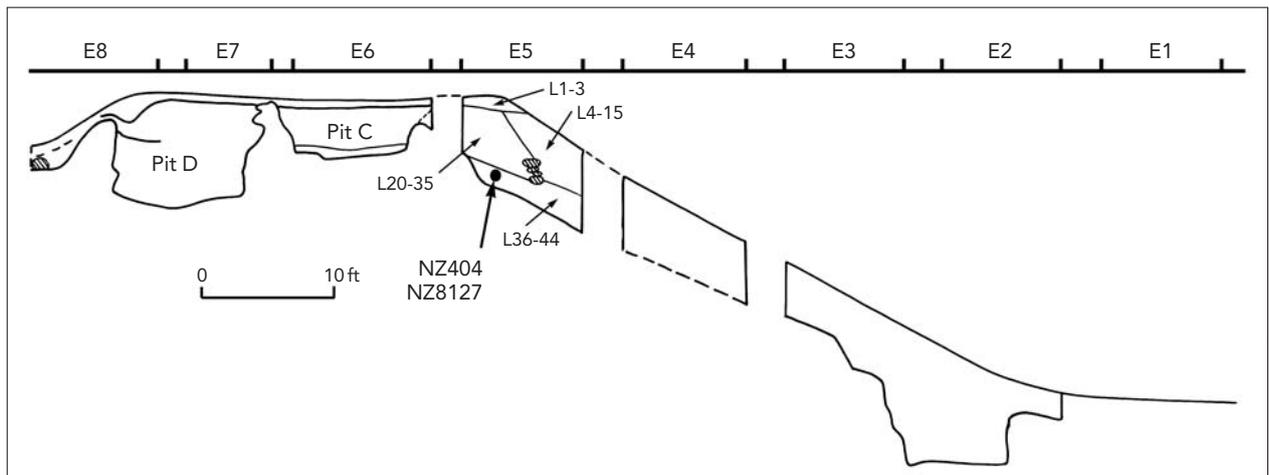


Fig. 12 The long cross section through Area A. The context of radiocarbon-dated charcoal samples NZ404 and NZ8127 is shown.

unlike those of the various pit fills. A burnt layer appeared midway up the section, with tightly packed shell separating a thin lower lens from the thicker upper part of the layer. Beneath the burnt layer were several layers of fine scoria with varying amounts of scattered shell. Above the burnt deposit was a series of layers of scoria and shell, culminating in scattered, fragmentary shell immediately below the topsoil.

Square E5 presented extremely complicated stratigraphy which, nonetheless, suggested a similar picture to that in square G5. Here, the scoria-block retaining wall had largely disappeared, and only traces of the lowest courses remained. Of the east and west sections, critical to the debate, only the west was fully recorded, as bulldozing for the reservoir destroyed part of the east wall before the section could be drawn. In Fig. 12, a mirror image of the west wall has been interpolated into the long section, as the two walls of the square were not dissimilar.

It was clear that in square E5, a series of earlier cultural layers (20 to 35) had been cut back to form a new scarp at the inner edge of the Upper Flat; that a retaining wall, now largely destroyed, had been built to hold the edge of the scarp; and that a new series of midden and spoil layers (4 to 15) had been thrown down the scarp from the Upper Flat, accumulating on top of the earliest layers (36 to 44), which continued undisturbed beneath the base of the scoria retaining wall. The position of the sample that provided the first radiocarbon date for the site (NZ404) is indicated. This consisted of scattered charcoal near the original ground surface and may represent initial clearance of vegetation on the site. A second sample from the same context (NZ8127) was subsequently dated. If there is any equivalent in this

square to the burnt layer part way up the sequence of younger layers outside the walled scarp in square G5 (Fig. 11, middle), it would appear to be layer 15, an ashy zone at the very base of the sequence of younger layers.

Debate during excavation centred on exactly which layers in square E5 pre-dated the cutting of the scarp and where the later layers began. This issue, argued passionately in 1960, seems less important now and I have chosen the interpretation that seems to fit best with the surviving photographs and section drawings.

In the north face of square E5, a clearly defined posthole appeared to have been dug from the surface of layer 22 and sealed by layer 21. This suggested structural activity on an old surface before the construction of the Upper Flat in its present form.

The long scarp down to the Lower Terrace and the terrace itself were found to carry deep and extensive deposits of scoria rubble and midden. Square E4 was not completely excavated and only the upper layers in the east wall were drawn before the bulldozers moved in (Fig. 13). All that can be illustrated for this square is the estimated depth of deposit. The eastern halves of squares E3 and E2, however, were fully excavated and the east walls were recorded in detail. An astonishing feature of this area was a deep pit-like feature at the base of the steep scarp. This feature was about 240 cm wide. Its wall at the base of the scarp was about 200 cm deep, while the opposite wall was about 137 cm deep. Apart from an early layer resting on the surface of the Lower Terrace in square E2, through which the pit appeared to have been dug, the entire stratigraphic sequence of pit fill and overlying slope deposits appeared to post-date the pit.



Fig. 13 Reservoir construction engulfs the excavations in Area A, June 1961 (photo: Bob Jolly).

The pit fill and subsequent slope deposits were similar to fill layers elsewhere – a mixture of scoria rubble, finer gritty scoria and shell. The lower fill, particularly, contained large amounts of rubble. There is no record of a burnt layer in the area excavated; a description of the bottom-most layers in the base of the pit has not survived, but the existing section drawing does not seem to indicate anything comparable to the burnt layer that appears in various sections on the Upper Flat.

The Outer Scarp and Lower Flat

Excavations on the Lower Flat were mainly conducted during the closing stages of the excavation. Work continued here while bulldozers were at work in the crater, destroying the excavations on the Inner Scarp and Lower Terrace. Unfortunately, no original documentation other than photographs has survived.

Golson's interpretation, based on observation at the time, was unequivocal (Golson 1960: 33). The northern wall of Pit D and part of its fill had been cut away by the formation of the Outer Scarp. Photographs show that there was a stone retaining wall along the Outer Scarp also. The lower courses

were uncovered in square E8 in a position not unlike that of the corresponding course of stones in square E5.

Photographs also show one or more extraordinarily deep squares on the Lower Flat. These are presumably either or both of squares E8 and E9. The excavation was more than 200 cm deep in this area. The fill was compact and relatively undifferentiated earth with only occasional flecks of shell. Similarly deep deposits appear to have extended through square D9 almost to the edge of the large pit that was visible on the surface. All that can be said of this area is that it contained one or more very large, deep pits, comparable in size to Pit D.

The Upper Terrace

The Upper Terrace was the last area to be destroyed by the bulldozers and appears in the final photographs as a tiny grassy island in the midst of a scoria wilderness. Despite its late destruction, however, no notes or plans have survived and there are only a few photographs of the initial stages of work in this area. General views of the excavation indicate similar evidence here to what was encountered on the Upper Flat. In his interim report, Golson (1960: 34) described

inter-cutting cooking pits immediately beneath a scoria rubble or gravel deposit similar to layer 3 on the Upper Flat. A circular pit 1 m wide and a large posthole were the only other features exposed at the time he was writing. Photographs suggest there was at least one sizeable infilled pit in squares H9 and H10. Kear (n.d.) described typical slope debris deposits in square I9; one photograph of I9 in the distance shows that these were of some depth.

Discussion

Despite the lack of detail about parts of the excavation, a general interpretation can be developed.

The earliest activity in the area seems to have included modification of the tihī above and to the southwest of the Upper Flat, with the resulting deposition of slope debris in squares G5 and G6 and probably also in square I9, and the burning of vegetation and deposition of rubbish on the unmodified ground surface in squares E5 and G5 (the early fill layers on the edge of the crater).

Then came the construction of the Upper Flat in its present form, by cutting the inner scarp at the edge of the crater, building its retaining wall, and digging the pits, which seem to have been designed as a group to fit on the newly defined area. The Upper Flat at this time extended an unknown distance to the north, and the shape and extent of the Lower Flat, if it existed at all, are unknown. The Lower Terrace and its pit may also have been constructed at this time.

The first of the pits to be partly filled may have been Pit D. It is likely that the other three were all abandoned at about the same time, and that a single fire accounts for the distinctive burnt layers in all the pits and outside the retaining wall in square G5. If so, there appears to have been some dumping of spoil over the scarp in the vicinity of square G5 before the fire and while three of the pits were still in use. However, if the ash zone at the bottom of the later fill deposits in square E5 is also part of the same fire, there was little or no dumping in that area before the fire.

Then followed a major dumping episode, during which all the pits were filled and large amounts of debris were thrown down the crater slope. The origin of this material must have been either the Lower Flat or, more probably, the higher points to the northeast and southwest of the Upper Flat. After the pits were completely filled, the surface was used for a few small fires and a little midden was deposited. Then a layer of largely sterile scoria was deliberately laid to form a new surface. Only a small amount of occupation took



Fig. 14 The 1965 excavations in Area B, high up on the crater rim. The principal tihī (citadel) is out of sight to the right rear (photo: Wilfred Shawcross and Anthropology Department, University of Auckland).

place on this surface – most noticeably the deposition of a small heap of shell midden in square F7.

Unfortunately, the Upper Terrace and Lower Flat cannot be tied closely to this sequence. The only possible link between the Upper Terrace and the Upper Flat is the presence on the former of a scoria layer similar to layer 3 on the latter. However, it seems reasonably certain that the Lower Flat in its present form took shape after the construction of the Upper Flat and its pits, and certainly after the abandonment and infilling of Pit D. It is therefore possible that all the complex sequence of pit building on the Lower Flat, suggested by the deep deposits in the excavated squares in the centre of the flat and the presence of visible pits on the periphery, took place after the cessation of pit building and use on the Upper Flat.

Area B: the southeast part of the crater rim

In November 1965, Wilfred Shawcross directed the excavations on an extensive flat area of the crater rim between the middle and uppermost defensive ditches (B on Fig. 4). The flattened area extends for about 130 m northeast of the innermost ditch. It follows the curve of the crater rim, facing outwards towards the Tāmaki Estuary, and is backed by a bank along the lip of the crater. This flat is partially subdivided by



Fig. 15 The excavation in Area C on the crater rim in 1971. The large volcanic cone of Mt Eden/Maungawhau is visible on the skyline to the left (photo: Janet Davidson).

low, right-angled extensions from the bank, which do not reach to the outer edge of the flat.

A large area of this flat was laid out in squares and the turf removed (Fig. 14). In the majority of the squares, sterile scoria was found immediately beneath the thin topsoil. This extensive flat was probably formed by cutting back into the natural curve of the rim. Either it was an open space and perhaps assembly point on this high part of the site, or the site ceased to be used before any planned structures could be built. It is highly likely that the construction of this flat area destroyed earlier evidence of occupation in this part of the site, but it is possible that traces of earlier structures remain in the bank at the edge of the crater, which was not tested during the excavations.

Area C: the northeast part of the crater rim

A smaller flat area, lower down on the same part of the rim between the middle and lower defensive ditches (C on Fig. 4), was investigated under my direction over a period of 10 days in August 1971 and a further three days in August 1972. A varying number of volunteers took part (Fig. 15).

This area, designated 'the pit area' at the time, is not unlike the flat investigated by Shawcross in 1965, but on a

much smaller scale. It is the first significant flat area after a fairly steep climb up a narrow stretch of rim from the present car park. The route would once have passed the group of pits, now destroyed, on the knoll just to the north of the Upper Flat in Area A. The lowest transverse ditch is now almost invisible; the flat on which the pit area is situated begins about 25 m up-ridge from it. It is a long terrace extending for about 70 m and, like the larger flat further up, it faces outwards over the outer slopes. The northern end, where the investigation took place, is right on the crater rim; there is an increasingly thick bank on the edge of the crater, from which one subdividing arm extends onto the terrace in the area investigated (Fig. 16). The only features visible before excavation were several depressions along the outer edge near the northern end. The largest exposure of shell midden recorded during the earlier mapping of the site was on the scarp immediately below this group of depressions.

The excavations were designed to sample the depressions on the outer edge of the flat, another depression a little further along the terrace, and the flat area abutting the edge of the crater and the beginning of the bank.

The pits

The row of depressions proved to be pits, as expected (Fig. 17). For the most part, they had been dug directly into

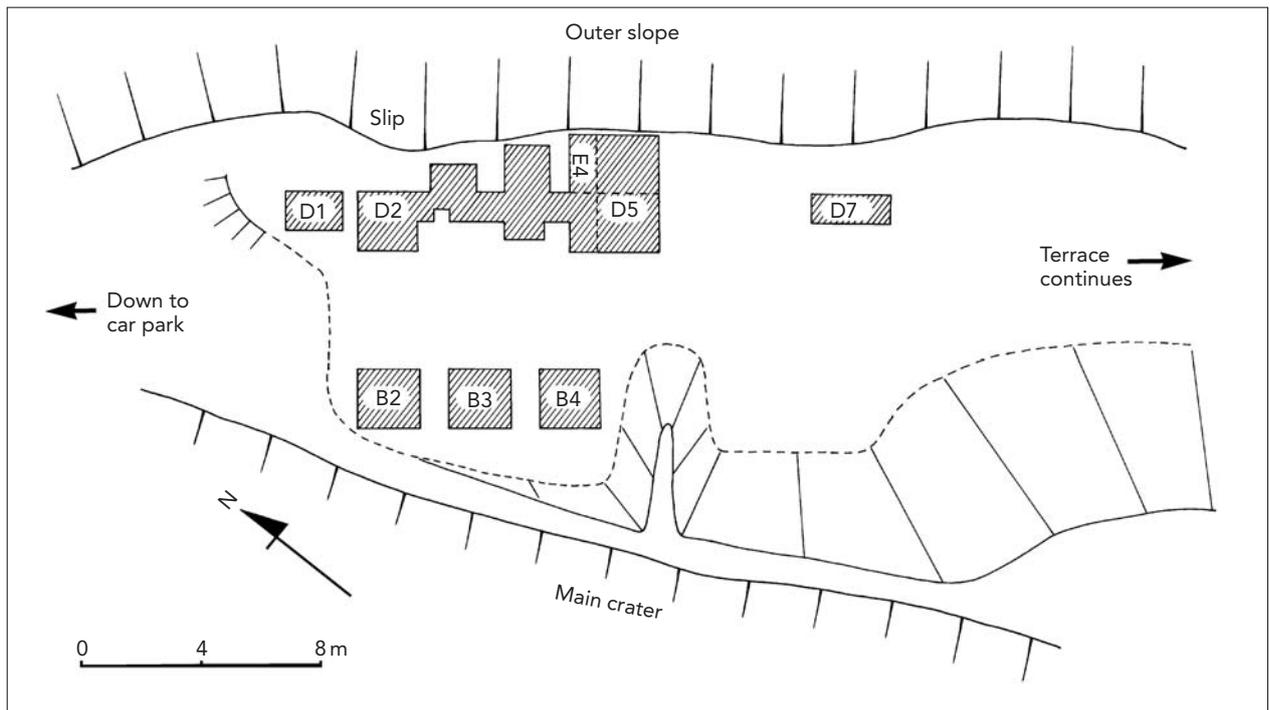


Fig. 16 Layout of the excavations in Area C in 1971 and 1972.

a natural reddish scoria and, although there were scatters of midden and stones and some smaller features on the surface between them, there was insufficient stratigraphy to demonstrate relationships between the pits (Fig. 18).

Pit 1 was a small rectangular pit with a well-preserved scoria-block facing on three sides and a bare natural scoria wall at the inner end. The quality of the facing was comparable to that in square G5 in Area A. The floor of the pit measured about 110×80 cm and its maximum depth would have been about 80 cm; the surviving facing was 70 cm high. No post-holes were found either in the floor or around the edges. The fill was a mixture of scoria, earth and midden, with more midden at the bottom and against the northwestern wall, and a very black lens at the top of the fill, just beneath the topsoil.

Pit 2 was longer and narrower, dug into the natural scoria on three sides but into fill layers towards the outer edge of the flat. It had a scoria-block facing along the wall nearest to *Pit 1*, but natural scoria walls on the other side and the inner end. The outer end was not established. It was probably at about the point where the facing on the side petered out; there was a concentration of stones at this point. However, the excavators followed the natural scoria wall on the other side

into further midden layers. *Pit 2* appears to have cut into, or been cut by, another pit or other feature in the relatively unstable fill deposits on the outer slope. The fill of *Pit 2* was an undifferentiated deposit of scoria with charcoal and some shell; as with *Pit 1*, there was a blacker lens in the top of the fill beneath the topsoil, and several noticeable black patches were observed on the surface of the fill. A single small post-hole, 20 cm in diameter and 16 cm deep, was found in the floor. Assuming that the outer wall was near the end of the stone facing, the pit would have measured about 220×80 cm. The facing was only 50 cm high, but the depth of the pit from the original ground surface could have been about 70 cm.

Pit 3 was the largest and deepest pit, and the most eroded. Two quadrants were excavated in 1971 and the other two in 1972. The pit floor measured about 300×150 cm. Allowing for erosion of the edges, the depth from the original ground surface may have been about 110 cm. No postholes were found in the floor and there was no trace of a facing. The presence of a 30 cm-deep posthole in the top of one wall and the very eroded nature of parts of the walls raised the possibility that a superstructure had been supported on posts erected around the top of the pit rather than in the floor. The fill was divided into upper and lower portions by

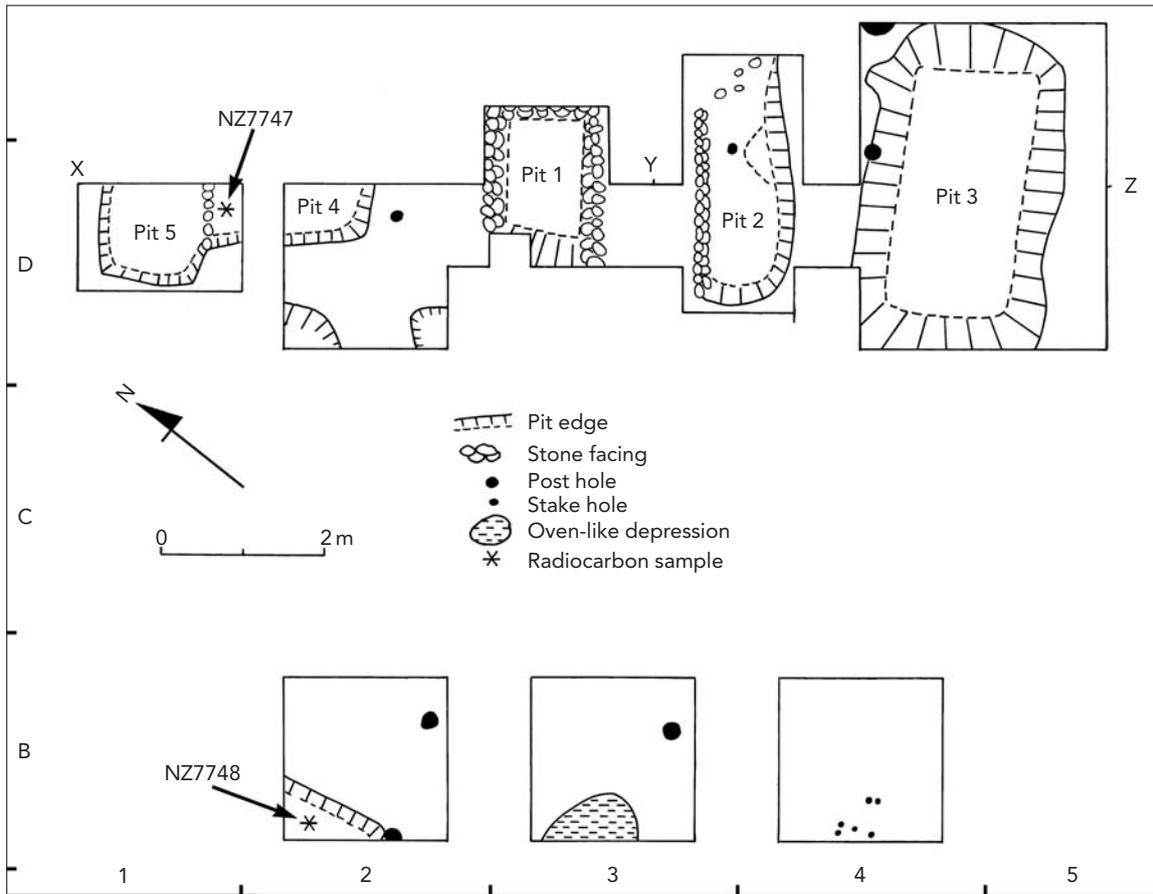


Fig. 17 Excavated features in Area C. The contexts of radiocarbon-dated shell samples NZ7747 and NZ7748 are shown.

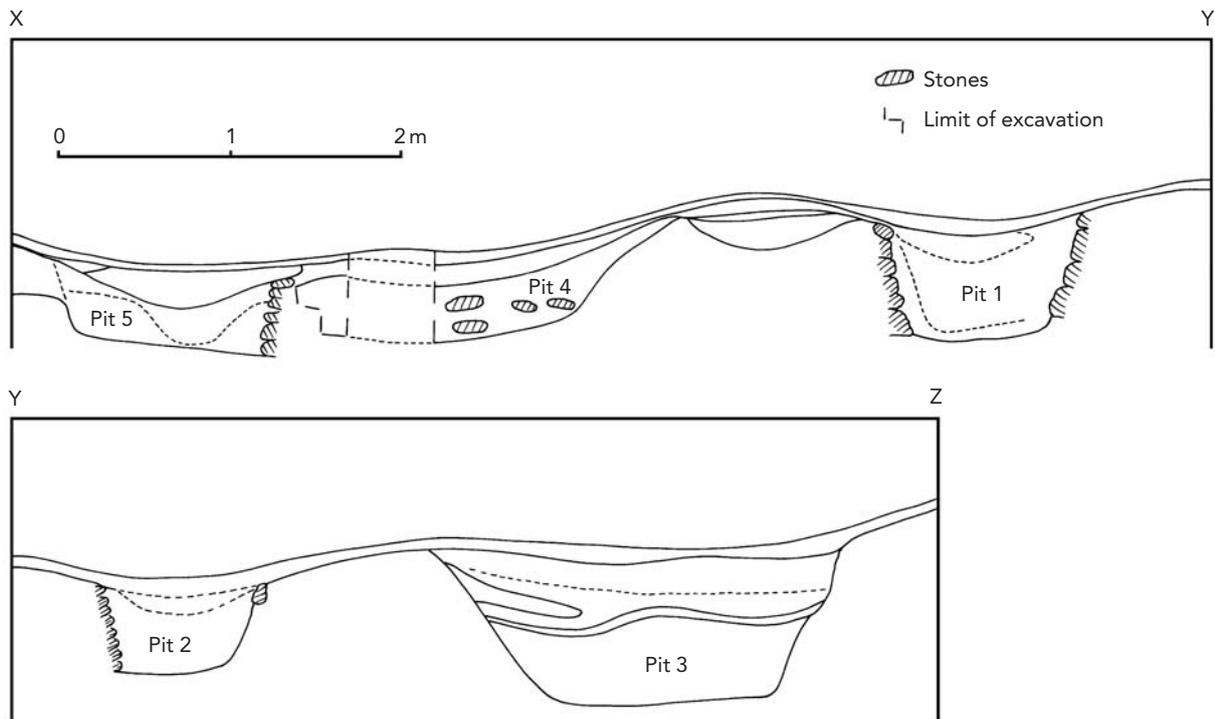


Fig. 18 Cross section through the pits in Area C (see Fig. 17 for X, Y, Z).

a wavy layer of ash and charcoal. The bottom fill was loose and contained a lot of scoria rubble; the top fill was also rubbly, with some shell in the upper part and considerably more shell and some fish bones in the lower part.

Pit 4 was a rectangular pit of undetermined length and width. It may originally have been about 80 cm deep although the existing fill was only 50 cm deep. The fill was very rubbly in square D2 but considerably finer, with more midden, in square D1. Shells from this part of the fill were used for the radiocarbon sample NZ7747. This pit was cut by the later *Pit 5*, which had a scoria-block retaining wall where the two pits intersected.

Pit 5 was dug into natural scoria on its inner end but into an earlier fill of loose brown scoria with occasional shell along the northern side. It was about 110 cm wide and may have been about 2 m long with an original depth of 60–70 cm. The bottom of the fill consisted of loose shell midden, stonier towards the retaining wall. Above this was a blacker layer with stones, and there was a thick lens of orange material (presumed to be redeposited volcanic ash) in the top.

At the conclusion of the 1971 investigation, Pits 1, 3 and 5 were refilled over plastic sheeting. In 1972, *Pit 1* was re-excavated and *Pit 3* reopened and fully excavated as part of a programme of interpretation of the features on the site. They have since partially refilled as a result of natural processes.

Other features

Contrary to expectation, no pits were revealed in the area of square D7 (Fig. 16). Black shelly soil was fairly continuous under the topsoil in the eastern part of the rectangle and filled some scoops and depressions to depths of up to 40 cm. In the northwestern corner, where the surface was slightly higher, compacted natural scoria was encountered immediately under the topsoil. There were no definite postholes, ovens or hearths.

Squares B2 to B4, where a cooking area or building might have been expected, were equally disappointing. On the inner side of squares B3 and B4, towards the crater, there was a thin layer of charcoal-stained scoria between the topsoil and the underlying natural scoria. This was associated with a group of small stakeholes in square B4 and a possible oven in square B3. There was also a single posthole in square B3.

In square B2, the charcoal-stained scoria was above a layer of brown fill about 20 cm deep; beneath this was another thin black layer representing an earlier occupation

surface. This in turn covered a shallow pit or terrace feature, only a small part of which was exposed. This was filled with lenses of scoria rubble and shell, from which the radiocarbon sample NZ7748 was taken.

The only other features encountered were in square D2, where parts of two midden-filled depressions and a solitary posthole were uncovered.

Discussion

The majority of features encountered in this excavation were clearly associated with the construction and use of the flat area. Although there was more evidence of occupation here than on the larger flat investigated by Shawcross, it was still insubstantial compared with the complex deposits lower down the site, and could be considered a poor return for the energy that would have been needed to construct the flat in the first place.

Earlier use of this part of the site is indicated by vestiges of occupation at the north edge of the flat: the pit-like feature in B2 and the fill into which the north wall of *Pit 5* was dug. It is likely that more extensive earlier deposits and structures were removed during construction of the flat and deposited, presumably, on the slopes below.

The principal activity on the terrace, as revealed by excavation, was the construction and use of the pits along the outer edge. This lasted long enough for *Pit 4* to be replaced by *Pit 5*. The pits do not seem to have been accompanied by a significant amount of residential occupation. Although there are traces of cooking, this appears to reflect fairly limited activity rather than actual residence in the immediate vicinity.

The pit fills probably signal renewed construction activity somewhere in the vicinity, presumably slightly further up the rim. These fills are not pure rubbish dumps, but redeposited layers, which usually incorporate some midden. This dumping was not sufficient to fill the pits completely and their upper edges have eroded quite markedly. It can be assumed that no further significant activity took place on this flat area after the pits ceased to be used.

Area D: terraces on the northern slope

The main investigation in 1971–72 focused on the large terraces on the northern slope below the reservoir, which were due to be damaged by construction of the road down the mountain from the car park at the edge of the reservoir. The excavations here took place between 22 November 1971 and 15 January 1972, and were jointly directed by

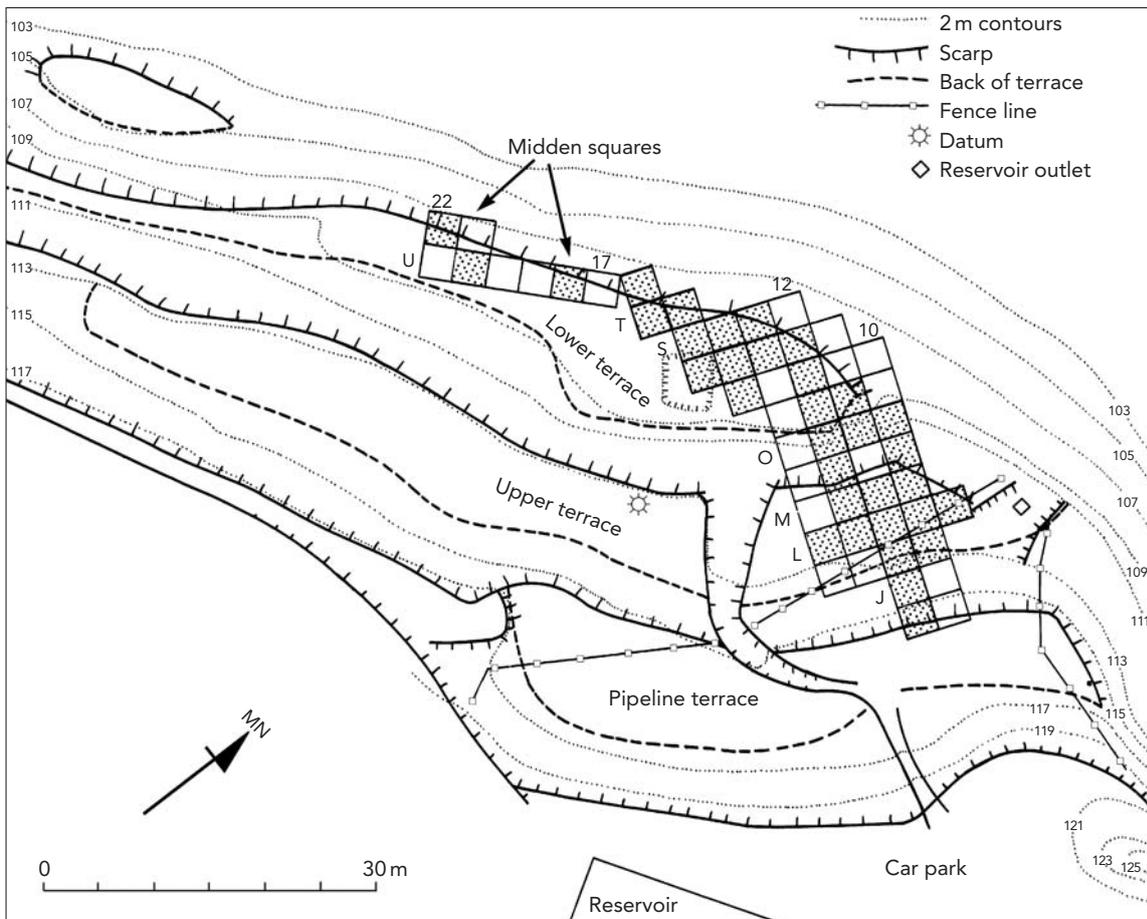


Fig. 19 Area D, excavated in 1971–72, showing terrace contours and excavation grid.

J.R. McKinlay of the New Zealand Historic Places Trust and the author. Two other people were employed full time and a varying number of volunteers also participated.

The two lowest terraces below the reservoir (designated the Upper Terrace and the Lower Terrace on Figs 6 and 19) did not appear to have been affected by reservoir construction or other recent activity, apart from the bulldozing of a path across the Upper Terrace, which had left some debris on the Lower Terrace. The Pipeline Terrace, on the other hand, appeared to have sustained some interference during reservoir construction. Mapping of the terraces by McKinlay in 1971 highlighted a remarkable feature – the surface of each terrace was almost exactly level from one end to the other. The only definite surface feature visible on any of the terraces in 1971 was a large rectangular pit near the centre of the broader northern part of the Lower Terrace.

The excavations concentrated on the northern ends of the Upper and Lower terraces and the outer edge of the Lower Terrace (Fig. 19), as these were the places most likely to be



Fig. 20 The excavations in Area D in January 1972. The Upper Terrace is in the foreground, with part of the Lower Terrace visible in the centre and the Midden Squares to the left (photo: Janet Davidson).

damaged by road construction. A 3 m grid was set out over the main excavation area; within this, 2 m squares were excavated, leaving 1 m baulks, in the expectation that deep

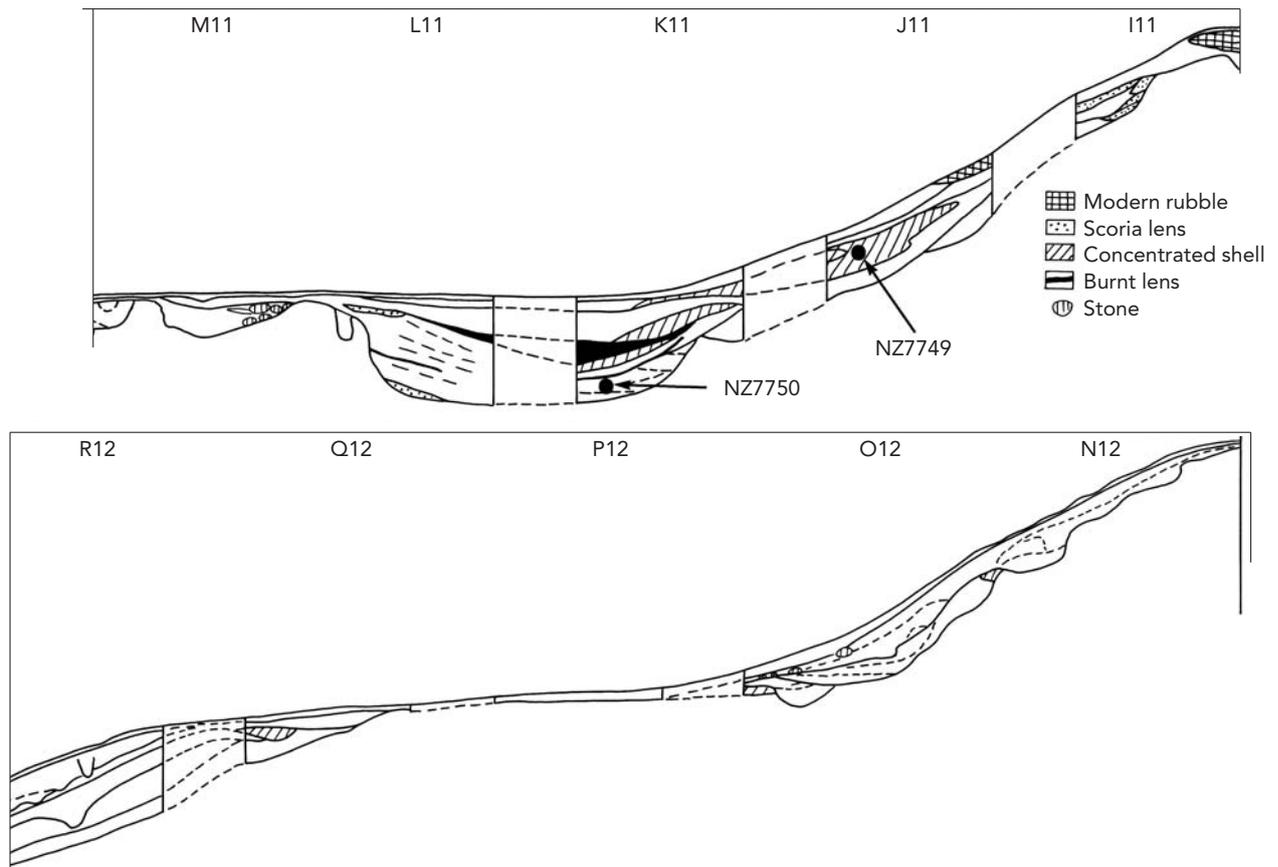


Fig. 21 The long cross section through the Upper and Lower terraces in Area D. The contexts of radiocarbon-dated shell samples NZ7749 and NZ7750 are shown.

stratigraphy similar to that found on the Upper Flat in 1960 might be encountered. Excavations began on the Upper Terrace, moving progressively down across the Lower Terrace and southwards to what became known as the Midden Squares (U18, U21 and V22) (Fig. 20).

Fig. 21 illustrates the long cross section across the two terraces. Both were formed by cutting back into the slope of the hill to form a flat surface backed by a scarp considerably steeper than the original slope of the hill. Pits and other features were then dug into this flat surface and in most cases refilled. Rubbish was cast down the scarps after they had formed and was also dumped into disused features on their surfaces.

Two factors complicated the excavations in this part of the site. First, the underlying natural material varied between cindery scoria and relatively soft, bright orange clay derived from volcanic ash. The change from scoria to ash occurred suddenly in the southernmost part of the excavation on the Upper Terrace, and similarly on the southern edge of the excavations on the Lower Terrace. Second, rabbits had

caused considerable disturbance in some areas, particularly in the fills of pits.

The Upper Terrace

Much of the northern end of the Upper Terrace was a flat scoria surface in which numerous features had been dug and then filled (Fig. 22). The limit of this surface is shown by the dotted line running from square L9 through M10 and M11. North and west of this line, the terrace surface was built on a series of fill layers, mostly interpreted as slope debris deposited above the old soil that developed on the original scoria slope.

There was no trace of the original soil horizon or the slope debris layers in squares I11 and J11 on the scarp above the terrace. Most of the deposits on this scarp appeared to be relatively recent, ranging from modern rubble derived from the reservoir construction, to thick lenses of shell midden that appeared to post-date the infilling of a large pit on the terrace below. Shell from one of these lenses provided the radiocarbon sample NZ7749.

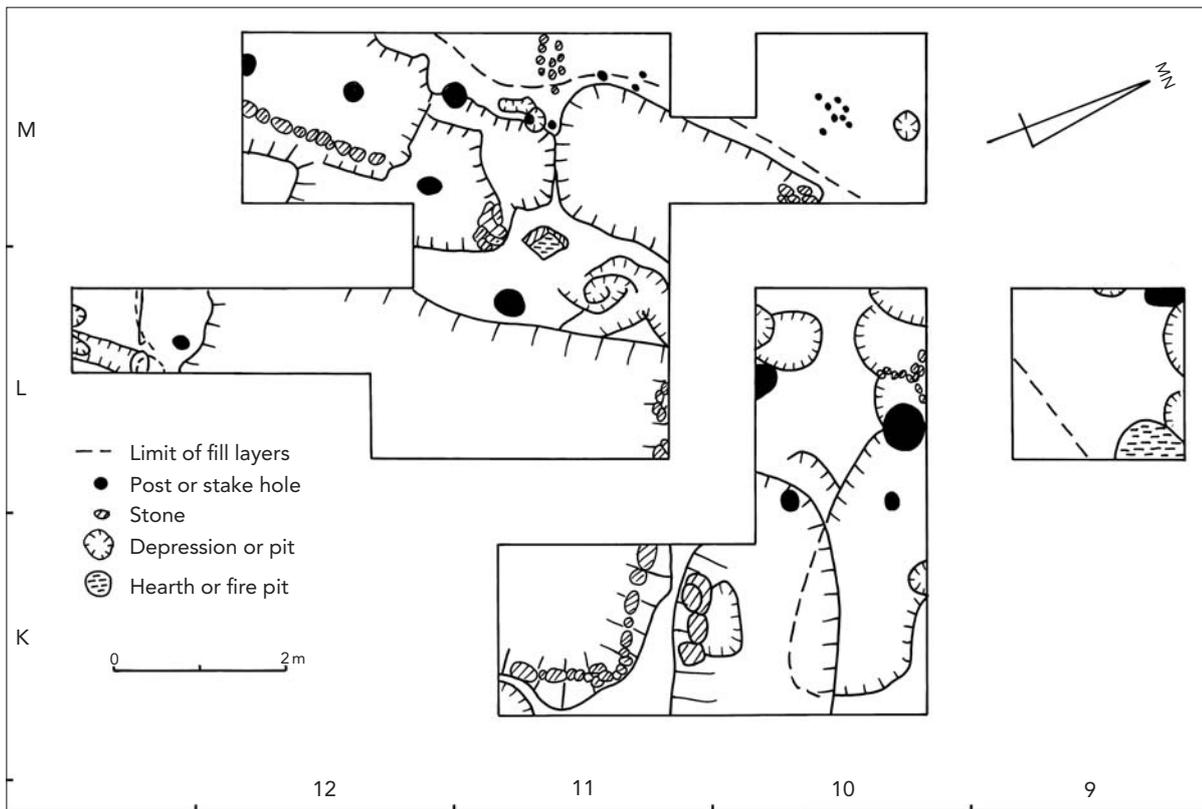


Fig. 22 Excavated features on the Upper Terrace in Area D.

An interpretation of the pits on the Upper Terrace is given in Fig. 23. The scoria surface was very crumbly and the edges of the pits badly eroded; intensive rabbit burrowing, particularly in Pits 4 to 7, had also helped to blur the relationship between different features.

Pit 1 was about 120 cm deep with a floor that measured approximately 550 × 350 cm. It had a partially intact scoria-block facing on the north and east sides; at its northwest corner, the wall was eroded and the fill layers lapped over into an amorphous feature, which in turn was cut through by a later posthole. The fill of *Pit 1* is illustrated in Figs 21 and 24. It is clear that this large pit was filled progressively and perhaps over quite a long period from the south, with a series of layers of earth containing scattered midden, which presumably derived from activities further south on the terrace. There was a thick and distinctive burnt layer in the northern part of the fill, which was reminiscent of the burnt layer in parts of the 1960 excavation. Shells from beneath the burnt layer in square K11, which was nonetheless relatively late in the infilling of the pit, provided the radiocarbon sample NZ7750.

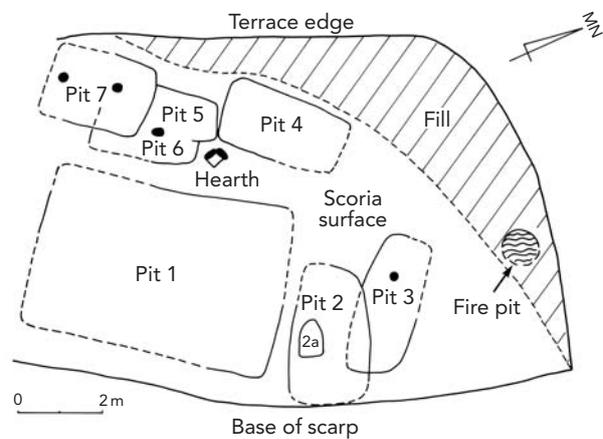


Fig. 23 Interpretation of the features on the Upper Terrace in Area D.

Although the south edge of the pit was established, it had been modified by the construction of a smaller, later pit whose extent was not fully traced in the fill of the larger pit. Several postholes and a slot-like feature in the natural ash surface immediately south of *Pit 1* were considered possibly to belong to a building, perhaps a house, whose relationship to the pit was not established.

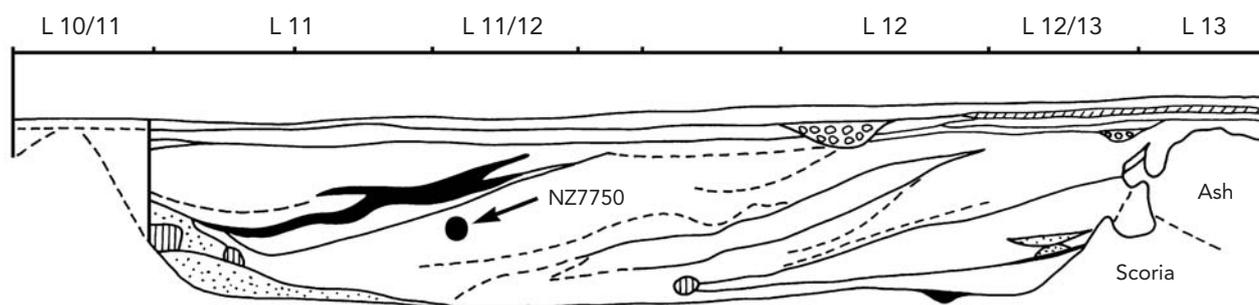


Fig. 24 Cross section through Pit 1 on the Upper Terrace in Area D. The approximate position of radiocarbon-dated shell sample NZ7750 in the stratigraphy of the pit fill is shown.

Pit 2 was about 60 cm deep and its floor was estimated to measure 280 × 130 cm. This pit was an irregular, rounded rectangle in plan, with a shelf-like feature beyond the west end. The fill contained an unusually large amount of fish bones.

Pit 2a was a bin pit dug through the floor of *Pit 2* to a depth of about 25 cm. It is thought to have been dug from high up in the fill of *Pit 2*.

Pit 3 was an oval, boat-shaped pit, about 55 cm deep. The floor was about 280 × 120 cm. It had one posthole, jammed with a large stone.

Pit 4 was about 90 cm deep with a floor area measuring about 250 × 120 cm. It had an intact scoria-block facing at the north end and traces of a collapsed facing at the south end. No postholes were found in the floor. The fill was a series of layers of earth and scoria with scattered midden.

Pit 5 was 50 cm deep. Its floor was only about 70 cm wide and its length unknown; it may have been a bin pit of square rather than rectangular plan. The small area of floor remaining was quite uneven.

Pit 6 was about 70 cm deep with a floor measuring about 200 × 120 cm. It had a complex fill of earth, scoria and midden. One posthole was found in the floor.

Pit 7 was about 100 cm deep. The floor was about 120 cm wide and its length was probably 250 cm. In the southwest corner it had been dug partly into fill layers above the old ground surface; elsewhere it had scoria walls, with an intact scoria-block facing on the east side. The fill was brown earth with midden, interrupted in the middle by a layer of scoria rubble and shell. There were two postholes in the floor.

The nature of the stratigraphy and the interference of rabbits made it difficult to determine the relative ages of the pits. *Pit*

3 was clearly later than *Pit 2*, but the relationship of *Pit 2* to *Pit 1* was not established. It was thought that *Pit 4* was probably later than *Pit 5*, and *Pit 7* later than *Pit 6*. During excavation, it seemed that *Pit 5* was later than *Pit 6*. However, it later became apparent that ash from the hearth near the intersection of *Pits 5* and *6* extended over the top of the fill of *Pit 5* but ceased at the edge of *Pit 6*. The alignment of the pits can also be considered in proposing a sequence. In this case, *Pits 4, 7* and *1*, and possibly *3*, might form a planned arrangement.

It is suggested that *Pits 5* and *2* may be the earliest features, followed by the hearth. This consisted of two stones set at an angle, partly enclosing a thick rectangular patch of ash, and surrounded by more scattered ash. Possibly associated was the posthole to the southeast. If this hearth was in a building, all other postholes have been destroyed by later pit construction. *Pit 6* was the next to be built. Last was the main group of *4, 7, 1* and, perhaps, *3*. The pits on the outer edge of the terrace seem all to have been filled rapidly and covered over with a deliberately laid scoria-rubble surface. *Pit 1* may have taken longer to fill.

Even later in date would be the small pit cut into the southern end of *Pit 1*. The relationship of the possible building in this area to the pits is not known.

Other features on the Upper Terrace are either late, or cannot be related to the pit sequence. They include the definite fire pit on the very edge of the terrace, various scoops and depressions filled with dark soil and midden in the terrace surface, postholes and stakeholes along the western edge, two postholes towards the centre, and two scatters of burnt stone – each the equivalent of a *kete* (basket) full – in squares *M11* and *L10*. The presence of a small *hāngi* just below the topsoil above the fill of *Pit 1* (Fig. 24) should also be noted.

A large posthole in square L10 and a smaller one in the baulk between squares K10 and L10 (dug into the fill of Pit 2) were post-European. One contained a concrete post.

The Lower Terrace

The Lower Terrace was formed, at least at its northern end, in the same way as the Upper Terrace: by cutting back into the natural slope to form a flat surface backed by a steep scarp. By the time this terrace was built, there was already a considerable build-up of slope debris layers above the original ground surface, following the original slope line, and these layers were truncated as part of terrace formation (Fig. 21). Only the uppermost deposit on the slope below the terrace in square R12, for example, may have been laid down at the time of terrace formation or during the life of the terrace. These earlier slope layers also formed the bulk of the deposits in squares S13, S14, T15 and T16. The extent of the scoria surface is shown in Fig. 25.

The original base of the scarp at the back of the terrace was identified in squares O11 and O12, and it was apparent that quite a lot of material had been thrown down the scarp from the Upper Terrace after the Lower Terrace was constructed (Fig. 21).

On the northeast tip of the terrace, the original scoria surface was covered by a very shallow topsoil. The only significant features here were the remains of a burial and a large posthole, 60 cm deep, with packing stones in the bottom (Fig. 25).

The burial had apparently been placed in a small pit, 75 × 65 cm in plan and about 65 cm deep. The body is thought to have been in a crouched position with the head to the east and the feet to the west. The pit was reopened at some time by means of an extension on the south side. Most of the bones were removed, leaving only the radius and ulna of one arm and most of the bones of one foot, which had all been hard up against the walls of the original pit. At the time of excavation, the burial pit had an upper fill, about 40 cm deep, of dark grey-brown earth in which some small pieces of obsidian were found, and a lower fill of soft orange-brown earth and white sandy grains. There were extensive traces of *kōkōwai* (red ochre). A very small bone needle or pin was found between the arm bones. These remains were taken to Dr Ranginui Walker of the Auckland District Māori Council to determine reburial by the appropriate people. No study of them was undertaken.

To the south of this open area of terrace was a group of pits. Two had been completely filled in; the third was the large pit visible on the surface, which had been only partly filled.

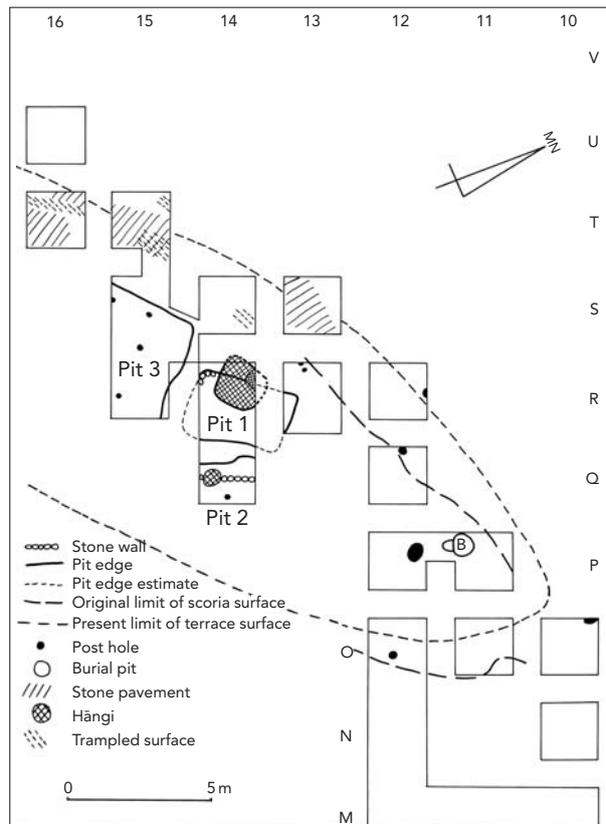


Fig. 25 Excavated features on the Lower Terrace in Area D.

Pit 1 was about 100 cm deep with a floor of about 300 × 180 cm. It had an undifferentiated fill of earth and stone, with a lens of charcoal near the bottom. Traces of scoria-block facing were found in the southwest corner. No postholes were located in the floor.

Pit 2 was only partly exposed and its dimensions are unknown. It was only about 80 cm deep but its floor was clearly considerably more than 200 × 100 cm. It had a scoria-block facing all along its west wall, quite some distance out from the natural scoria face. During excavation it was assumed that there was only one pit, with the facing constructed well out from the pit wall and the gap then filled with rubble. On reflection, however, it seems possible that there were two pits: an earlier shallower one, with a natural scoria wall; and a later deeper one, with a stone retaining wall set into the fill of the earlier pit. One posthole was found in the floor of this pit.

Pit 3 was the large pit visible on the surface. Because it had not been fully filled, its walls were very eroded and its actual dimensions accordingly difficult to establish. It may have been between 450 cm and 600 cm long and about 100 cm

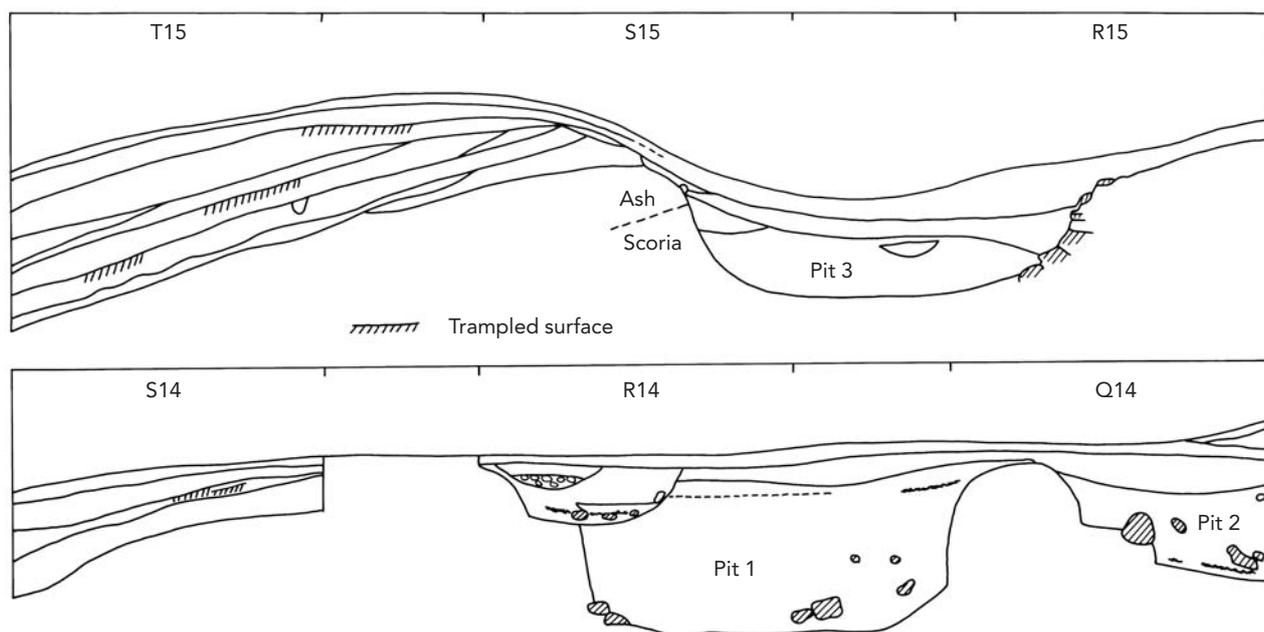


Fig. 26 Cross sections through features on the Lower Terrace in Area D and the slope below. Note the hāngi features above Pit 3 and the trampled surfaces in both slope areas.

deep. Well-preserved postholes were found in this pit. The two at the base of the west wall were 45 cm and 30 cm deep, and the two away from the wall 30 cm and 35 cm deep. There was also a stakehole, more than 30 cm deep but only 8 cm wide, which was not aligned with the posts.

Because it was left unfilled, Pit 3 appears to have been the most recent feature on the terrace. It is possible, however, that all the pits were constructed at the same time, and that Pits 1 and 2 were deliberately filled to provide a flat surface for other activities whereas Pit 3 was not. The same brown earth deposit covered and sealed Pits 1 and 2.

Evidence of cooking activity was quite widespread on the Lower Terrace and seemed to have taken place at various times. Early evidence of cooking was a hāngi dug into the natural scoria surface of the terrace in square O12 beneath the subsequent build-up of rubbish layers on the scarp. Another possibly early example was a scoop depression dug through the lower slope debris layers in the west of square S14. There was also evidence of cooking in square Q12. The main concentration, however, was on top of the pits, both on the surface covering Pits 1 and 2, and in the upper part of the fill of Pit 3. This appears to represent the very last activity on the terrace. A large hāngi had been dug into the western wall of Pit 1 (Fig. 26); there was a small one dug into its fill, another in the top of the fill of Pit 2 and another in

the fill of Pit 3. Much of the fill of Pit 3 was a dense black hāngi-derived deposit.

Isolated postholes were found in various places but there was no evidence of any actual buildings. The postholes in squares O12, Q12 and R12 were all about 30 cm deep. A much larger hole in the northwest corner of square O10 appeared to be a modern disturbance and not a possible candidate for a palisade posthole.

A notable feature of the Lower Terrace was a series of surfaces in squares S13, S14, T15 and T16 (Fig. 26). The most recent of these was a stone or rubble pavement just below the topsoil (Fig. 25). In some places this was a dense layer of small stones, and in squares S13 and T16 it was bounded by a deliberately laid row of much larger stones on the outer edge. In other places the stones were more scattered; it was not possible to identify the pavement with any certainty in square S14.

On top of the layer below the pavement in squares T15 and T16 (and the equivalent layer in square S14), a hard, trampled surface was identified. In square S14, two similar surfaces were found, one above the other near the top of the same layer. In square T15, similar trampled surfaces were found on two earlier layers (Fig. 26).

It seems likely that these trampled surfaces represent paths along the outer perimeter of the terrace and, indeed,

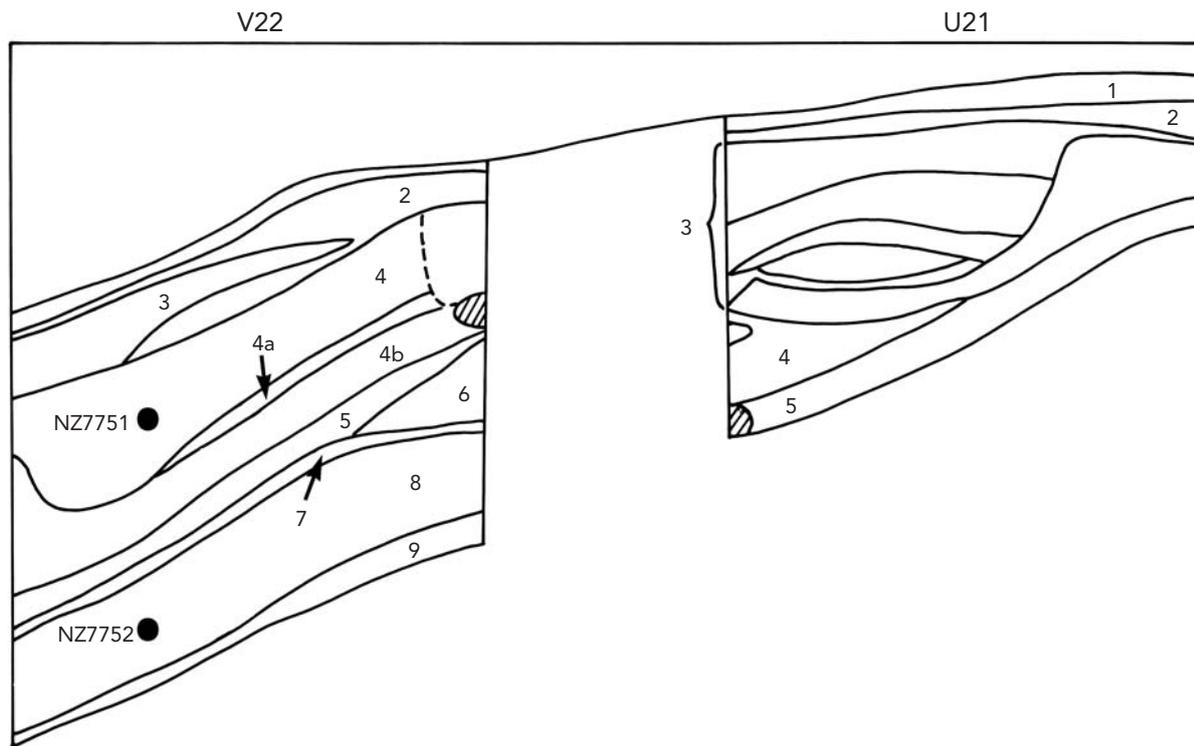


Fig. 27 Cross section through the Midden Squares in Area D (the north face of square V22 and mirror image of the south face of square U21). The contexts of radiocarbon-dated shell samples NZ7751 and NZ7752 are shown. The layers are as follows. Square U21: 1, turf; 2, brown earth with yellow granules; 3, variable fill – from top, grey-brown earth with shell, similar with less shell, rubblely, ashy, earthy; 4, brown earth with scattered shell; 5, rubble. Square V22: 1, turf; 2, grey-brown earth with shells; 3, large scoria rubble; 4, fine earth with much broken and scattered shell, a, more granular, b, less shell; 5, rubblely with many whole shells; 6, heavy rubble; 7, black ashy earth with dense broken shell; 8, loose lenses of shell and rubble; 9, stony rubble.

the site at various times. The presence of three such surfaces at different levels in square T15 is particularly important, since it suggests that the slope debris layers accumulated gradually and not as a result of one frantic period of activity. Only the uppermost trampled surface and the stone pavement were contemporary with the construction and use of the Lower Terrace. The presence of earlier trampled surfaces suggests, however, that there was a well-used route along this part of the site over a longer period.

The Midden Squares

The three squares to the south of the main excavations on the Lower Terrace (U18, U21, V22), together with square U16, revealed deep deposits of loose scoria rubble and midden (Fig. 27). In squares U16 and V22 these deposits simply followed the original line of the slope. In squares U18 and U21, however, the lower layers followed the slope but the upper layers built up the surface to its present almost flat appearance. In these two squares, the dumping may have taken place over a short period, to provide the flat surface

around the perimeter of this part of the site. Shells from two successive midden layers in square V22 provided the radiocarbon samples NZ7752 and NZ7751.

Discussion

In considering the formation and use of the terraces in this part of the site, Kear's (n.d.) distinction between slope debris and man-made deposits is useful. In most of the squares around the periphery of both terraces, the original scoria slope was covered with a sterile soil that presumably represented the pre-occupation ground surface. On top of this in most areas were what appeared to be slope deposits – predominantly earth and scoria with only occasional shell fragments. Deposits of this type were found to the north of the terraces in squares L9, N10 and P10, as well as along the western side of the Lower Terrace. These deposits presumably represent human activity higher up the hill before the terraces were constructed. The trampled surfaces on several layers in square T15 and the presence elsewhere of burning on the surfaces of various slope layers suggest that

a number of episodes of earthworking higher up the mountain gave rise to these slope debris deposits. Only the uppermost deposits in these squares and the deposits on the scarps between the terraces appear to be truly man-made deposits, in each case probably cast down from the terrace immediately above.

The Midden Squares, on the other hand, contain layers more closely resembling man-made deposits, cast down from somewhere fairly close at hand, partly, at least, to build up the surface of the terrace.

It does not seem likely that the Lower Terrace could have been constructed before the Upper Terrace. If it had been in existence when the Upper Terrace was constructed, it would have received spoil from the construction activities above. There is no clear evidence as to whether the two were built simultaneously, or whether the Upper was built first. The large amount of scoria that must have been derived from digging the Upper Terrace and its pits is not identifiable on or around the Lower Terrace, but nor is the material derived from the digging of the Lower Terrace apparent on its outer edges. It is likely that whatever the order of building, the Upper, Lower and Pipeline terraces were in use at the same time.

Of the various domestic activities that might be expected, storage is the best represented, followed by cooking, with dwelling, as usual, most difficult to identify. It is possible that there was a house on the Upper Terrace, represented by the hearth, before the main phase of pit construction. There may also have been another house, of indeterminate age, south of Pit 1. However, no concentrations of portable artefacts were found in either area to support these possibilities. There was no evidence of houses on the excavated part of the Lower Terrace.

The presence of the largely exhumed burial on the Lower Terrace was unexpected. The large post nearby may have been associated with it, marking it in some way. The proximity of cooking activities is surprising. Although the main concentration of cooking above the filled pits may have taken place after the burial was removed, there was an early hāngi close by, in square O12, and further cooking activity of uncertain age in square Q12. These associations suggest a more relaxed approach to burials than would now be tolerated. It is also possible, however, that the burial and its exhumation took place at a time when the terrace was unoccupied and no memory of its use for cooking was retained.

No evidence of fortification or even fencing was found on either terrace. It is fairly evident, however, that the Lower

Terrace was an important thoroughfare over a long period, with trampled paths eventually being superseded by a stone-paved surface. It is perhaps not surprising that these paths were in roughly the same place as the modern road down the mountain.

Area E: garden area on the western side

The so-called 'garden area' is on a protrusion at the base of the mountain, extending to the western boundary of the Domain, beyond which quarrying has destroyed a large part of the lava field. There are known to be one or more lava tubes in this area and it is possible that one runs under the centre of the protrusion.

The only obvious surface features are two low stone walls (one running east to west across the middle of the area and the other along the northern edge) and a small area of terrace or pit construction immediately to the southeast of the central wall. The lower flattish area just to the north also has some possible stone wall features but these have been disturbed by pipelines associated with the reservoir. In August 1971, a line of squares (row M) was opened along the proposed route of the new road down the mountain, which ran across the middle of this presumed garden area. These squares were designed to section the two stone walls and sample the area between them (Figs 28 and 29). The excavation overlapped with the excavation of Area C on the crater rim and lasted for nine days.

One of the problems in this area, as in other parts of the site, was the variability of the natural surfaces on and in which cultural features had been constructed. It became apparent that scoria was close to the surface under both the stone walls but dipped in the area between them, forming a natural hollow in which clay derived from volcanic ash had accumulated. Pit construction was easier and pit walls were more stable in this intermediate area.

Stratigraphy throughout this area was simple. Under the topsoil was a very stony soil, varying in colour from black to brown. This overlay the natural scoria or clay, which in places were a fairly bright orange or yellow colour. Various cultural features were identified in the squares but, in marked contrast to Areas A, C and D, there were no midden deposits.

The walls

The stone wall on the northern edge of the garden area consisted of a dense concentration of fist-sized and smaller stones sitting on top of the brown soil, presumably on the old ground surface (Fig. 30). There appeared to be no



Fig. 28 The excavation in Area E in 1971. The more prominent of the low stone walls is visible running along the naturally raised area through the upper excavated squares (photo: Janet Davidson).

structure to the wall, at least in the excavated part. In the southeast of square M3, extending into M4, a charcoal-stained surface at the same level as the base of the wall covered the fill of a pit-like feature spanning the two squares.

In squares M9 to M11, the natural scoria was close to the surface and in places quite hard. The central stone wall had been built along the line of a natural hump in this ground surface. It appeared to have been constructed by laying two parallel rows of large stones and heaping smaller stones between them (Fig. 31). The stony soil in squares M10 and M11 was noticeably blacker in the vicinity of the wall and browner away from it.

Other features

The pit-like feature in squares M3 and M4 had well-preserved walls and a rather uneven scoria floor. No postholes were found in the exposed part. Assuming that it was a pit rather than a ditch, it could have measured about 300 × 140 cm. The depth from the original ground surface would have been about 70 cm. Four distinct postholes,

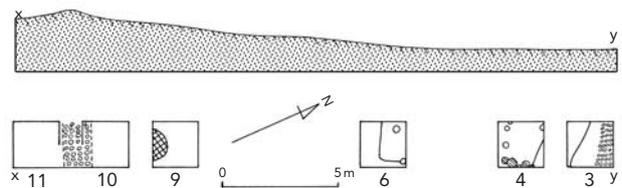


Fig. 29 The excavation in Area E. The cross section X–Y shows the ground surface. A stone wall runs along the highest part.

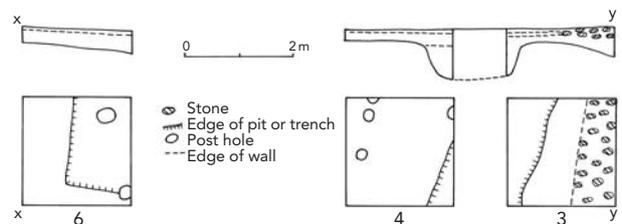


Fig. 30 Features in the northern part of Area E.

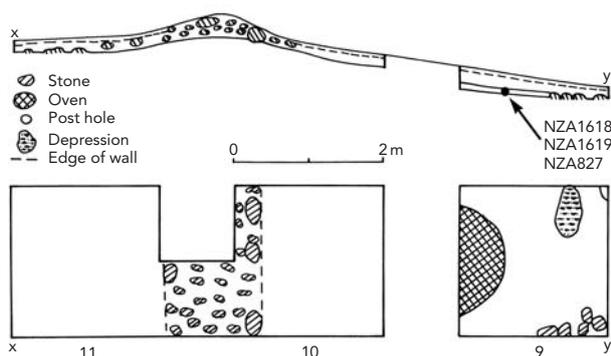


Fig. 31 Features in the southern part of Area E, which sectioned the stone wall that runs on top of a natural ridge. The context of the radiocarbon-dated charcoal sample, which gave the results NZA827, NZA1618 and NZA1619, is shown.

ranging in depth from 20 cm to 40 cm, were the only other features in square M4.

Part of a larger pit was the only feature in square M6. This had near-vertical walls and a smooth, apparently trampled floor with one large (50 cm-deep) posthole. There was also a well-defined wall slot in the eastern wall. If this slot was in the centre of the end wall, the pit would have been about 2 m wide. The depth was between 90 cm and 100 cm. There was a hearth-like depression in the surface of the brown soil above the pit fill.

The only cultural features in square M9 were a possible posthole in the northwest corner and a large, shallow hāngi pit in the southern half of the square. In the surface of the natural scoria were a number of shallow, amorphous holes, which did not appear to be cultural in origin. Charcoal from this square provided the radiocarbon sample that gave the determinations NZA827, NZA1618 and NZA1619 (Fig. 31).

Discussion

This area is today quite exposed to the wind, which throws some doubt on its usefulness as a garden. However, it is possible that it was used for gardening at an early stage in the occupation of the site, when there may have been trees in the immediate vicinity to provide shelter. The soil is so stony throughout that the walls can hardly have been the result of stone clearance; they are best interpreted as boundary walls. The noticeably darker soil in the vicinity of the walls may reflect the additional use of brush fences or windbreaks, or some other heaping of organic material.

The most striking feature of Area E is the almost complete absence of occupational debris. Two weathered

shell fragments and one fish spine were collected during excavation and there was no refuse to indicate what had been cooked in the hāngi in square M9. The two pits appear to have been dug, used and then refilled with material derived from the digging of other pits in the vicinity; at no time was occupational debris available in the vicinity for dumping into the pits. The excavated sample is too small to permit any estimate of how many pits are in this area; only two possible pits are now visible on the surface.

In view of the special position of this area, isolated between the occupied parts of the cone and the more extensive garden areas below, it may not be too fanciful to ask whether this was a special garden area, perhaps associated with garden rituals.

Subsequent investigations on the northern slopes

In February 1972, road construction down the northern slopes exposed a thick fill of shell and redeposited soil, scoria and rubble running along the slope from square U16 on the Lower Terrace in Area D to a small terrace immediately to the west of the Midden Squares, which was effectively destroyed by the roadworks. A burial was disturbed in this area, exposing bones representing parts of a leg, arm, hands and feet. In 1983, further human remains were found to be eroding in the same area (Coates 1984). It seems likely that this was the remainder of the previous burial, as the bones from the two exposures can be accounted for by one individual (stone edging at the front of the hole from which the bones were eroding in 1983 might have been put there by the bulldozer operator in 1972).

In 2008, a small excavation was carried out well below the road on the northern slopes, at a point where it was intended to join a new pipe to the existing pipes from the reservoir, which are buried on the slope. The excavation was mainly in the fill from the original pipe-laying, but traces of slope wash including midden were also found (Foster 2008).

Chronology

The chronology of occupation on Maungarei, based on radiocarbon dates, was discussed in an earlier paper (Davidson 1993). The contexts of the samples are discussed in the account of the excavations, above, and shown on Figs 12, 17, 21, 24, 27 and 31.

There are 11 radiocarbon dates in all. Charcoal sample NZA827 produced a large standard error (the CRA was

Table 1 Radiocarbon determinations for Maungarei (Ch1, charcoal no information on species; Ch2, charcoal selected by Rod Wallace; Sh, marine shell).

	Lab. no.	CRA	$\delta^{13}\text{C}$	Sample type	Probability	Cal BP range
<i>Late Horizon</i>	NZ7747	526 ± 50	+0.8	Sh	68.2%	260–80
					95.4%	275–0
<i>Middle Horizon</i>	NZ7748	668 ± 50	+0.2	Sh	68.2%	410–260
					95.4%	470–140
	NZ7749	655 ± 50	+1.0	Sh	68.2%	410–250
					95.4%	460–130
	NZ7750	685 ± 50	+0.9	Sh	68.2%	420–270
					95.4%	490–190
	NZ7751	674 ± 50	+0.4	Sh	68.2%	410–270
					95.4%	480–180 93.8%
					95.4%	170–140 1.6%
	NZ7752	732 ± 50	+0.5	Sh	68.2%	440–310
95.4%					500–260	
<i>Early Horizon</i>	NZA1618	403 ± 49	-26.7	Ch2	68.2%	500–430 34.8%
					68.2%	410–390 4.0%
					68.2%	380–320 29.4%
					95.4%	500–310
	NZA1619	383 ± 54	-26.4	Ch2	68.2%	490–430 21.2%
					68.2%	410–320 47.0%
					95.4%	500–300
	NZ8127	391 ± 44	-26.7	Ch2	68.2%	490–430 29.9%
					68.2%	410–320 38.3%
					95.4%	500–310
	NZ404	509 ± 40	—	Ch1	68.2%	500–455
					95.4%	510–440 80.6%
					95.4%	360–330 14.8%

230 ± 110, $\delta^{13}\text{C} = -25.72$). When this was queried, two new runs of the sample were undertaken (NZA1618 and NZA1619). The laboratory then advised that the initial result (NZ827) should be disregarded and the other two (NZA1618 and NZA1619) taken as a more acceptable indication of the age of the sample (R. Sparks, pers. comm. 1990). The conventional radiocarbon ages are given in Table 1, together with the dates corrected for marine

reservoir and secular effects in years Cal BP using the OxCal program (Bronk Ramsey 2005). The SH04 curve was used for the terrestrial sample (Reimer *et al.* 2009), and Marine09 for the marine samples with a value of ΔR of -7 ± 45 years (McCormac *et al.* 2004). The age ranges are presented in Fig. 32.

The five shell dates for the Middle Horizon and three of the four charcoal dates for the Early Horizon were

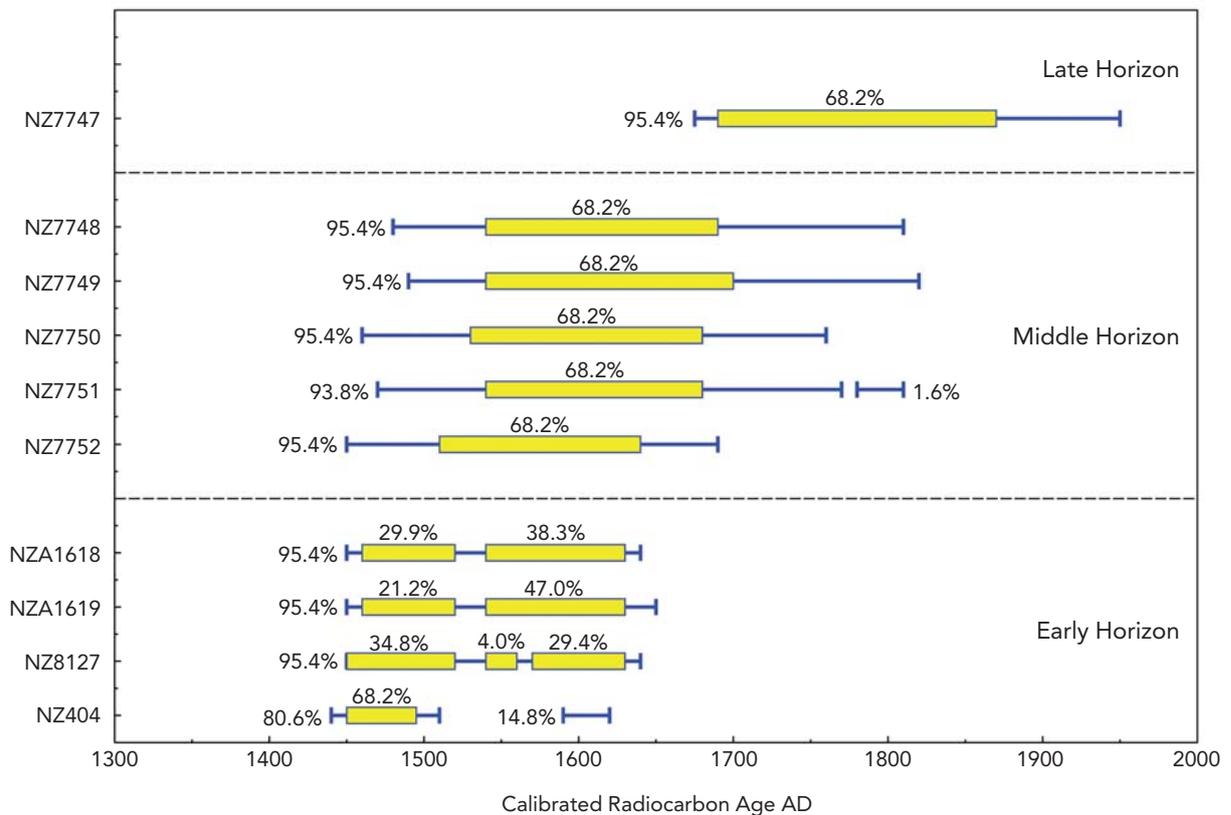


Fig. 32 Maungarei radiocarbon dates in years Cal AD after secular correction and calibration using the OxCal program (Bronk Ramsey 2005). The SH04 curve was used for the terrestrial samples (Reimer *et al.* 2009) and Marine09 for the marine samples with a value of ΔR of -7 ± 45 years (McCormac *et al.* 2004). The dates are grouped into three time horizons.

satisfactorily pooled using the OxCal program to give an overall age assessment for each of these two horizons. The date obtained on charcoal by Golson (1961) could not be included as the charcoal was unidentified and the $\delta^{13}\text{C}$ was not measured. However, its context was identical with that of the sample dated as NZ8127. There is only one date for the Late Horizon.

The 68.2% probability ranges are:

Late Horizon AD 1690–1870

Middle Horizon AD 1580–1660

Early Horizon AD 1460–1510 (34.6%),
AD 1560–1620 (33.6%).

Extending the ranges to the 95.4% probability gives:

Late Horizon AD 1675–1950

Middle Horizon AD 1540–1680

Early Horizon AD 1450–1630.

The three horizons warrant some explanation. The Early Horizon was established on the basis of the charcoal date from square E6 in Area A. The sample comes from just above

the original ground surface and antedates all the subsequent activity in Area A: the construction of the Upper Flat, the building of its pits and their infilling, and the limited subsequent use of the resulting flat area. It is thus likely to be at least slightly earlier than any of the deposits dated by the shell samples NZ7748 to NZ7752, which have been grouped in the Middle Horizon. The other two dates allocated to the Early Horizon are charcoal dates from Area E, the garden area. They cannot be linked stratigraphically to any other part of the site, but their close similarity to the early sample from Area A suggests that they represent early clearance of Area E, which, unlike the other areas, was never subsequently used for habitation.

Four of the shell dates relate to the period of construction and use of the terraces in Area D. NZ7752 is stratigraphically earlier than NZ7751 in one of the Midden Squares not stratigraphically linked to the Lower Terrace itself (Fig. 27). NZ7750 from the fill of Pit 1 on the Upper Terrace is stratigraphically earlier than NZ7749 from the scarp above the Upper Terrace (Fig. 21). These two pairs

are not stratigraphically linked. The fifth shell date in the Middle Horizon is from the earlier phase of activity in Area C on the crater rim, which was largely obliterated by later remodelling, pit construction and filling. In Area C, there is a clear separation between NZ7749, which groups with the Middle Horizon dates in Area D, and the sole date from the Late Horizon, NZ7747, which relates to the filling of pits on the remodelled surface that postdates NZ7749.

The pooling of the five Middle Horizon dates suggests that virtually all the activity in Area D took place between AD 1540 and 1680, and may well have taken place within the narrower time span of AD 1580–1660. The earlier phase of activity in Area C also fell in this period.

The single Late Horizon date barely overlaps with the pooled Middle Horizon dates and fails to do so at the 68.2% range. The remodelling of the crater rim could therefore have followed very soon after the Middle Horizon activities, but could also have taken place almost any time during the 1700s. The radiocarbon date does not preclude an even later event, but historical evidence that occupation of the site had ceased before the early 1800s and the sparseness of traditional references to it make an early or mid-1700s date for the late horizon more likely.

The charcoal samples are not easy to interpret. The three calibrated dates and the pooled result all have two (and in one case three) intercepts on the calibration curve. At this point it is not possible to say whether there really is an Early Horizon, or whether these samples date events indistinguishable from those of the Middle Horizon. However, the fact that Golson's (1961) date, NZ404, has a stronger probability of falling within the earlier intercept of NZ8127 from the same context in Area A offers some support for the possibility of initial occupation of Area A before AD 1500.

In conclusion, it can be said that the main period of occupation in Area A on the lowest part of the crater rim and the terraces of Area D on the adjacent outer slopes took place over a fairly brief period in the later 1500s and earlier 1600s, and that there was also activity further up on the northeast part of the crater rim at this time. The remodelling of the northeast part of the crater rim and, arguably, also Area B to the southeast nearer the tihi, was a later event, resulting in little actual occupation. Whether or not the charcoal dates represent an Early Horizon, it is clear from the evidence of fauna and charcoal discussed below that by the time the Middle Horizon occupation took place, the settlement on Maungarei existed in a landscape already highly modified by Māori activity.

Structural history

Like the large volcanic cone site of Pouerua in the inland Bay of Islands, Maungarei has been subjected to 'a vast number of occupation and construction events' (Sutton *et al.* 2003: 227). In contrast to Pouerua, however, most of these appear to have taken place over a relatively short period.

In the areas excavated, there is rather little evidence of initial forest clearance. The old soils on the original slopes of the mountain, identified inside the crater in Area A and on the flanks below the terraces in Area D, seem soon to have been covered by slope debris and cultural deposits originating from the second tihi and probably also from the lower northeast part of the crater rim.

The excavations on the southeast of the crater rim (Area B), adjacent to the main tihi, revealed an extensive, freshly created scoria surface with virtually no evidence of activity of any kind. It is unlikely that this part of the rim, close to the summit, had never been used for housing, storage, or cooking; it must therefore be assumed that, in its present form, it represents a late remodelling, which removed evidence of earlier activity and redeposited it on the slopes below. As noted above, it is possible that vestiges of earlier occupation remain to be found in the bank along the edge of the crater.

The narrower terrace on the lower northeast part of the rim (Area C) also consisted mainly of a freshly created scoria surface. Here, several relatively small pits had been dug, presumably used, and then partly filled, but there was only minimal evidence of cooking or other activity in the adjacent area investigated. On this part of the rim, however, there had clearly been earlier occupation, evidenced by the remains of a pit or other feature on the crater edge, and by the earlier fill layers on the outer edge, into which the pits had been partly dug. The very extensive shell midden just below the outer edge of the terrace (which was too large to have resulted from the minimal activity on the present terrace surface) is further evidence that significant reshaping of this part of the rim had also probably removed and redeposited a lot of debris of earlier occupation.

The lowest part of the crater rim (Area A), on the other hand, had received a considerable amount of redeposited material, as well as undergoing its own process of remodelling. The slope debris deposits in squares G5 and G6 in particular, through which Pit B was largely dug, reflect considerable structural activity on the second tihi area above. Both the terraces on this tihi today have partially filled pits on their surfaces, which are likely to post-date the construction and use of the upper flat below. It is reasonable to assume,

therefore, that there has been ongoing modification of this tihi area from before the construction of the Upper Flat until after its pits were abandoned, and that much of the material from earlier use of the tihi has been redeposited down the slope. It may be noted that some of the largest pits visible on the surface of the cone today are on a terrace to the west of the main tihi area. This terrace and its pits are also likely to be a late feature, construction of which may have obliterated evidence of earlier activity on that part of the rim.

The excavations revealed no traces of small sloping terraces comparable to those that characterised the earliest use of the Pouerua cone. All the excavated terraces on Maungarei are large and, as noted above, the Upper and Lower terraces in Area D on the northwestern flank, which were surveyed with precision, are remarkably level from end to end. One of the principal functions of the terraces on this part of the mountain seems to have been for pit storage. Because of the crumbly nature of the scoria, it is only possible to dig a certain number of pits on a terrace before the terrace surface becomes unsuitable for further pits. The use of scoria-block facing and retaining walls can extend the life of a terrace and its pits to some extent, but eventually the terrace must be abandoned or its surface significantly lowered. The prevalence of scoria rather than ash on Maungarei is the probable explanation for the apparent reduction of the surface of the crater rim. Once scoria has been dug up and loosened, there is nothing that can be done with it except to throw it down the slope, starting a process that eventually results in the formation of Kear's (n.d.) slope deposits considerably further down. Each remodelling lowers the rim, or previous terrace, leaving little or no evidence of its predecessor.

This process of lowering results in constant redeposition of cultural material. At one extreme, this forms slope deposits consisting mainly of scoria with only a few inclusions of shell and charcoal. At the other extreme, a primary midden deposit may be dug up, mixed with a little scoria, and redeposited only a short distance further down. This may result in inverted stratigraphy.

Much of the occupation in Areas C and D could have taken place during a period of only 80 years between AD 1580 and 1660. The final reshaping of the crater rim in Areas B and C was probably slightly later, after AD 1690. Construction and use of the Upper Flat in Area A was probably contemporary with the occupations of Area D, but the last refilling of the pits and laying of a flat scoria surface with few signs of occupation may have been part of a final remodelling of the entire crater rim.

This reconstruction is necessarily incomplete. There has been no excavation on the much more extensively terraced eastern slopes of the cone (see Fig. 53 below), an area that may well have been occupied earlier and more continuously than the northern slopes. It might be expected that evidence of occupation would be concentrated on the parts of the cone exposed to the sun, but this does not seem to be the case. The most extensive terracing is around the north-east to southeast slopes, facing the Tāmaki Estuary and the Panmure Basin, with less evidence of terracing on the western slopes. Although a significant part of the south side has been modified by the old quarry, the eastern terraces appear to have continued towards the south. There is extensive terracing on the southern slopes of other large cones, most notably Maungawhau/Mt Eden, suggesting that sun was not the major factor in determining settlement location on cones. Exposure to westerly winds may have been a limiting factor on the western side of Maungarei, as some modern informants have suggested (G. Murdoch, pers. comm. 2010).

Artefacts and other portable items

Evidence of the manufacture and use of tools and other objects was widely scattered through the deposits, but the assemblage is very small in relation to the volume of deposit excavated. This is probably partly due to the difficulty of hand-picking objects from the scoria matrix of the deposits, but partly also because no definite living or working floors were found in the excavations. The assemblage is discussed in three categories: bone and shell items; the stone assemblage, both worked and unworked; and European artefacts.

Obvious artefacts and most of the obsidian from the 1971–72 excavations were catalogued in the Auckland War Memorial Museum's archaeology register (numbers prefixed AR) soon after the excavations. Artefacts and unworked stone found during recent processing of material from these excavations and all such material from Area A, returned from Canberra, have been given 'field numbers' prefixed by MW. This material is held in the Auckland War Memorial Museum.

Bone and shell items

Adornment

Personal adornment is evidenced by a tattooing chisel and two simple pendants, and perhaps also by two perforated scallop shells.

The tattooing chisel is a segment of long bone, probably bird bone, cut flat across the butt and perforated by drilling from both sides. The teeth are indicated by scarfs in the bone but the working edge of the instrument has been damaged (Fig. 33C). This item was found on the same surface as the second trampled path in square T15 on the Lower Terrace in Area D in 1971–72, and can therefore be assumed to pre-date the construction of the terrace.

A small pendant (Fig. 33D) was found near the bottom of the fill of Pit 2 on the Upper Terrace in Area D. It is made from a mammal tooth, now unidentifiable to species, and has been ground and polished on all surfaces so that much of the original tooth has been removed. It could be a much larger tooth that has been worked to resemble a human incisor, rather than an actual human incisor, as originally thought. It has been drilled from two sides.

The other pendant was found in the fill of Pit D on the Upper Flat in Area A. It is part of a ray spine shaped to a blunt point at one end and perforated at the other (Fig. 34B). The perforation has broken and a slight notch on one outer edge of the pendant may indicate an attempt to repair it sufficiently to secure a suspension cord.

Two flat valves of the scallop (*Pecten novaezelandiae*) with rough perforations were found in Area D, one in the fill of Pit 7 and the other in the complex overlapping fills of Pits 5 and 6. In each case the perforation is roughly central and about 2 cm in from the hinge. The perforations are not drilled but roughly pierced, with maximum diameters of 13 mm and 19 mm. The edges of the shells are weathered and rough. It is possible that these were simple breast ornaments.

Points and other worked bone

Three perforated bone points, thought to be needles, were recovered during the excavations in Area D. The smallest, only 23 mm long but with a relatively large eye, was found with the partly exhumed burial on the Lower Terrace (Fig. 33E). It is made from a long bone, probably of a bird. The longest needle (Fig. 33A), which is also probably made from a long bird bone, came from the fill of Pit 4 on the Upper Terrace. The third needle (Fig. 33B), from immediately above the surface of the Lower Terrace in square O12, sealed in by later deposits on the scarp at the back of the terrace, has been so thoroughly ground and polished to a lenticular section that the original bone cannot be determined with certainty, although it was possibly from a bird.

A sawn piece of human cranium was found deep in the fill of Pit 1 in square L11 in Area D.

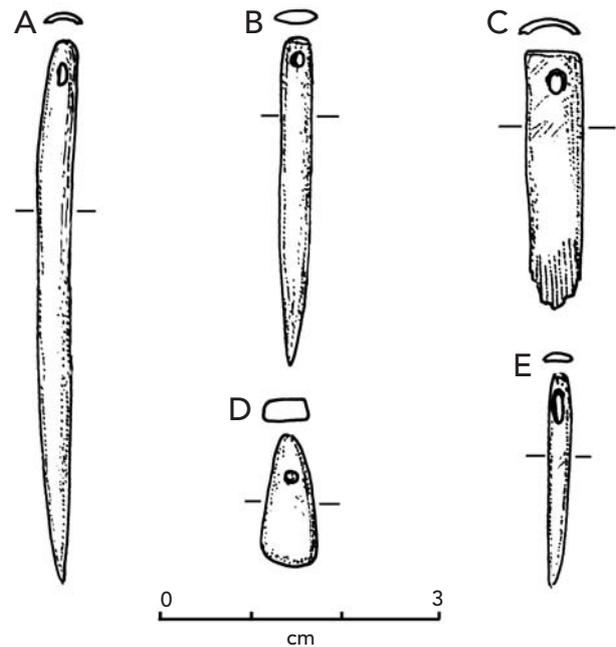


Fig. 33 Bone and tooth artefacts from Area D. A, needle AR4039; B, needle AR4040; C, tattooing chisel AR4038; D, perforated tooth pendant AR3983; E, needle AR4042.

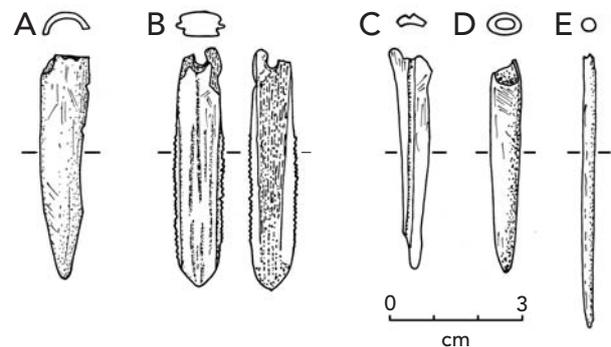


Fig. 34 Worked bone items from Area A. A, possible awl MW039; B, ray spine pendant MW040; C, grooved long-bone-shaft fragment MW041; D, broken bone point MW042; E, broken bone point, probably a needle, MW043.

Four pieces of worked bone were found in Area A in 1960. Two fragments came from the poorly documented Upper Terrace. One is the distal part of a bone point (Fig. 34D); the other is a shaft fragment of a long bone in the process of being divided by sawing, presumably into long, thin tabs for making needles or other fine points (Fig. 34C). Both could be either mammal or bird bone. They are catalogued as being from squares H10 layer 5 and H9 layer 6, respectively. Two broken points came from inside the crater. One, from layer 6 in square E4, is a large sliver of long

bone, probably from a bird, filed to a blunt point, and is possibly an awl (Fig. 34A). The other is a long, narrow point, probably a needle, although it has broken below the eye, if any existed (Fig. 34E). It came from layer 8E in the baulk between squares E2 and E3 on the Lower Terrace, which is the same context as a broken adze described below.

The stone assemblage

During the 1971–72 excavations, workers were asked to collect not only artefacts, but also any examples of what appeared to be foreign stone (i.e. not scoria) from the midden and fill deposits. Unfortunately, no samples were taken of stone that was obviously associated with cooking areas, or of the ‘pavement’ on the Lower Terrace in Area D. However, some heat-shattered rock was collected from other deposits. The stone assemblage has not been studied petrographically, but since all foreign stone in the deposits has been carried up to the site by people in the past, proper identification of all stone resources is a worthwhile project for the future.

The artefacts include a small number of adzes, most of which are unfinished or fragmentary; hammerstones, grindstones and cutters; and flakes and cores of various kinds of stone. The stone resources used by the people of Maungarei for tools include obsidian imported from beyond the Auckland area. Most of the rest of the artefactual stone appears to be greywacke and chert derived from the Waipapa series of rocks, readily accessible on Motutapu and adjacent islands quite close to Maungarei. The Waipapa series was mapped and described in detail by Mayer (1968, 1969), who defined the term greywacke in this case to mean ‘a texturally and/or compositionally immature sandstone with a high degree of induration’ (1968: 217). Mayer found the cherts to range widely in colour, including white, cream, grey, green, red, buff and black, and to be extremely hard, breaking with a conchoidal fracture (1968: 218). The chert most commonly found in Auckland archaeological sites is green, although two orange/black chips in the Maungarei assemblage may also be chert.

Adzes

A complete adze, a broken one, and part of a small adze or chisel were found during the 1960 excavations, and four adze segments, two of which are part of one tool, were found in 1971–72.

The complete adze is a small, wedge-shaped blade of irregular, almost circular section (Fig. 35, right). Its context is not recorded and it may have been a surface find. It is

partly ground on the front and back surfaces and hammer-dressed elsewhere.

The broken adze comprises the butt and central section of a tool that has a typically triangular section at the poll but is more plano-convex at the break (Fig. 35, left). It was found in the baulk between squares E2 and E3 in Area A in layer 8E in the fill of the deep feature at the back of the Lower Terrace. This is presumably the item described by Golson (1960: 34) as a ‘broken hog-backed adze found amongst the scoria boulders of one of the layers of the crater scarp’. It has some hammer-dressing on what is assumed to be the front. Traces of what may be haft polish on the sides and back suggest that this tool was actually used when complete, rather than being just a broken preform. It is not unlike a complete adze from Taylor’s Hill (Leahy 1991: Fig. 7).

A spall consisting of the back and parts of the sides of a very small adze or chisel of rounded quadrangular section (not illustrated) was found in fill in the baulk between squares F6 and F7 in Area A. It is fully ground apart from what appears to have been the butt end, where the grinding is incomplete. The fragment is about 40 mm long and 22 mm wide. Neither the cutting edge nor poll is present but this tool is unlikely to have been more than 50 mm long or to have had a cutting edge wider than about 16 mm.

The butt end of a flaked preform with only slight signs of hammer-dressing was found in the stony soil of square M4 in Area E in 1971 (Fig. 36C). It has an irregular section, probably intended to be elliptical rather than quadrangular.

The butt and blade sections of another unfinished adze were found quite close together deep in square U18 on the scarp below the Lower Terrace in Area D (Fig. 36A). This tool appears to have been close to completion, with an elliptical section and an extensively hammer-dressed body; the bevel and cutting edge were still to be formed when it broke in two places. Turner has shown that ‘Motutapu preforms were very susceptible to transverse fracture, especially where length was disproportionate to thickness’ (Clough & Turner 1998: 27); this is exemplified here.

The butt end of an adze, which appears to have been recycled as a hammerstone, was found in a rubble layer immediately above the old ground surface in square U21 on the scarp below the Lower Terrace in Area D (Fig. 36B). It is hammer-dressed and has extensive areas of ‘haft polish’, some of which probably derive from its use as an adze. However, some polish is also present on ridges between flake scars that must date from after the adze broke, and there is pecking on the poll, suggesting that the fragment may have been used as a hafted hammerstone.

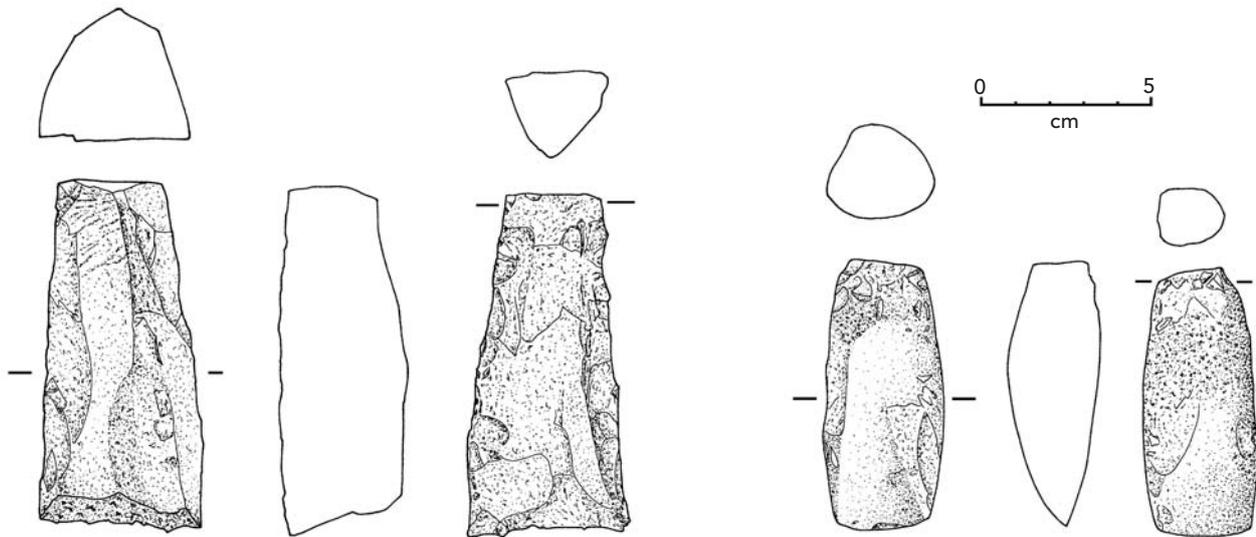


Fig. 35 Adzes from Area A. Left, the butt of a triangular-sectioned adze MW044; right, a small complete adze MW045.

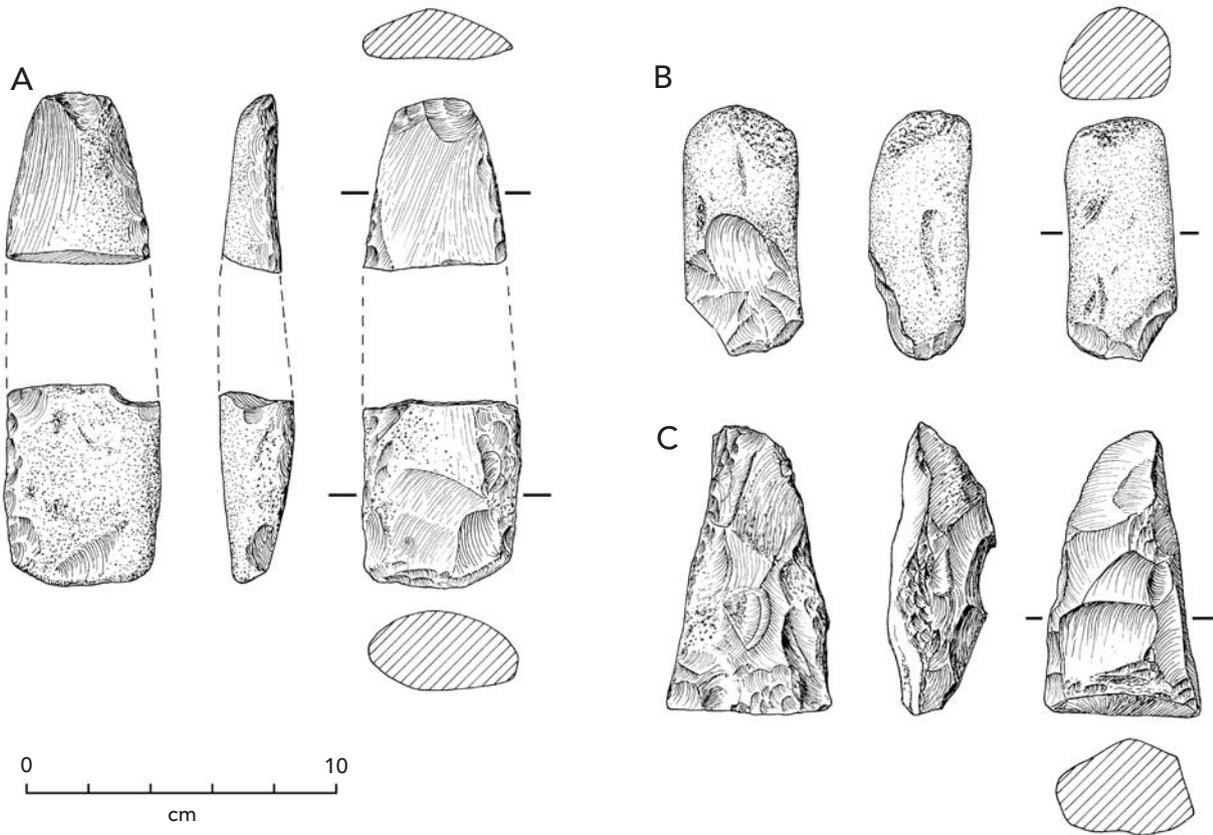


Fig. 36 Adzes from Areas D and E. A, two parts of a broken preform from Area D AR3993; B, part of an adze reused as a hammerstone from Area D AR3952; C, broken preform from Area E AR4047.

Although most of these adze pieces appear to be made from Waipapa greywacke, the broken 'hog-back' and the fragment from Area A are a darker grey colour rather than grey/green and may not be of Waipapa stone.

Adze manufacture or finishing was obviously carried out at Maungarei, in view of the broken preform recovered from Area D, although the example from Area E, where there is no other evidence of tool working, might have been recycled as some form of hoe or digger in the garden. A fragment (MW102, not illustrated) from just below the turf in the baulk between squares R14 and Q14 on the Lower Terrace in Area D is possibly the butt of a blank similar in size and shape to that of the broken preform from square U18. Half a split greywacke cobble from the upper fill of square Q14 in Area D may be a discarded piece of raw material for a small adze: Turner (Clough & Turner 1998: 28) has shown that a common way to begin adze manufacture using Motutapu greywacke was to split a beach cobble in half longitudinally by throwing it at an anvil. This served the dual purposes of testing the stone and providing two blanks.

Adze use and/or maintenance are reflected by small chips and flakes from finished adzes. Seven tiny fragments from ground adzes were found in Area A. Five, which may all have been from the same tool, were found with two apparently unworked spalls of greywacke and a small chip of obsidian on the interface between two fill layers in Pit D. Perhaps someone sheltered from the wind in the disused and partly filled pit and did a little work of some kind. The other two were from the fill of Pit C. A small chip from a ground adze came from square D1 in Area C; a larger piece from a highly ground quadrangular-sectioned adze and another probable small chip came from below the topsoil in square R12 on the Lower Terrace in Area D; and other probable adze chips came from the upper midden in square J11 and a fill layer in square L9. A flake with hammer-dressing from the upper pit fills in the baulk between squares M11 and M12 on the Upper Terrace of Area D could be from manufacture, remodelling or use.

Hammers, grindstones and cutters

Two grindstone pieces, from the upper fill layers of square U16 below the Lower Terrace, suggest some finishing or regrinding of adzes and the working of long, narrow items. They are both relatively small pieces of larger slabs. One has evidence of grinding on only one surface; the other is dished on two surfaces. Both also have signs of grooving across the dished surface (Fig. 37D).

Several small water-worn pebbles, all from the Lower Terrace, show evidence of use as hammerstones. A small, elongated pebble with evidence of pecking on one end was found just below the turf in square Q14 and exemplifies this kind of tool (Fig. 37B). A similar, slightly larger pebble from near the base of the deposit in square O11 has no sign of use, but is presumably a hammerstone waiting to be used. Also from square O11, but of uncertain context, is a still larger, less regular pebble with some wear on one end (Fig. 37C). The broken end of a similar pebble, with extensive pecking, came from the base of square U18 (Fig. 37A). All of these hammers could have been used in adze manufacture or maintenance.

Two small pieces of greywacke from the Upper Terrace in Area D have a polished edge compatible with use as a cutter or saw. The larger, from the fill of Pit 2, has a straight edge about 26 mm long with polish evenly distributed but more obvious on one side than the other. The second, from the upper midden fill of Pit 1, is a tiny chip only 15 mm long; it has a slightly curved edge 12 mm wide with marked wear on both sides. This small object would have been used for very fine cutting work, during which only part of the edge would be used at one time and the tool could be rotated slightly to make smaller and deeper cuts. Both of these items might have been used in bone working, the larger perhaps to cut bone into preforms for needles and points, as seen in the grooved bone from Area A (Fig. 34C). Clough & Turner (1998: 30–31) suggested that similar cutters from the Waipuna site might have been used for cutting sandstone, whereas examples with 'nibbled edges' would be used for sawing bone artefacts. The Maungarei examples, particularly the small one, are too small for cutting sandstone.

Flakes and cores

The obsidian is described separately below. The remainder of the stone assemblage contains relatively few flakes and cores, and more spalls and shattered items.

Two unusually large stone items were found in Area D. A discoid core (Fig. 38, left) came from a thick orange fill layer in square T16 on the Lower Terrace, and a large flake (Fig. 38, right) with no evidence of use or further modification came from the midden in square J11 on the scarp above the Upper Terrace. On the surface opposite the flake scar there is clear evidence of the prior removal of a hinge flake from what must have been a larger core. These two items reflect the adze-making technology that is typical of early sites in many parts of New Zealand but continued in use on

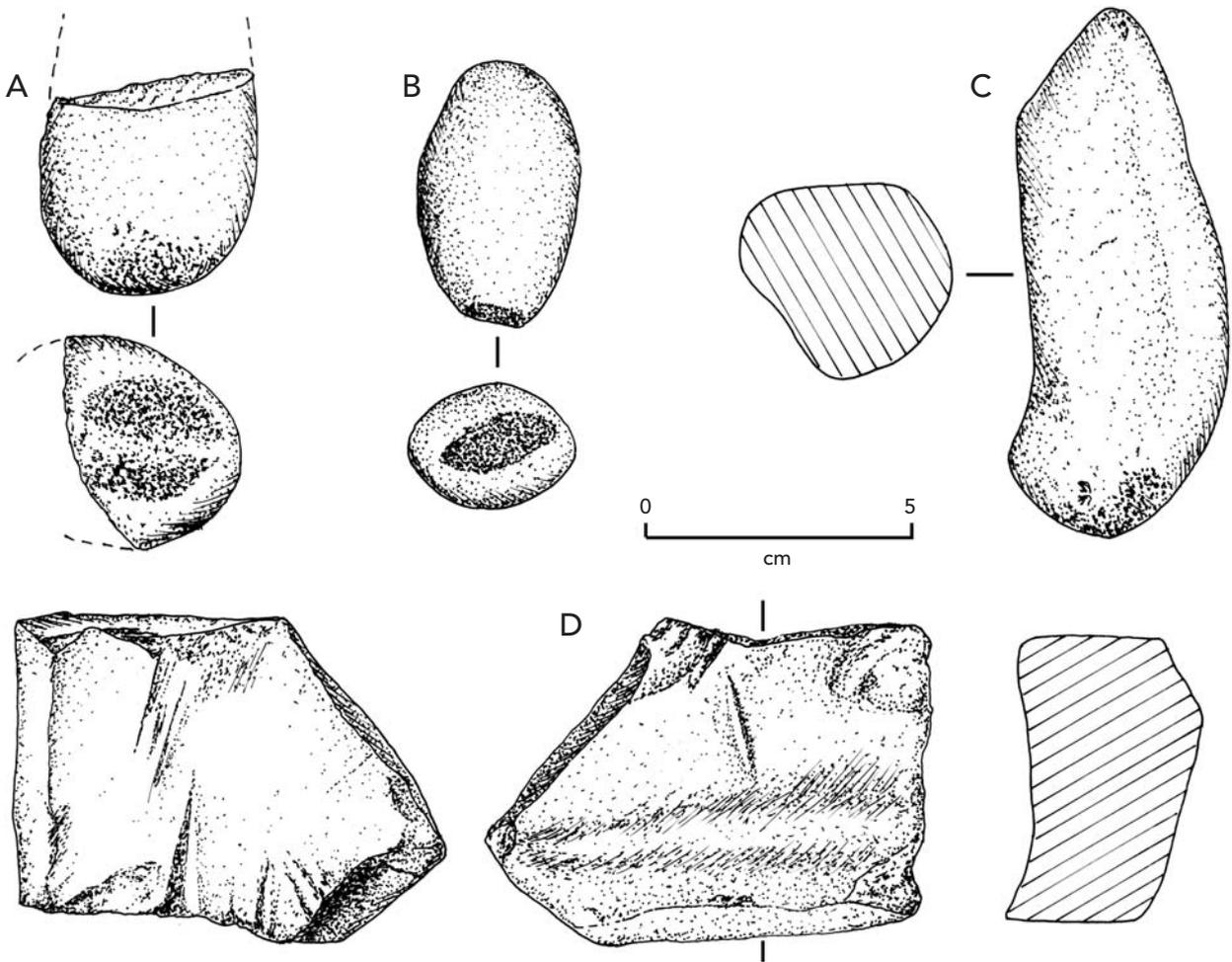


Fig. 37 Hammers and part of a grindstone from Area D. A, MW053; B, MW052; C, MW054; D, MW056.

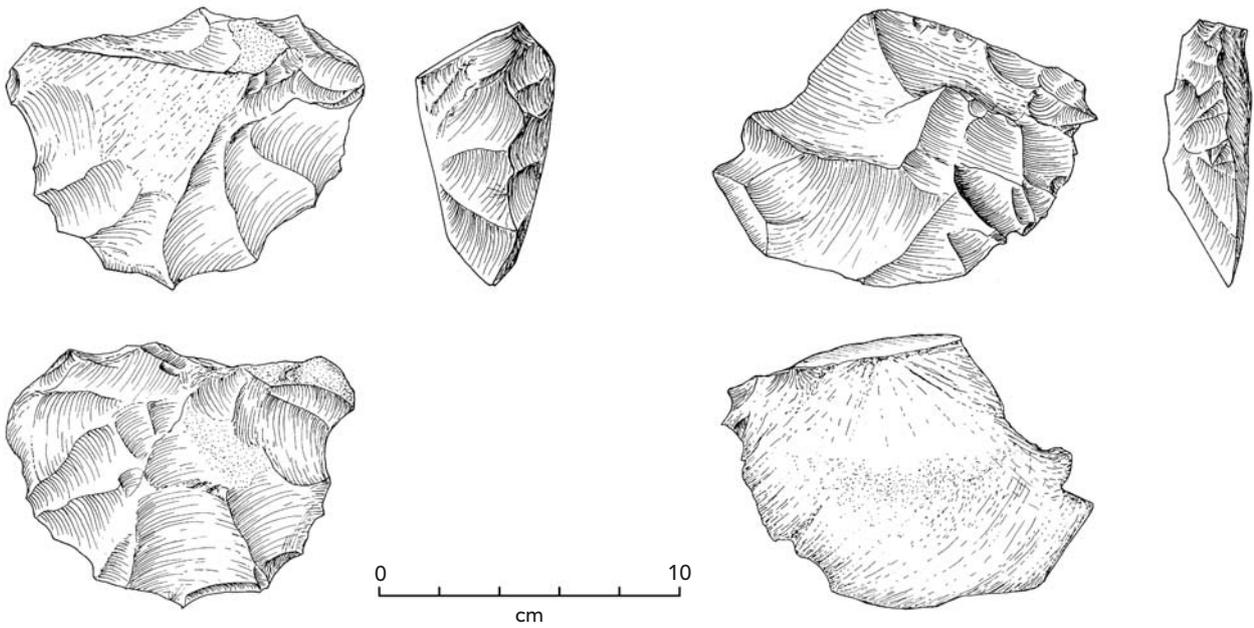


Fig. 38 Large flaked items from Area D. Left, discoid core AR4037; right, large flake AR3982.

nearby Motutapu Island and in the Auckland area generally into the time when Maungarei was occupied. They reinforce the idea that large pieces of greywacke raw material, as well as preforms and adzes, were occasionally brought to the site.

A large pebble of what appears to be red and white chert, which weighs 450 g, was found in the uppermost midden layer in square V22 below the Lower Terrace. It has extensive areas of water-worn cortex and has had a number of small flakes removed from one side. The only other partial core is a greywacke piece from square E7 in Area A.

Only 42 other possible flakes were identified among the much larger quantity of spalls and pieces collected, predominantly from Area D. None of these shows signs of use. Most appear to be greywacke, and two may be chert. There were six flakes from three contexts in Area A, three from Area C, twenty-one from the Upper Terrace in Area D, six from the Lower Terrace, five from the Midden Squares and one with no context. The small number from the Lower Terrace contrasts with the relative abundance of obsidian in that area (Table 2).

Obsidian

One hundred and eighty-nine pieces of obsidian were recovered, consisting of cores, flakes, slivers and pieces, many of which are tiny. Although obsidian was recovered from all kinds of contexts, a relatively high proportion came from the Lower Terrace in Area D, perhaps reflecting activities that were actually carried out there, whereas most of the rest was from fill layers. The distribution is given in Table 2.

The great value of obsidian compared with other stone materials that were available to pre-European Māori was its ability to form extremely fine, sharp edges. Obsidian blades made by pioneering experimental archaeologist Donald Crabtree in the United States and used for open heart surgery have been shown to cause less tissue damage than normal surgical scalpels. At 10,000× magnification, a razor blade edge appears flat whereas an obsidian flake still appears as a cutting edge at about 30 angstroms width (Buck 1982: 266). A disadvantage of obsidian is that it is very brittle, so it is not suitable for heavy work. However, the stone is unrivalled as a material for cutting hair or flesh. Experimental research has shown that even a tiny obsidian flake is very effective in skinning an animal and removing meat from bones. Although this quality of sharpness is its main advantage, pieces of obsidian that have higher edge angles, such as 45–90°, make very effective scrapers on harder materials like wood.

The size of pieces of obsidian in a site can reflect how valuable this material was to the people inhabiting the site.

Table 2 Distribution of obsidian at Maungarei.

Area A	
Pit fills	9
Lower flat and scarp	6
<i>Sub-total</i>	<i>15</i>
Area C	
Early pit fill	2
Terrace surface	5
Late pit fill	4
<i>Sub-total</i>	<i>11</i>
Area D	
Scarp above Upper Terrace	8
Upper Terrace surface	3
Upper Terrace pit fills	8
Scarp between terraces	39
Lower Terrace northeast surface	31
Burial pit	4
Lower Terrace pit fills	4
Hāngi area	30
Other terrace surface	1
Scarp below Lower Terrace	10
Midden Squares	21
No context and surface find	4
<i>Sub-total</i>	<i>163</i>
Total	189

If the supply of obsidian was abundant, then the average size of pieces discarded and not reutilised may be expected to be somewhat larger than if access to the source of supply was more difficult. However, distance from source was not the only determinant of value, since social factors were involved too. A strong trading link may have existed between two communities separated by a considerable distance, decreasing the value of this commodity. Another community quite close to the source of supply may have been denied access to it because of inter-group hostility. In such a case, the short supply of obsidian makes it very valuable. It is therefore useful to examine the size as well as the number of obsidian pieces in a site. Each piece from Maungarei was weighed on a Sartorius model BA310S top-loading balance to 1 mg precision. Similar data are available for the Whangapoua site on Great Barrier Island (Aotea Island),

Table 3 Maungarei obsidian mass (g) statistics compared with obsidian from a selection of other sites.

Site	No.	Min.	Max.	Mean	SD	Skewness		Kurtosis	
						g1	w1	g2	w2
Maungarei	189	0.02	13.1	1.3 ± 0.2	2.1 ± 0.1	3.2	10.1	14.6	33.9
Whangapoua	464	0.01	41.8	1.1 ± 0.1	2.7 ± 0.1	8.8	26.2	117.2	510.5
Kauri Pt	5733	0.02	135.2	3.8 ± 0.1	6.1 ± 0.1	5.1	69.6	59.8	879.2
Pahia	1573	0.10	1591.1	5.1 ± 1.7	66.5 ± 1.2	22.8	77.5	525.7	4252.2

the swamp excavation at Kauri Point in the western Bay of Plenty, and a surface collection from Pahia, west of Riverton in Southland (B.F. Leach, unpublished data). Statistics of this information appear in Table 3.

All of these collections display expected non-normal characteristics. Significant positive skewness reflects the presence of a few larger cores of obsidian amongst abundant small pieces. Significant positive kurtosis reflects a very strong peak in abundance at the smaller end of the size range, corresponding to the size of tools used by people. Note the much larger mean size at Pahia. This almost certainly reflects preferential selection during surface collecting on the site. The other three samples are less likely to suffer from selective bias, so the mean sizes probably do reflect the relative value of obsidian to the people at these sites. The pieces of obsidian at Maungarei were quite small compared to these other collections and the largest specimen was only 13 g.

The 189 pieces of obsidian were carefully examined with low-power binocular microscope⁵ for evidence of use as tools. Not a lot of previous research of this kind has been carried out on New Zealand obsidian assemblages, but studies by Morwood (1974), Turner (Clough & Turner 1998: 32–33) and Holdaway (2004) provide a useful starting point. It is important to avoid making interpretations about functional use unless they can be thoroughly justified. With this in mind, some simple descriptive terms that are linked to function should be used.

For example, micro-flaking along an edge can be on one or both sides. Use of the edge of a piece of obsidian as a knife (to and fro sawing action) leaves damage on both sides, either scratches or micro-flaking or both. Use of an edge as a scraper in one direction leaves micro-flaking on one side and, in the case of heavy work such as scutching a piece of flax (*Phormium* spp.), scratches on the other. The micro-

flaking occurs on the opposite side of the edge to the direction of the scraping. The same tool could then be turned 180° to scrape in the same direction as previously. This would produce micro-flaking on the other side of edge as well. In other words, a uni-directional scraper can have micro-flaking on both sides of the edge. However, most flakes are more conveniently held in one way only, and micro-flaking on both sides of a uni-directional scraper is therefore likely to be uncommon. A bi-directional scraper (held in one position but used to scrape in two directions) will also leave micro-flaking on both sides.

In any assemblage of obsidian there are usually numerous pieces displaying flaking that is not the result of using the object as a tool. The dividing line is not always clear. For example, item AR4008 from Maungarei shows small flake scars all around its edges in a neat pattern, but these are not thought to be edge damage from use as a tool. Micro-flaking and scratch marks are a better indication of such use. Given the obvious complexities, description of edge wear may be reasonably certain, while interpretation of function is much less so.

Twenty-eight pieces of obsidian from Maungarei showed edge damage that could be described as use-wear:

MW007b Use-wear occurs along an acute-angled edge of this piece of obsidian. A photomicrograph clearly shows this bi-directional damage (Fig. 39, right). The flake scars are minute and reflect light use. This object qualifies as a knife/cutter.

AR3986 Two edges on this piece of green obsidian show clear edge damage associated with use. One edge is concave, qualifying as a spokeshave form, with uni-directional micro-flaking. The other edge is acute-angled and has bi-directional micro-flaking, such as occurs during action as a knife.

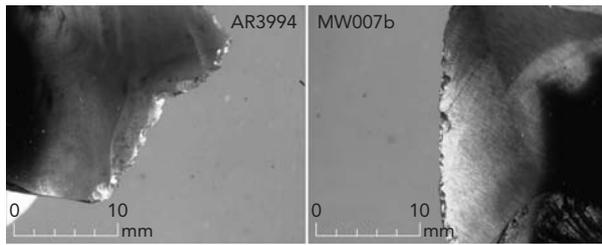


Fig. 39 Two obsidian flakes with use-wear interpreted as knives/cutters.

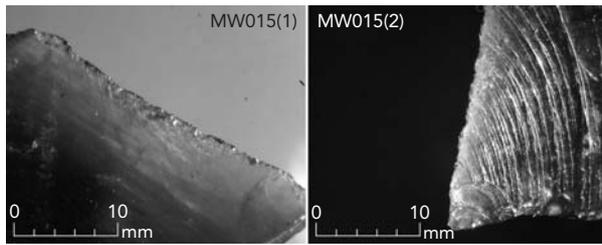


Fig. 41 An obsidian flake with an acute-angled edge showing considerable use-wear. This has been used as both a knife/cutter and a sharp-edged scraper, possibly for scutching flax.

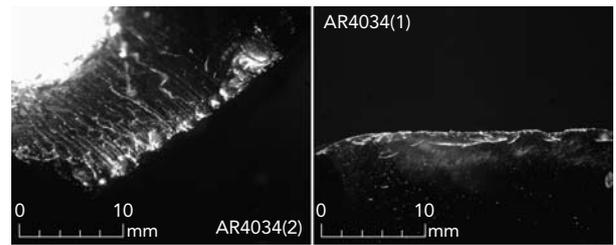


Fig. 40 An obsidian core or nucleus with use-wear on two edges. One edge is interpreted as a spokeshave and the other as a steep-edged scraper.

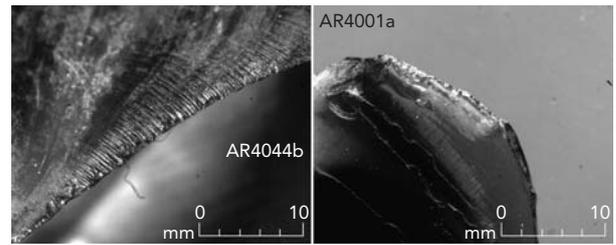


Fig. 42 The acute-angled flake on the left has considerable edge damage. It has been used as both a knife/cutter and as a sharp-edged scraper, possibly for scutching flax. The piece on the right has been used as a steep-edged scraper.

Spokeshave scrapers are very useful for scraping shafts of spears and similar objects that have round cross sections.

AR4018b This piece of green obsidian has a protruding piece about 15 mm wide with a convex end bearing considerable edge wear. This convex edge has uni-directional flaking around it. Such a form is sometimes referred to as a nose-scraper. Such implements are useful for scraping along a concave groove, for example during wood carving.

MW014g This is a very small chip of obsidian with a maximum dimension of 10 mm and is probably the tip of a broken tool. An edge with a 90° angle has minute uni-directional flake scars along it, suggesting that the original tool was used as a scraper for some purpose.

MW016 This is also a small, pointed chip of obsidian, and quite thin. Again, it appears to be part of a broken tool, possibly a drill point since there are bi-directional flake scars along both edges. If it was a drill point, it must have been used for very fine work, because this flake would be very brittle. Alternatively, it is the tip of a sharp implement used as a knife.

MW008b A somewhat larger piece than most, with uni-directional micro-flaking on one straight, high-angled edge. This has been used as a scraper for heavy work.

AR3994 An acute-angled flake with minute bi-directional flake scars. Part of the original edge of this flake has been broken away and the new edge also has use-wear on it. This suggests considerable use as a knife/cutter (Fig. 39, left).

AR4034 This is a core or nucleus with several high-angled edges. One edge is concave and has been used as a spokeshave, indicated by heavy uni-directional micro-flaking (Fig. 40, left). Another straight edge was clearly used as a steep-edged scraper, as it has minute uni-directional flake scars (Fig. 40, right). Several edges and surfaces of this piece show micro-channels and ridges, which could be confused with use-wear. However, this is minute flow-rippling from when the obsidian was molten. Cracks appear in some of these ripples.

AR3990 An acute-angled flake with minute bi-directional flake scars, suggesting light work as a knife/cutter.

MW020a This is shaped like a drill, with acute angles along both edges. The small flake scars along both edges are uni-directional and along the same side, showing that this tool was used as a scraper, not a drill.

AR4027a An acute-angled flake. The working edge is convex and some has broken away. What remains shows mainly uni-directional flake scars, so use as a scraper is indicated.

MW021 An acute-angled flake with minute bi-directional flake scars. This was probably a knife/cutter.

AR4030i This is shaped like a drill and has minute bi-directional flake scars, suggesting use as a drill.

MW025 An acute-angled flake with minute bi-directional flake scars. This was probably a knife/cutter.

MW015 An acute-angled flake. This is a most interesting piece. One edge shows use-wear, with minute bi-directional flake scars (Fig. 41, left), and one of the sides shows very severe scratching up to 4 mm wide (Fig. 41, right). This suggests that this implement was used as a knife/cutter as well as a uni-directional scraper for sustained heavy work, possibly scutching flax.

AR4033b There is minute uni-directional flaking along the acute-angled convex edge of this flake, suggesting use as a scraper.

AR4035 An acute-angled flake. The minute flake scars are uni-directional, so this implement was used as a scraper for fine work.

AR4016d There is uni-directional edge damage along a convex edge of this flake, suggesting use as a spokeshave.

AR4025a This is a drill-shaped flake with steep edges and minute bi-directional flake scars, which suggest use as a drill.

AR4019 An acute-angled flake with minute bi-directional flake scars. Use as a knife/cutter is indicated.

AR4033a Quite a large flake with a hinge fracture 60 cm long. In the centre of this edge over a distance of 10 mm there are minute uni-directional flake scars, suggesting use as a high-angle scraper.

AR4044b This small flake has an acute-angled edge with minute bi-directional flake scars along it. On one side there are intense scratch marks that have formed grooves on the surface from a scraping action (Fig. 42, left). This implement may have been used as a knife/cutter and for heavy scraping, perhaps during scutching of flax, as with *MW015* above.

AR4050a One acute-angled edge of this item has minute bi-directional flake scars, suggesting use as a knife/cutter.

AR3979 Two concave edges on this implement have minute uni-directional flake scars, suggesting use as a spokeshave.

AR4049 One concave edge on this core tool has minute uni-directional flake scars, suggesting use as a spokeshave.

AR4016e One acute-angled edge on this tool has very fine bi-directional flake scars, suggesting use as a knife/cutter on some relatively soft material.

MW009 This flake has been heated in ash, giving it a frosted appearance. There is considerable uni-directional flaking along the nose-shaped end of this flake, suggesting heavy work as a scraper. The flaking is fresher than the rest of the flake surface, so either the flake was retrieved and used after it was heated, or the edge was damaged during excavation. Distinguishing between these two options is not easy.

MW4001a One edge of this implement has considerable minute uni-directional flake scars, suggesting heavy work as a scraper (Fig. 42, right).

This small collection of 189 pieces of obsidian from Maungarei is mainly of detritus, left over after useful implements broke during use and were no longer serviceable. However, 28 have sufficiently clear evidence of edge damage from use as tools for their purpose to be identified. The most common use was as scrapers of various kinds (10 items), some for relatively heavy work and others for lighter tasks. Two of these show severe use marks, possibly sustained during scutching flax. Others would have been used for debarking pieces of flat wood or scraping wood into shape. Knives/cutters were about equally common in the collection (nine items). It is hard to know what these implements were used for, but given that obsidian flakes can have extremely fine edges, they could have been used for a range of tasks, from trimming hair, cutting cordage and preparing flax fibre, to skinning dogs and cutting up meat. Four items can be interpreted as spokeshaves. These could have been used for smoothing the shafts of spears or wooden paddles. There are only two implements that could be interpreted as drills, but this is not surprising given the brittleness of obsidian – there are other rock types that are more suitable for this purpose. Finally, there are three multi-purpose tools, two serving as both knife/cutter and scraper, and one as a spokeshave and scraper.

Sources of obsidian

To identify the sources of the obsidian found at Maungarei, the assemblage was sent to Mark McCoy at the University of Otago, who established X-ray fluorescence (XRF) spectra with a Bruker AXS hand-held XRF (McCoy *et al.* 2010). Spectra from the artefacts were compared with those obtained from source material from the North Island to arrive at an assessment of the geographic origin of each artefact. Sixty-eight pieces were too thin for reliable spectra

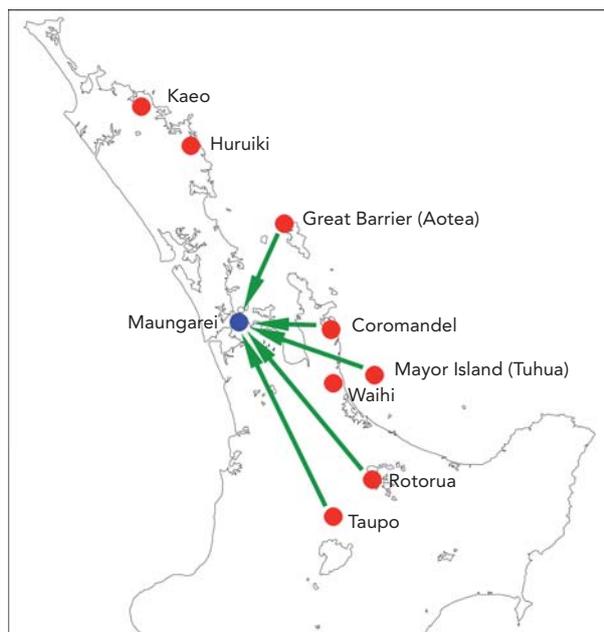


Fig. 43 Obsidian at Maungarei was derived from most of the main sources in New Zealand except those in Northland.

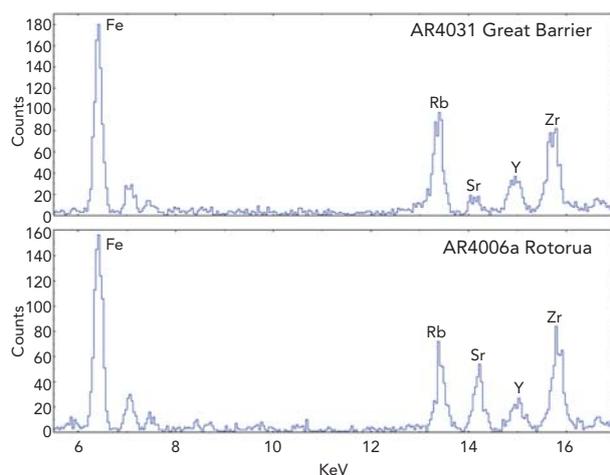


Fig. 44 X-ray spectra of two of the Maungarei obsidian artefacts. Upper, from a source on Great Barrier Island (Aotea Island); lower, from a source at Rotorua.

to be obtained. By far, the bulk of the remaining 121 pieces was shown to be derived from sources on Great Barrier Island (Aotea Island), with smaller numbers from Mayor Island (Tuhua), Rotorua and Coromandel sources, respectively (Fig. 43). Typical spectra are shown in Fig. 44, and the source allocations are given in Table 4.

Baked clay

A piece of baked clay with a partial fingerprint impression was found in the fill of Pit 3 in Area C. It looks as if it

Table 4 Source of origin of Maungarei obsidian (M.D. McCoy, pers. comm. 2010).

Origin	Number
Great Barrier Island (Aotea Island) (Te Ahumata)	90
Mayor Island (Tuhua)	15
Rotorua	6
Great Barrier Island (Aotea Island) (Awana)	2
Cooks Bay/Purangi	2
Hahei	1
Central North Island (similar to Maraetai)	1
Unknown A (similar to Awana)	2
Unknown B (similar to Coromandel or Taupo)	2
Total	121

resulted from a person rolling or fiddling with a piece of clay to produce an elongated object similar in size and proportion to a finger bone, which then became fired. Two other amorphous fragments, which could have been parts of small balls, were also found in the fill of this pit. Baked clay items, including flutes and objects with incised decoration, have been reported from sites in Auckland and the Hauraki Plains (Furey 1986: 17, 1996: 148; Foster & Sewell 1999: 17). The Maungarei pieces are unimpressive in comparison.

Unworked stone

The remainder of the stone assemblage consists of pebbles, spalls, shattered pieces and fragments of a variety of stone types. There is a significant amount of greywacke; a small amount of mostly green chert; some obviously volcanic pieces, probably from the immediate vicinity; and several other kinds of stone, some heat-shattered. As noted above, at least some greywacke was brought to the site as raw material. Unused pebbles, almost certainly intended for use as hammerstones, were also present. There is an intriguing group of other pebbles, some possibly intended for use as hammerstones but others almost pea-sized. Some of the smallest may have arrived in the deposits, like the inedible shells (discussed below), as by-products of mass harvesting of cockles; others, particularly pretty coloured ones, may have been brought in as curiosities.

Several small pieces of what appeared to be kōkōwai were collected, although there may have been many similar-sized pieces missed among the ubiquitous scoria gravel. Two pieces came from the slope layers in squares S15 and T15 in

Area D, and a tiny fragment from the fill of Pit 3 in Area C. A less certain piece was found in square M9 in Area E. Kōkōwai from the burial pit on the Lower Terrace was not retained.

European artefacts

The use of the Mt Wellington Domain for grazing and recreation is reflected in the faunal remains of cattle, sheep and pig, described below. Not surprisingly, artefactual evidence of recreational and other activities was also found in the surface and turf layers of Areas C and D.

From Area C came two pennies, dated 1940 and 1947, and a few fragments of clear, rather thick bottle glass. Area D yielded a glass marble; a flat metal plate measuring 100×70 mm with two small perforations; some tangled, rusty wire; and a piece of brown glass, probably from a beer bottle. Concrete fragments, probably dating from reservoir construction, were scattered about in several places.

Of greater interest, from Area D, were nine brass shells and the remains of a Yale RKB18 padlock, which had been heavily battered on both narrow sides, presumably in an attempt to force it open. The RKB18 was a standard lock used in low-security situations by the Auckland City Council water department and its successor, the Auckland Regional Authority water department, into the late 1970s at least, and this example presumably dates from the period of reservoir construction on the mountain in 1960.

Brass rim-fire shells

Eight of the brass shells came from just under the turf in square M11 and the baulk between M10 and M11 on the Upper Terrace. One (MW034) was from the turf layer in square R13. They all appeared to be .22 long-calibre rim-fire shells. Although rim-fire was patented as early as 1831, the .22 long did not appear until 1871. Some of the shells in the excavations could be of nineteenth-century age, and it is considered useful to describe these formally for future reference. The nominal specifications of various manufacturers of the .22-calibre cartridge are given by Barnes & McPherson (2000) as having a rim diameter of 0.275 in (7.0 mm) and case length of 0.590 in (15.0 mm). The dimensions of the nine shells from the excavation are given in Table 5.

There are three types of head-stamps on the shells (Fig. 45). These were identified by the Chief Armourer at the National Forensic Services of the New Zealand Police. The top row in Fig. 45 shows the head-stamps on shells MW038, MW030, MW031 and MW036. These are all brass shells



Fig. 45 Nine .22 long shells from the excavations in Area D at Maungarei.

Table 5 Rim-fire shell dimensions from Maungarei excavations.

Cat. #	Rim width (mm)	Case length (mm)
MW30	6.89	15.31
MW31	6.88	15.36
MW32	6.89	15.47
MW33	6.88	15.72
MW34	6.96	15.59
MW35	6.80	15.53
MW36	6.88	15.38
MW37	6.85	15.46
MW38	6.97	15.36

and belong to ammunition manufactured by Imperial Chemical Industries in England between about 1926 and 1962. Ammunition with this head-stamp was loaded in New Zealand throughout this period. Items MW032, MW034 and MW037, in the middle row of Fig. 45, are nickel-plated brass, and were manufactured by Remington Arms Company USA between about 1934 and the late 1950s. The bottom row, MW038 and MW035, are brass shells. This head-stamp was in existence from 1886 until 1978. It was initially used by the Dominion Cartridge Company of Canada from 1886 to 1927. The company then became Canadian Industries Ltd and used this head-stamp from 1928 to 1976. Valcartier Industries Inc. of Canada used it from 1976 to 1978.

All but shell MW036 show firing-pin marks, and the impressions appear to be consistent within each group and different from one group to another, suggesting three

different rifles. The general preservation of these shells was different from one group to another. The nickel-plated shells were the freshest in appearance, and the two on the bottom row were the most corroded, suggesting greater age.

We cannot be certain what activity is reflected by the shells. However, as rabbits were still present on Maungarei at the time of the excavations and rabbit burrows had disturbed the deposits in several places, rabbiting is a distinct possibility.

Discussion

The small Māori artefact assemblage from Maungarei is not unlike that recovered elsewhere in the Auckland region, including the sites at Station Bay on Motutapu Island. However, it falls short of sites such as the smaller volcanic cone of Taylor's Hill, where a much larger assemblage of adzes and greater diversity of bone artefacts were recovered (Leahy 1991); Waipuna (R11/1436), an open site further up the west bank of the Tāmaki Estuary, which yielded a larger assemblage of greywacke artefacts (Clough & Turner 1998); R10/497 on Motutapu Island, a small terraced site, from which a range of bone and stone items was recovered (Watson 2004); or Westfield (R11/898), an open settlement site further up the west bank of the Tāmaki Estuary beyond Waipuna, adjacent to the now destroyed cone of Te Apunga ō Tainui (McLennan's Hills) (Furey 1986).

The stone assemblage appears to reflect the use of predominantly local stone resources, with the important exception of obsidian. The adze technology is entirely compatible with what is known of the history of stone working in the Auckland area. Golson (1959: 46) described the material culture of the Pig Bay site on Motutapu as 'Archaic throughout'. However, Turner (Clough & Turner 1998: 27–28) has shown that people in the Auckland area chose to continue using this important local resource and working it with the technology most suited to it, after people in many other regions had turned to other stone resources that required different working methods, as shown by Best (1977).

Faunal analysis

Little or no midden was found on the southeast part of the crater rim or in the garden area on the western side, but there were large quantities of predominantly shell midden in the other three areas investigated. Content varied from small amounts of fragmentary redeposited shell in fill layers

that consisted mainly of scoria rubble and grit, to primary midden deposits of fresh shell. Even the latter, however, usually contained significant amounts of scoria, making sieving difficult or impossible.

Methodology

No shell has survived from the 1960 excavation in Area A. Bone hand-picked during excavation was retained. In the 1971–72 excavations, workers were asked to pick out bone and unusual stone (i.e. not scoria) where possible, together with examples of unusual shells. Some bulk samples were taken, often from sections after excavation of a square was completed. A few were sieved in the field, but most were true bulk samples. The samples ranged in weight from less than 1 kg to 25 kg, with the majority in the 1–3 kg range.

The laboratory study distinguished between the 'small bags' containing hand-picked items, and the bulk samples. All the small bags were examined. Stone and examples of unusual shells that might not be represented in the bulk samples were extracted. If any identifiable bone was present, all bone was extracted and given a catalogue number.⁶ If there were only a few unidentifiable fish spines, these were returned to the bag with the remaining shells. These bags were subsequently discarded.

Cockles had been extracted from six bulk samples for radiocarbon dating. The remainders of these samples were catalogued and retained but not further investigated. The intact quantitative samples were catalogued and retained, and about half were sorted, while the rest were kept for future study. Initially, the samples to be studied were sorted without sieving and all residue retained. Later, the remaining samples were sieved through ½ in (3.175 mm) mesh and the residue retained unexamined.

The bulk samples consisted largely of scoria grit and rubble, and cockle (*Austrovenus stutchburyi*) shells. Almost all samples also contained pipi (*Paphies australis*). Any bone, all whole cockles and pipi, and fragments with a complete hinge were extracted, along with all identifiable pieces of other shells. A bivalve species such as a scallop (*Pecten novaezelandiae*) might be represented by one fragment, not including a hinge, while a gastropod such as the cats eye (*Lunella smaragdus*) or mudsnail (*Amphibola crenata*) might be represented by one or more recognisable fragments that did not include the operculum, protoconch or aperture rim.

Cockles were divided into left and right valves. The right valves were counted to generate MNI values (minimum number of individuals). Both left and right valves were

Table 6 Summary of quantitative midden samples from Maungarei, listing minimum number of individuals (MNI).

Cat. #	Context	Shell	Rat	Fish
AM028	C/E5 Upper fill Pit 3	516	—	1
AM030	C/E5 Lower fill Pit 3	117	—	—
AM273	C/D2 Upper fill Pit 4	158	—	—
AM018	D/J11 L3 south face (upper midden)	383	—	—
AM020	D/J11 L3 shell lens	444	—	—
AM341	D/J11 L4 (loose midden)	911	—	3
AM019	D/K11 L3 centre of square	262	—	—
AM014	D/K11 L3 south face	147	—	—
AM015	D/K11 L3 west face	75	—	—
AM092	D/L11 Upper part pit fill	159	—	—
AM274	D/L11 Upper midden in north face (sieved in field)	498	—	—
AM016	D/K11 L4 south face	136	—	1
AM017	D/K11 L4 west face	81	—	—
AM021	D/K10 Base of Pit 2	119	—	1
AM271	D/N10 Top of midden northeast corner	101	—	—
AM272	D/N10 Top of midden northwest corner	68	—	—
AM344	D/R12 Yellow and orange midden bag 1	813	—	—
AM345	D/R12 Yellow and orange midden bag 2	643	7	—
AM343	D/S13 Between darker fill and orange fill	81	—	—
AM340	D/T15 Basal midden	157	—	—
Total		5869	7	6

retained. For other bivalves, where numbers were very small, minimum numbers were maximised by counting both left and right valves, then taking the larger number and also taking account of obvious size mismatches. Thus, three small left valves and one much larger right valve would give an MNI of 4.

Twenty-two samples were analysed. One, deliberately taken from a pipi lens within a larger midden layer, contained 99 pipi, one cockle and one gastropod (*Cominella* sp.). Another small sample proved to consist largely of scoria, ash and shell fragments, and gave an MNI of only six shells. These two samples are not considered further.

The 20 remaining samples studied are listed in Table 6 with their contexts and a summary of their contents. It can be seen that there are four cases where two samples are from one square and layer, and one case where three samples were taken from different parts of the same layer.

Almost all the bone material was hand-picked during excavation. Fish bones were analysed using the comparative

collection in the Archaeological Laboratory at the Museum of New Zealand Te Papa Tongarewa. Mammal and bird remains were analysed in the archaeological laboratories at Otago University's Department of Anthropology and Archaeology by Sarah Mann and Ian Smith (Appendix 1).

Shellfish

The 20 shell samples all consist largely of cockles, which is by far the dominant species. Details of the shell analysis are given in Table 7 and a summary is provided in Table 8.

The mussel shells are very fragmentary. Some have been identified as blue mussel (*Mytilus galloprovincialis*),⁷ but the green mussel (*Perna canaliculus*) may also be present. The shellfish deemed too small to be edible are mostly the gastropods *Zeacumantus lutulentus*, *Zeacumantus subcarinatus*, *Zeacolpus pagoda*, *Xymene plebeius* and *Cominella glandiformis*. In some cases the decision over what is too small to be edible was fairly arbitrary and was made in the context of the generally small size of other gastropods in the midden,

Table 7 Minimum number of individuals (MNI) values of shell species at Maungarei from quantitative samples.

Cat. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
AM028	453	31	1	1	1	1	—	2	4	7	1	3	—	—	11	516
AM030	100	8	—	1	1	—	—	—	1	1	—	—	—	1	4	117
AM273	139	2	—	—	—	—	—	—	—	—	—	—	—	—	17	158
AM018	365	7	2	—	—	—	—	—	—	1	—	—	—	—	8	383
AM020	427	8	1	—	—	—	1	—	—	—	—	1	—	1	5	444
AM341	882	13	—	—	—	—	—	—	—	2	—	4	1	—	9	911
AM019	257	2	—	—	—	—	—	—	—	1	—	—	—	—	2	262
AM014	141	5	—	—	—	—	—	—	—	1	—	—	—	—	—	147
AM015	72	1	—	1	—	—	—	—	—	1	—	—	—	—	—	75
AM092	157	—	—	—	—	—	—	—	—	1	—	1	—	—	—	159
AM274	497	1	—	—	—	—	—	—	—	—	—	—	—	—	—	498
AM016	135	—	—	—	—	—	—	—	—	—	—	—	—	—	1	136
AM017	78	1	—	—	1	—	—	—	—	—	—	1	—	—	—	81
AM021	95	3	—	1	1	2	—	—	1	3	—	10	—	1	2	119
AM271	92	4	—	1	1	—	—	—	—	1	1	1	—	—	—	101
AM272	65	2	—	—	—	—	—	—	—	1	—	—	—	—	—	68
AM344	799	5	—	—	—	—	—	—	—	2	—	1	—	1	6	814
AM345	633	4	1	—	1	—	—	—	—	—	—	—	—	1	3	643
AM343	75	2	—	2	—	—	—	—	—	1	—	1	—	—	—	81
AM340	128	14	7	—	—	—	—	—	—	—	4	1	—	—	3	157
Total	5590	113	12	7	6	3	1	2	6	23	6	24	1	5	71	5870

1, *Austrovenus stutchburyi*; 2, *Paphies australis*; 3, *Cyclomactra ovata*; 4, *Pecten novaezelandiae*; 5, mussels (see text); 6, *Paphies subtriangulata*; 7, *Ruditapes largillierti*; 8, *Macomona liliana*; 9, *Ostrea chilensis*; 10, *Lunella smaragdus*; 11, *Amphibola crenata*; 12, *Cominella* spp.; 13, *Amalda australis*; 14, *Diloma zelandica*; 15, several species too small to be eaten (see text).

notably the cats eye, and of the main components, cockles and pipi, as described below. Also too small to be eaten are a few specimens of the bivalve *Nucula hartvigiana*, tiny examples of both *Ostrea chilensis* and rock oyster (*Saccostrea glomerata*), and one very small chiton, represented by several plates.

Edible examples of shellfish species not represented in the quantitative samples but hand-picked during excavation include the bivalves toheroa (*Paphies ventricosa*), *Dosina zelandica*, *Tucetona laticostata* and rock oyster and gastropods *Dicathais orbita*, *Alcithoe arabica*, *Melagraphia aethiops* and *Penion sulcatus*.

All the identified shells except the single toheroa and perhaps the tuatua (*Paphies subtriangulata*) could probably have been collected in or near the Tāmaki Estuary. All are recorded in the comprehensive list of mollusc species

observed in the intertidal zone of the estuary and around its mouth by Hayward & Morley (2005: 58–63), although some were represented in that study only by dead shells. Despite the emphasis on cockles, the range of species present suggests that Maungarei people were gathering from more than one zone – from the mouth of the estuary up at least as far as the Panmure Basin, and from both the intertidal flats and the adjacent rocky areas.

In the 1990s, the densest cockle beds in the Tāmaki Estuary were at Farm Cove, northeast of Maungarei on the other side of the channel (Clark 1997: 35), although cockles were present throughout the estuary. In their more recent study, Hayward & Morley (2005: 27) show restricted occurrences of pipi from fairly close to the entrance to well above the Panmure Basin. The bivalves *Macomona liliana* and *Cyclomactra ovata* are likely to be found in the same places as

Table 8 Minimum number of individuals (MNI) values of Maungarei shells, all samples combined.

Taxon	MNI	%
Principal species	5590	95.2
<i>Austrovenus stutchburyi</i> (cockle)		
Secondary species	113	1.9
<i>Paphies australis</i> (pipi)		
Minor edible species	96	1.6
<i>Cominella</i> sp.	24	
<i>Lumella smaragdus</i> (cats eye)	23	
<i>Cyclomactra ovata</i>	12	
<i>Pecten novaezelandiae</i> (scallop)	7	
<i>Amphibola crenata</i> (mudsnail)	6	
<i>Ostrea chilensis</i>	6	
Mussel species*	6	
<i>Diloma zelandica</i>	5	
<i>Paphies subtriangulata</i> (tuatua)	3	
<i>Macomona liliana</i>	2	
<i>Ruditapes largillierti</i>	1	
<i>Amalda australis</i>	1	
Tiny inedible species	71	1.2
Total 5870	99.9	

*See text.

cockles and pipi, but are deep burrowers and require much greater effort to gather. *Amalda australis* is also an estuarine species, as is the carnivorous *Alcithoe arabica*, now rare in the estuary but thought to have been formerly abundant (Hayward & Morley 2005: 33). The mudsnail is particularly associated with mangroves in northern New Zealand (Morton & Miller 1968: 554) and is today confined to the parts of the Tāmaki Estuary inland from Maungarei, from the Panmure Basin south (Hayward & Morley 2005: 26).

The cats eye is common on rocky outcrops in the estuary and around its mouth but is also found grazing on large brown low-tidal seaweeds (Hayward & Morley 2005: 14). Both species of mussel and the indigenous rock oyster, along with the predatory *Dicathais orbita*, would also have been found in the rocky parts of the estuary or its entrance, although the New Zealand rock oyster has now been replaced throughout the estuary by the Pacific oyster (*Crassostrea gigas*). *Diloma* and *Melagraphia aethiops* are boulder- or stone-dwellers, which would also be found in rocky areas.

Ruditapes largillierti and *Dosina zelandica* were reported from the mouth of the estuary as 'offshore bottom communities' (Morton & Miller 1968: 583, citing Powell 1937), but Morton and Miller also describe *Ruditapes* as sometimes found on *Zostera* flats (1968: 543) and *Penion sulcatus* as preying on *Dosina* on patches of sand among low tidal rocks (1968: 162). According to Hayward & Morley (2005: 2), *Zostera* (seagrass) disappeared from the Tāmaki Estuary in the 1950s and 1960s but is now making a comeback.

The single fragment of toheroa could not have been collected nearby and, judging from modern distributions, is likely to have come from an Auckland west coast beach such as Muriwai or South Kaipara, either as part of a gift of food or, perhaps, as a tool. The southern end of Muriwai Beach is about 40 km from Maungarei as the crow flies and considerably more for anyone travelling by canoe and on foot. Similarly, the tuatua would not have been found within the estuary. The nearest source today would be Takapuna or Milford beaches on the North Shore, about 20 km away by canoe.

Scallops raise an interesting question. They inhabit shallow sand banks as well as deeper waters, and are 'mobile and somewhat migratory' (Morton & Miller 1968: 548). They have been easily gathered from shallow waters in the Manukau Harbour in recent times and Hayward & Morley (2005: 38) report that two live specimens were found at Bucklands Beach, east of the Tāmaki Estuary, in 1991. However, in view of the intense gathering of shellfish by the people of Maungarei, it seems unlikely that scallop beds would have survived very long in the vicinity. Two flat valves from Maungarei appear to have been worked (described above). It therefore seems likely that scallops were brought to the site from further afield, either as part of a gift of food, or as dead shells for other purposes.

Similarly, it seems unlikely that examples of the large, relatively deep-water bivalve *Tucetona laticostata* were items of food. They may have reached the site either as curiosities or, like the curved valves of scallops, for some use, such as scraping tools or small containers for pigment or other small items.

The shellfish described above as too small to be edible require explanation. Similar small shells (and sometimes also clearly dead shells) have been found in other sites in this part of Auckland and have usually been interpreted as incidental products of gathering practices (e.g. Fredericksen & Visser 1989: 98). Both *Cominella glandiformis* and *Xymene plebeius* are scavengers on cockle beds (Morton & Miller 1968: 398,

490) and the tiny bivalve *Nucula hartvigiana* occurs in quantities on *Zostera* flats and in association with pipi and cockles (Morton & Miller 1968: 490, 535, 543). The most numerous of the small shells are the two species of *Zeacumantus*, which are vegetarian browsers, present in large quantities on mudflats and, in the case of *Zeacumantus subcarinatus*, also in rockpools. *Zeacumantus lutulentus* is particularly typical of mangrove areas, in association with the mudsnail, but there is no clear association with mudsnails at Maungarei. It does therefore seem likely that these shells are a by-product of the gathering of pipi and cockles. As there are likely to have been huge quantities of *Nucula* in the vicinity of cockle and pipi beds, the presence of only three individuals in the quantitative samples from Maungarei suggests that gathering practices usually filtered them out. Single examples of small *Ostrea*, *Saccostrea* and *Zeacolpus pagoda* are probably shells from already-dead animals; *Zeacolpus pagoda* is an open-shore and deep-water species.

The results of the shell analysis are similar to those from other sites in the vicinity, such as Taylor's Hill to the north (Leahy 1991: 62–63), and Westfield (Furey 1986: 12), the Tamaki River pā (Foster & Sewell 1999: 16) and Waipuna (Clough & Turner 1998: 24) to the south. Cockles dominated in all these sites, although only at Westfield did they constitute more than 95% of the samples, as at Maungarei. Pipi are somewhat more significant in other sites. However, at Cryers Road, further up the Tāmaki Estuary and on the eastern side, cockles made up 98% or more of all samples analysed (Fredericksen & Visser 1989: 99).

Since cockles are by far the most important shellfish at Maungarei, some comments should be made about their food value. Vlieg provides useful nutritional information on this species per 100 g of wet weight (Vlieg 1988: 47, 80):

Protein	8.2 g
Oil/fat	0.9 g
Soluble carbohydrate	0.6 g
Moisture	87.8 g
Ash	2.5 g
Energy	43 kCal

These values can be compared with those for some other marine foods available to Māori in the Auckland area (Fig. 46). There is not much to choose between cockles and pipi as far as food value is concerned; of the marine foods compared, these two shellfish have by far the lowest values for protein and lipids. At a level of energy consumption of about 2000 kCal/day, a person living only on cockles would

have to consume about 4.7 kg of wet cockle meat per day. The average amount of wet meat per kg of total shell weight harvested is 109 ± 3 g. For a person to obtain this daily amount of 4.7 kg of cockle meat, about 42.7 kg of cockle shells would have to be harvested and, in this case, carried up the slopes of Maungarei. A group of 100 people would need 4.3 tonne per day. This shows that cockles are a very poor-quality food, and could only ever be considered a garnish at best. It is well known that a person attempting to live on cockle meat alone would soon die of starvation (Leach 2006: 234).

Cockle size

A noticeable aspect of the midden deposits on Maungarei is the apparently small size of almost all the shells. This is most obvious in the numerous small cockles and pipi. It appears to be true of most of the gastropods as well, although they are too few and too fragmentary to measure. Mt Wellington Borough Council workmen who visited the excavation in 1971 volunteered the information that small pipi in the excavations were comparable in size (*c.* 30 mm) to those present in the Tāmaki Estuary at that time.

Hayward & Morley (2005: 45), citing their own work and that of Stewart (2004), state that modern cockles in the Tāmaki Estuary have a smaller mean size than those elsewhere in Auckland, although they also claim (with no references) that they are 'much smaller than old shells in middens'. Pollution of the Tāmaki Estuary and siltation are seen as likely reasons for the small size of modern cockles. A study of cockles in the estuary in the 1990s (Clark 1997) showed a strong correlation between high levels of fine silt and small cockle size, although the interrelationships of size, density and environmental factors were complex.

Measurements of individual cockle shells in six of the analysed quantitative samples from Maungarei were taken with digital callipers and captured electronically in a database for analysis. There is some confusion in publications relating to cockle measurements, with the term 'length' having several definitions. The parameters used by Williams *et al.* 2008 are used here (Fig. 47), with definitions as follows:

SL (shell length) Maximum shell dimension parallel to the direction of movement in cockles, approximately along the axis through anterior and posterior adductor muscles, and perpendicular to any axis passing through the hinge (umbo).

SH (shell height) Maximum dimension from dorsal hinge (umbo) to the most extreme edge of the ventral shell margin.

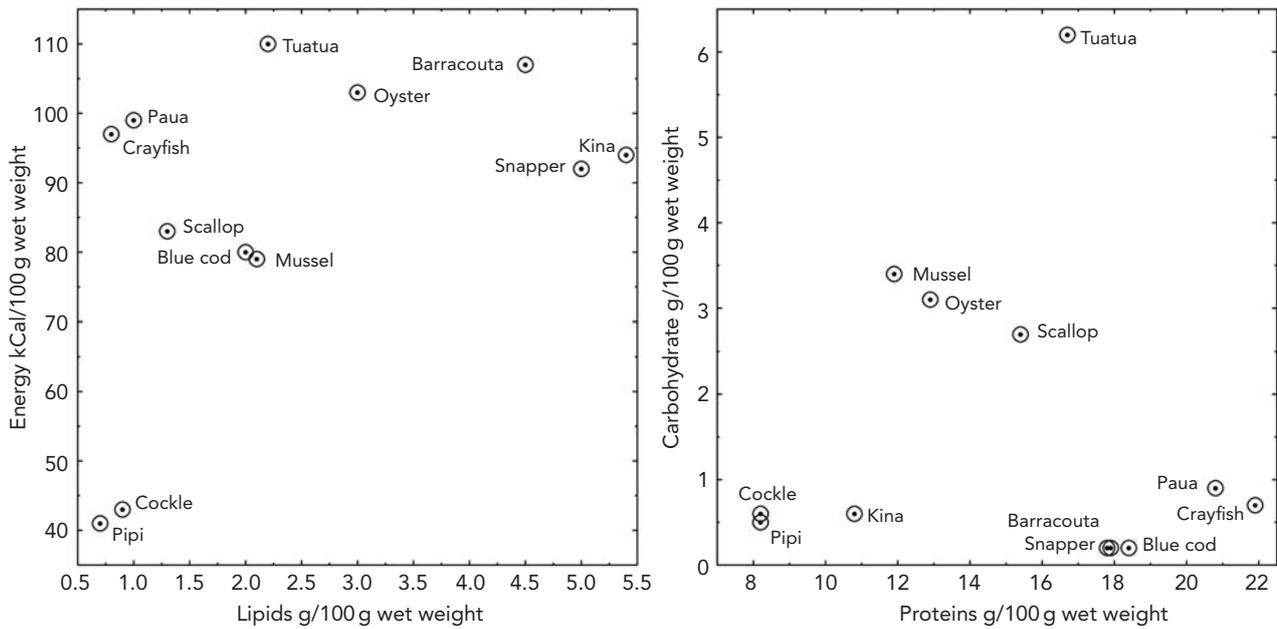


Fig. 46 Nutritive values of cockles compared with other commonly available marine foods (reproduced from Leach *et al.* 2001: 09–10).

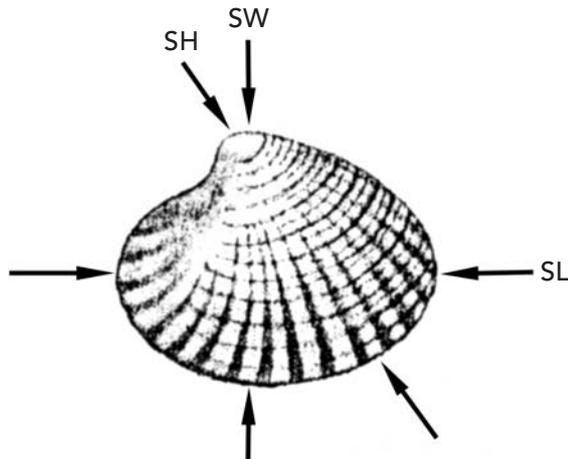


Fig. 47 Cockle measurements. SL, shell length; SH, shell height; SW, shell width.

SW (*shell width*) Axis perpendicular to the shell length dimension, from dorsal hinge (umbo) to ventral shell margin.

Regression equations are available linking these parameters together (Williams *et al.* 2006). The measurement taken on cockles from Maungarei and other sites discussed here is the SL dimension. Basic dispersion statistics were calculated for the six samples. These results are compared with those for two archaeological samples from Kauri Point Pā on Tauranga

Harbour in the Bay of Plenty, and archaeological and modern samples from Pauatahanui Inlet north of Wellington (Table 9). Size-frequency histograms for the Maungarei samples are given in Fig. 48.

At first glance it appears that the Maungarei size-frequency histograms are all very similar and the statistics not particularly different. However, closer scrutiny reveals some interesting differences and features. The first notable feature is that all these cockles are small. This is a well-known feature of Auckland archaeological cockles, probably first noted by Best (1927: 221) and regularly commented on by archaeologists, although usually without documentation, from the 1950s to the present.⁸

Modern fisheries management of cockle biomass is based upon current understanding of the biology of this species:

Maori and recreational fishers prefer cockles of 30 mm shell length and greater whereas commercial fishers currently prefer cockles of 25 mm and greater. ... As cockles become sexually mature at around 18 mm, using a size of recruitment between 25 mm and 30 mm should provide some protection against egg overfishing under most circumstances. However, using the smaller size of recruitment to estimate yield will confer a great risk of overfishing. (Annala *et al.* 2003: 116)

The comments about harvesting preferences are not supported by any evidence, and are somewhat naive. Recent

Table 9 Maungarei cockle length statistics compared with those from Kauri Point Pā and Pauatahanui Inlet.

Site	No.	Min.	Max.	Mean	SD	Skewness		Kurtosis	
						g1	w1	g2	w2
AM345	243	16.73	31.68	22.10 ± 0.15	2.33 ± 0.11	0.50	4.57	4.19	3.98
AM344	354	10.32	29.75	21.90 ± 0.14	2.70 ± 0.10	-0.43	5.05	5.05	8.10
AM341	561	11.17	42.97	20.84 ± 0.12	2.71 ± 0.08	1.13	10.35	10.83	38.43
AM018	365	10.73	31.60	19.92 ± 0.16	3.14 ± 0.12	0.55	5.83	4.11	4.48
AM028	429	11.50	36.70	19.59 ± 0.17	3.59 ± 0.12	1.32	9.76	5.44	10.55
AM030	97	15.13	29.82	20.28 ± 0.32	3.16 ± 0.23	1.09	4.33	3.90	2.10
Kauri – 11	310	15.00	34.50	22.38 ± 0.27	4.71 ± 0.19	0.94	7.05	2.77	0.78
Kauri – 6	813	11.00	42.00	23.11 ± 0.17	4.84 ± 0.12	0.30	6.35	2.76	1.38
Paua – Old	5753	15.10	66.00	38.45 ± 0.07	5.44 ± 0.05	0.69	25.73	4.39	21.65
Paua – Mod.	27288	2.00	56.00	21.54 ± 0.04	6.52 ± 0.06	-0.01	6.27	3.09	3.04

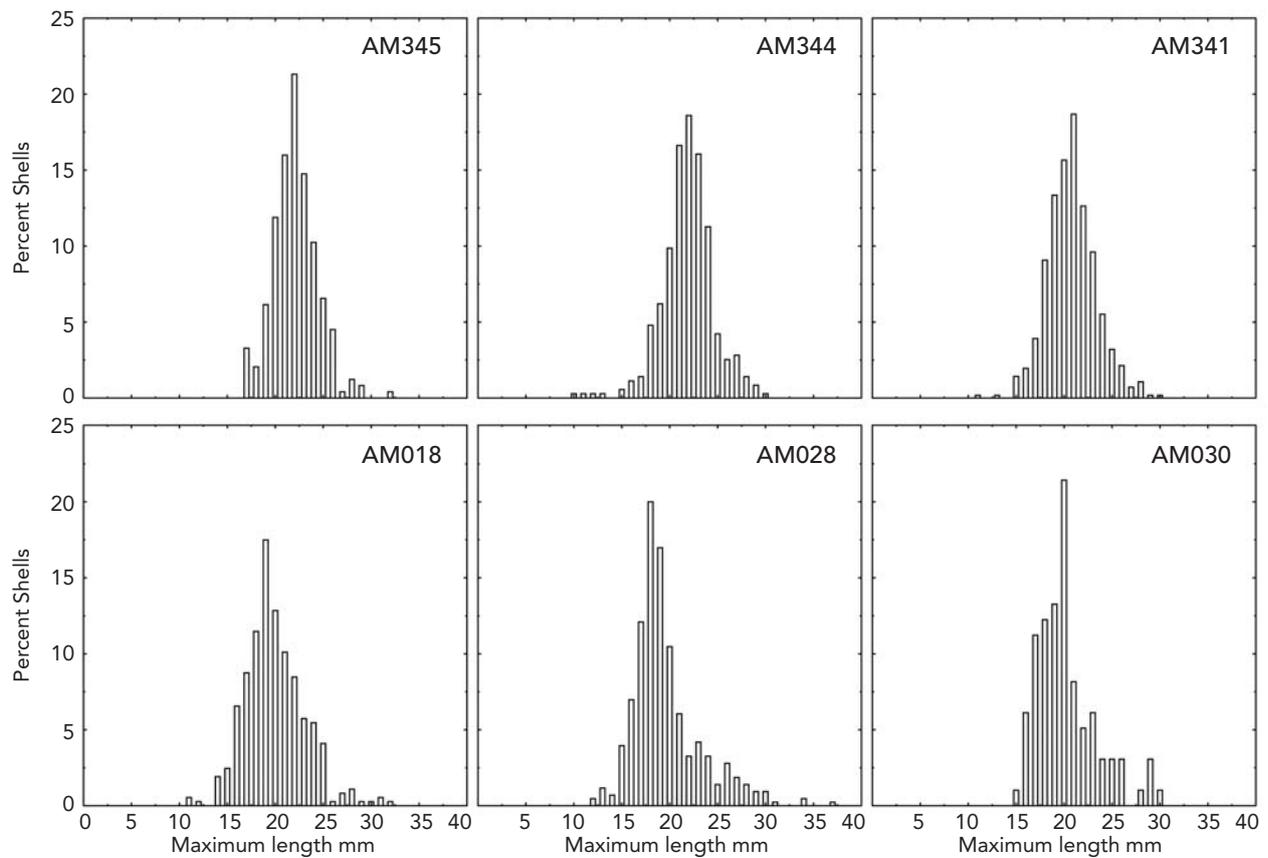


Fig. 48 Size-frequency histograms of cockle shell length (SL) from Maungarei. See Table 9 for statistical data relating to these histograms.

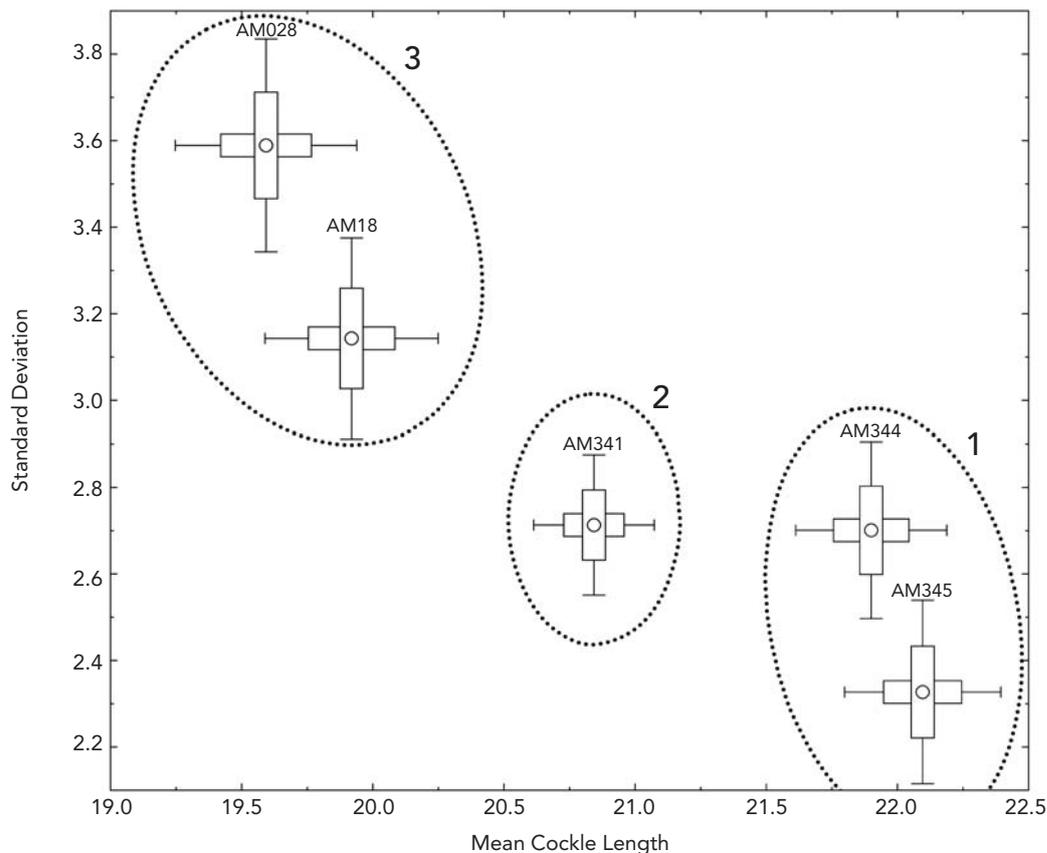


Fig. 49 Cockle mean sizes and standard deviations for three time periods at Maungarei. Those circled are not significantly different from each other. See Table 9 for statistical data relating to these plots.

research suggests that sexual maturity is closer to 20 mm (Williams *et al.* 2008: 14). This puts the Maungarei cockle sizes in sharp relief, indicating that the people of this site were harvesting very small cockles indeed. If the 20 mm figure is accepted, more than 42% of the total catch is sexually juvenile. Such a harvesting strategy would certainly have a dramatic effect on population dynamics in a fairly short period and, if sustained over a long period (hundreds of years), could easily result in rapid evolution in favour of a change in growth rate for the species, possibly a slowing down to avoid capture. Such rapid evolution has been documented for other marine species subjected to size-selective harvesting pressure (Leach 2006: 301–302).

All but one of the size-frequency histograms from Maungarei display significant positive skewness ($g_1 > 0$ and significance above $p = 0.05$, i.e. $w_1 > 1.96$), which certainly indicates that people were harvesting as many larger specimens as they could find. Sample AM345 (from relatively early in the site's history) shows significant negative skewness, which is curious. The only other sample that is

similar in this respect is the modern population sample from Pauatahanui. The latter is not surprising because this sample was deliberately taken to include every shell down to the tiniest. At Maungarei, cockles as small as 10.3 mm were being harvested and taken up to the site to be consumed as food. This is remarkable, as the amount of food in such small specimens could hardly be worth the effort of capture and transport. This suggests mass harvesting without taking much notice of size. It is not necessary to use a wooden-pronged shell-rake to achieve this. One common way of gathering cockles is to use both hands with fingers spread a little open, pushing them through the sandy substrate; the fingers act as a rake and capture all shells down to the size that will not pass through the gap between them. The two hands are then put together and shaken in the water to remove sand and grit, and all shells are placed in a container. If large cockles are readily available, the fingers can be opened up wider apart so that small specimens slip through.

Close scrutiny of the mean and standard deviation figures for Maungarei reveals some surprising indications of the

effects of people on the nearby cockle population over time. A student's t -test was carried out on all pairs of the six samples (15 tests). Of these, only pairs AM345/AM344, AM341/AM030, AM018/AM028, AM018/AM030 and AM028/AM030 proved not to be significantly different. When the means and standard deviations are plotted out, together with their appropriate standard errors, these patterns of significance and lack of it are more readily observed (Fig. 49).

There are three clusters in Fig. 49. The samples are arranged in chronological order from earlier to later, as follows:

AM344, AM345 Two samples from one layer below the Lower Terrace in Area D, preceding terrace construction.

AM341 One sample from a lower midden layer on the scarp above the Upper Terrace in Area D, post-dating construction of the terrace and its use for pit storage.

AM018 One sample from an upper midden layer on the scarp above the Upper Terrace in Area D, post-dating construction of the terrace and its use for pit storage.

AM028 Upper fill of Pit 3, part of the late occupation in Area C on the crater rim.

The largest cockles are in the two early samples labelled 1, which are not significantly different from each other. The most recent samples are those labelled 3. These last samples cluster together as not significantly different. They are the smallest cockles. The sample labelled 2 is intermediate in size between these two clusters and is significantly different from both. Unfortunately, the sixth sample, AM030 from the lower fill of Pit 3, was very small ($n=97$) and not so easily distinguished from other nearby samples. It falls within the cluster labelled 3, but has been omitted from Fig. 49. AM341/AM030 narrowly fails the significance test ($t=1.96$, $p=0.05$) with $t=1.66$.

Thus, there is evidence here that the average size of cockles in the harvest was declining over time from small to even smaller. It is interesting to see that the standard deviation also appears to have been changing through time. The later samples had larger standard deviations than the earliest ones. This suggests that whatever selective harvesting behaviour was being practised earlier on had to be abandoned in favour of gathering everything possible later in time, perhaps by narrowing the gap between fingers.

The earliest cockle samples from Maungarei are highly unlikely to date before AD 1450, so it is important to recognise that they do not represent harvesting from a

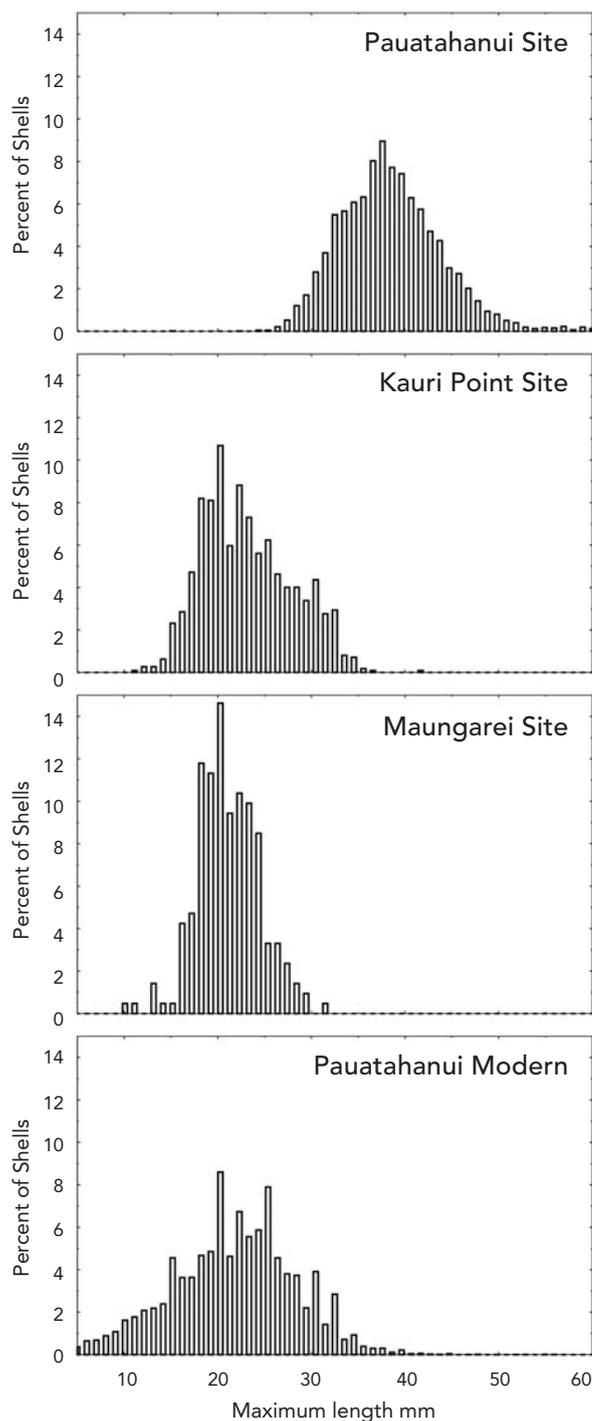


Fig. 50 Comparison of the Maungarei cockle shell lengths with others from New Zealand. See Table 9 for statistical data relating to these histograms.

population of virgin biomass. Just what the original cockle population in this area looked like is unknown; to shed any light on this requires earlier archaeological samples to be found and examined.

A clue to the possible extent of change from virgin biomass to that which prevailed during the period of occupation at Maungarei is provided by a comparison of archaeological and modern cockles at Pauatahanui (Fig. 50). At this site, which was occupied between about AD 1450 and 1550 (Leach *et al.* 2009: 23), people were harvesting cockles that, compared to those at Maungarei, seem enormous. No doubt this was the result of selective harvesting behaviour, but such large cockles must have been present to be gathered. It can be seen from Fig. 50 that such large cockles simply do not exist in the Pauatahanui Inlet today. In fact, the mean size of cockles today is strikingly similar to that of archaeological cockles from Maungarei and Kauri Point. Such a dramatic change is thought to be a combination of human predation and deteriorating water quality over time, exactly the same causes in place in the Tāmaki Estuary, albeit with much larger human populations, both prehistoric and historic, at the latter. Whether earlier archaeological samples of cockles from the Tāmaki Estuary will prove to be like those from the Pauatahanui site remains to be seen, although there is no obvious environmental reason why this should not be so.

The Kauri Point samples are both from the early part of the sequence at that site as described by Ambrose (n.d.) and are broadly dated by radiocarbon sample ANU 25, calibrated as AD 1330–1570 (2 σ) (Green 1978: 43). It would appear that here, too, there must have been heavy prior exploitation of cockle beds, and/or siltation of the harbour following forest clearance. In her pioneering study of shellfish-gathering in pre-European New Zealand, Swadling (1972, 1977) identified the cockles from the early site at Mt Camel in the far north as being close to an unexploited population, while those from later sites in the vicinity showed effects of human harvesting. The size range at Mt Camel was 26–48 mm and the average size 36.4 mm. These measurements are similar to those of the archaeological cockles from Pauatahanui.

Fish

The study of fish bones followed the procedures outlined by Leach (1986). Number of identified specimens (NISP) and MNI values were calculated. Tables 10 and 11 show the distribution of fish according to area. The relative abundance of each species in the total assemblage is given in Fig. 51. There are no significant differences between areas.

As noted above, fish bones were hand-picked by excavators from the deposits in Areas A, C and D, and this

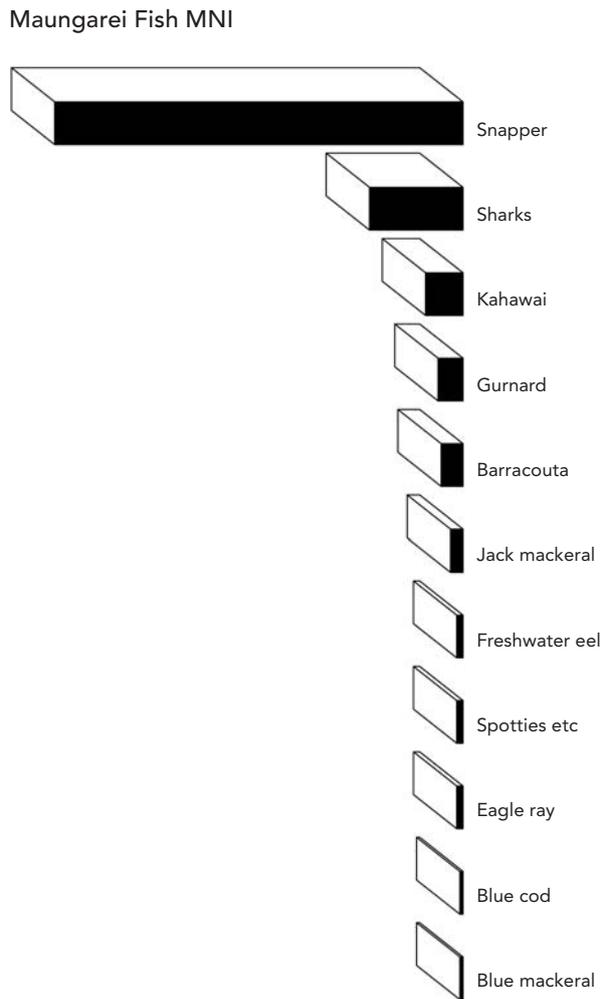


Fig. 51 The relative abundance of fish species at Maungarei. The total minimum number of individuals (MNI) value is 200.

unsystematic collection provides the main body of fish remains from the site. However, fish remains were identified from three of the bulk samples. An MNI of one snapper was present in each case, together with an elasmobranch, a kahawai and a gurnard in sample AM021. This total of six fish from the relatively tiny volume of the combined bulk samples suggests a higher presence of fish in the site than is reflected by the size of the existing collection of hand-picked bones.

Although some of the fish found at Maungarei could have been taken in the Tāmaki Estuary, it is highly unlikely that all of them were. The Maungarei people would have been travelling by canoe to more distant fishing grounds, probably around the nearby islands of Rangitoto, Motutapu and Motuihe (Fig. 2). The southern tips of Rangitoto and Motuihe are only about 5 km by canoe from the mouth

Table 10 Maungarei fish: minimum number of individuals (MNI) and number of identified specimens (NISP) values by area.

Family/Class	MNI							NISP	
	1	2	3	4	5	6	Total	%	Total
Sparidae: snapper	26	5	61	14	25	—	131	65.5	224
Chondrichthyes: sharks, rays	1	1	17	3	8	—	30	15.0	106
Arripidae: kahawai	1	1	6	—	4	—	12	6.0	16
Triglidae: gurnard	—	—	7	—	1	—	8	4.0	10
Gemphylidae: barracouta	1	1	1	—	4	—	7	3.5	7
Carangidae: jack mackerel	—	—	2	—	1	1	4	2.0	6
Anguillidae: freshwater eel	—	—	2	—	—	—	2	1.0	2
Labridae: spotty, etc.	1	—	1	—	—	—	2	1.0	3
Myliobatidae: eagle ray	—	—	2	—	—	—	2	1.0	2
Mugiloididae: blue cod	1	—	—	—	—	—	1	0.5	1
Scombridae: blue mackerel	—	—	1	—	—	—	1	0.5	1
Totals	31	8	100	17	43	1	200	100	378

1, Area A; 2, Area C; 3, Area D Upper Terrace; 4, Area D Lower Terrace; 5, Area D Midden Squares; 6, context unknown.

Table 11 Maungarei Fish: minimum number of individuals (MNI) percentage and standard error by area.

Family/Class	1	2	3	4	5	6
Sparidae: snapper	83.9±15.0	62.5±45.0	61.0±10.2	82.4±22.4	58.1±16.3	—
Chondrichthyes: sharks, rays	3.2±8.1	12.5±32.7	17.0±7.9	17.6±22.4	18.6±13.1	—
Arripidae: kahawai	3.2±8.1	12.5±32.7	6.0±5.2	—	9.3±10.1	—
Triglidae: gurnard	—	—	7.0±5.6	—	2.3±5.8	—
Gemphylidae: barracouta	3.2±8.1	12.5±32.7	1.0±2.5	—	9.3±10.1	—
Carangidae: jack mackerel	—	—	2.0±3.3	—	2.3±5.8	100±50
Anguillidae: freshwater eel	—	—	2.0±3.3	—	—	—
Labridae: spotty, etc.	3.2±8.1	—	1.0±2.5	—	—	—
Myliobatidae: eagle ray	—	—	2.0±3.3	—	—	—
Mugiloididae: blue cod	3.2±8.1	—	—	—	—	—
Scombridae: blue mackerel	—	—	1.0±2.5	—	—	—
Totals	100	100	100	100	100	100

1, Area A; 2, Area C; 3, Area D Upper Terrace; 4, Area D Lower Terrace; 5, Area D Midden Squares; 6, context unknown.

of the Tāmaki Estuary. This raises an important question about the extent of the harvesting territory of Maungarei people and their relationships with neighbouring groups, considered below.

As discussed below, the size range of snapper brought to the site suggests the use of several kinds of nets. Although no items of fishing gear were found in the excavations, fish such as kahawai, barracouta and jack-mackerel were often taken on lures. Larger snapper were often taken with baited hooks. However, the absence of any durable items of fishing equipment at the site means it is quite possible that all these fish were taken by netting. There is abundant ethno-historical information from the time of Captain Cook onwards about the widespread use of large seine nets in the northern half of the North Island (Leach 2006: 109–113). Eagle rays frequent inshore waters, especially during summer months, and play havoc with nets when they are caught.

The Maungarei fish assemblage is typical of northern North Island assemblages, which are dominated by snapper (Leach 2006: 163, 164). Leach (2006: appendix 1) provides MNI for 26 assemblages from the northern North Island, studied using the standard methodology: two small assemblages from the Tāmaki Isthmus, six from four sites on nearby Motutapu Island, six from Northland, two from Great Barrier Island (Aotea Island), two from the Hauraki Plains and eight from the Coromandel Peninsula. Snapper were present in all except one very small Northland assemblage and dominant in most; kahawai, labrids, barracouta, gurnard and blue cod were also well represented in sites, although in much smaller numbers. Jack mackerel are not distinguishable in this list from other Carangidae, notably trevally. Blue mackerel occur in few sites. Species numerous in some sites but not present at Maungarei include tarakihi, leatherjacket (typical of rocky shore habitats of the Coromandel) and yellow-eyed mullet.

The presence of only two eels at Maungarei, despite the proximity of extensive wetlands, is not surprising, as eels are absent from most of the assemblages considered above and, if present, usually represented by very few individuals. There is an MNI of three eels from Hot Water Beach on the Coromandel Peninsula and one from each of five other sites. Irwin (2004: 242) comments that eels were ‘anomalously absent’ from the late Māori lake village of Kohika in the Bay of Plenty, but this is in fact typical rather than anomalous in sites where fish bones have been studied.

One of the interesting features of the Maungarei assemblage in this comparison is the relatively high proportion of Chondrichthyes. It could be argued that the MNI is inflated, since the identified specimens are nearly all vertebrae, but their very wide distribution through a diversity of contexts suggests that this is not so. Seasonal shark fishing is said to have been important in the middle Waitemata Harbour in the vicinity of Kendall Bay and Kauri Point (Graham 1910), and sharks caught there may have been dried and taken elsewhere for later consumption (Davidson 1990: 13). Murdoch (n.d.: 16) notes that the use of important shark-fishing grounds between the Waitemata Harbour and Kawau Island was a cause of dissension between the people of Tāmaki and Hauraki.

Fish bones have been less systematically identified in small assemblages from a number of salvage excavations in the vicinity of Maungarei. Again, snapper predominate when numbers are given, as at Taylor’s Hill (Leahy 1991: 62), Westfield (Furey 1986: 13), and one excavation at Hamblins Hill (Pearce 1975: 196). Ten species of fish are reported from Fisher Road (Foster & Sewell 1988: 63, 1989: 20) but only by presence. The Fisher Road assemblage includes all the species found at Maungarei except eels, labrids and eagle rays, plus trevally, stargazer and yellow-eyed mullet. It should be noted that the amount of fish remains recovered from these sites is very small.

Snapper size

Live fork lengths of snapper were estimated from the bones using the method described by Leach & Boocock (1995). Statistical data are presented in Table 12 with comparative data from seven other New Zealand sites. Size-frequency diagrams are given in Fig. 52. Several things are notable about the snapper caught by the people at Maungarei. First, some were tiny, the smallest being a mere 128 mm long and 43 g in weight. The size-frequency diagram shows that there were notable numbers of these small snapper as a separate node. They are in the age range of only one to three years, and could have been caught only by some trapping method, presumably a very small mesh net. There would be little food on such small fish. None of the small bones shows signs of gastric erosion, so they are not from the stomach contents of larger fish.

Second, the people at Maungarei also had access to very large snapper. The biggest had a fork length of 903 mm, and is estimated to have weighed 14.1 kg. This is at the extreme end of the size range of snapper in New Zealand, and

Table 12 Maungarei snapper live fork length statistics compared with a selection of other sites.

Site	No.	Min.	Max.	Mean	SD	Skewness		Kurtosis	
						g1	w1	g2	w2
Maungarei	145	128	903	428.6±13.3	160.6±9.4	0.12	1.74	2.78	0.46
Houhora	8847	218	1010	490.5±0.9	81.6±0.6	0.33	22.07	3.79	15.28
Twilight	1914	176	994	532.0±2.3	102.5±1.7	0.37	10.85	3.64	5.73
Galatea	212	246	799	464.2±7.1	103.2±5.0	0.52	4.36	3.35	1.15
Cross Creek	997	146	782	400.0±3.0	94.9±2.1	0.28	6.86	3.27	1.80
Foxton	1080	239	953	471.5±3.0	100.0±2.2	0.48	9.32	3.44	3.04
Mana Island	527	266	939	463.7±5.1	116.1±3.6	0.70	7.92	3.17	0.84
Rotokura	824	138	870	575.0±3.3	93.5±2.3	-0.38	7.21	4.87	11.09

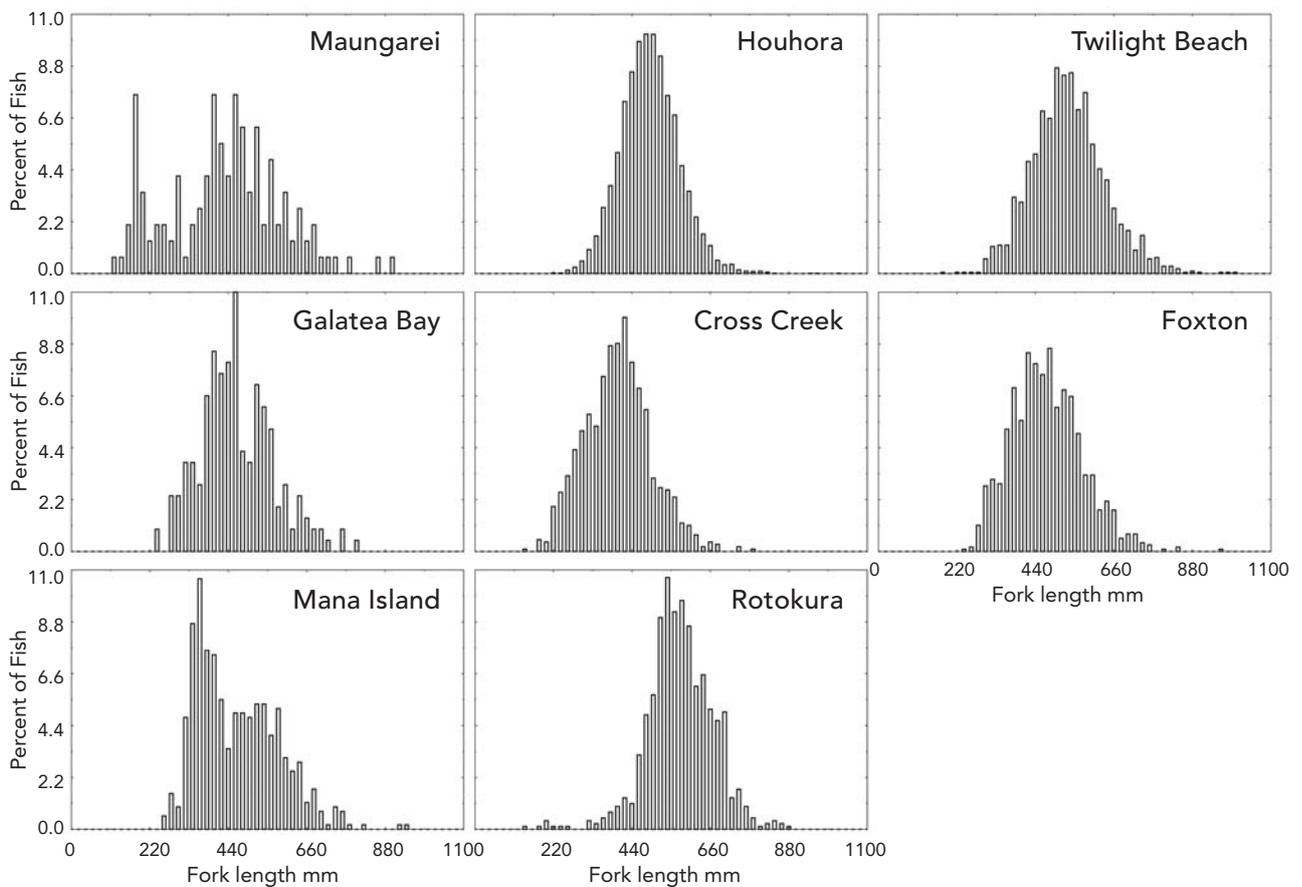


Fig. 52 Size-frequency histograms of snapper fork length from Maungarei and several other sites for comparison. See Table 12 for statistical data relating to these catches.

whenever a fish of such a size is caught today it is likely to make the national news. In Table 12 it will be seen that such monsters also occur in other archaeological sites.

Third, the shape of the Maungarei snapper size-frequency curve is clearly multi-nodal, something not seen with such clarity in other archaeological catches. This suggests that the Maungarei people were harvesting shoals of specific age cohorts that entered the estuarine waters from the Hauraki Gulf and were mass captured at these times. Juvenile shoaling snapper are known to have visited the upper reaches of estuaries in the Auckland area in former times. After about four years of age, snapper tend to become more independent of their age cohort. The larger specimens in the snapper catch may have been taken with baited hook and line despite the lack of evidence of fishhooks in the site.

Most archaeological sites have snapper size-frequency distributions that display significant positive skewness with values of g_1 greater than zero in Table 12. Values of g_1 are significant if their associated normalised deviates (w_1) are greater than 1.96 ($p=0.05$). Although the value of g_1 for Maungarei is positive, w_1 is less than 1.96 and is therefore not significant. The only site that displays significant negative skewness is Rotokura and, like Maungarei, this site also had some extremely small snapper.

The kurtosis values are also interesting. Archaeological snapper catches sometimes have a pronounced leptokurtic character, or positive kurtosis (a narrower peak than the shape of a normal distribution). This is indicated by a value for kurtosis (g_2) that is greater than 3.0. Significance is again indicated by the associated value of w_2 being greater than 1.96. It is thought that this leptokurtic shape is due to the use of gill nets, which are selective by size, so that both larger and smaller specimens escape. Leptokurtosis is therefore a fairly good indicator for the use of gill nets. Five of the sites in Table 12 have this feature to a significant degree. Maungarei, on the other hand, stands out with a value of g_2 less than 3.0 (platykurtic), although w_2 is not significant. This odd result reflects the multi-nodal shape of the size-frequency curve. The most likely interpretation is that several kinds of net were being used by the Maungarei people.

As has been seen above, the snapper MNI for Maungarei was 131 fish. The mean live weight of these fish is estimated to have been 2177 ± 184 g. One way of calculating the total weight of fish this represents is the mean weight \times MNI, which would be 285,150 g. An alternative way of calculating the total weight is adding up the weight of each individual fish represented by bones that can be measured. This

estimate is 315,624 g. The two values are reasonably close together, representing a fish catch of about 300 kg. It should be remembered that this probably represents a minuscule sample of the total catch of snapper carried up to the site.

Mammals and birds

The mammal and bird study is described in detail in Appendix 1.

European-introduced mammal remains identified include sheep, cattle and pig, all from near the surface, and rabbits from surface contexts and burrows. The sheep and cow would have been animals grazing in the Domain. The single pig bone, however, found in the turf layer in square E2 inside the crater in Area A, shows numerous knife cuts resulting from carving and is presumably the discarded remains of a relatively recent picnic.

A human tooth, patella and skull fragment could have derived from inadvertent disturbance of earlier burials during later terrace construction. A cut piece of human skull, however, indicates the use of human bone for artefact manufacture.

Rat bones were not assigned to species but, on the basis of size and context, it is thought that most, if not all, are the Pacific rat (*Rattus exulans*), introduced in pre-European times. Relatively few dogs are represented, and bones of individual dogs appear to have been widely scattered in the site. As argued in Appendix 1, the relative scarcity of the main limb bones of dogs may be due to the detachment of limbs and their removal for consumption elsewhere. This has also been suggested for Taylor's Hill (Leahy 1991: 68).

The few identified bird remains seem to reflect opportunistic capture, as most are not species that would normally be targeted. Both the definite and possible kiwi bones are from early contexts – the slope deposits pre-dating the formation of the lower terrace in Area D – as is the weathered piece of moa bone. This last may have been a curiosity, perhaps found in one of the lava tubes in the vicinity, as lava tubes have been a source of natural moa finds elsewhere in the Auckland volcanic field. The pūkeko is interesting, as these birds are seldom found in archaeological sites. In this case, the bone is from a definite and apparently secure midden context in the fill at the base of one of the pits on the Upper Terrace in Area D. The European-introduced red-legged partridge is a puzzle; it is from an apparently pre-European fill layer in one of the midden terraces, unassociated with any other faunal remains and therefore presumably intrusive.

Rat, dog and bird remains have been found in other sites in the area but generally in very small amounts, and bird bones have often been too fragmentary for identification. Where dog remains have been fully reported, there are both similarities and differences with Maungarei. At Fisher Road (Foster & Sewell 1989: 20) and Westfield (Furey 1986: 12–13), all body parts were represented. The largest assemblage is from Taylor's Hill, where an MNI of seven dogs, including a pup, was found. All body parts were represented, although here too there was an indication that some meat-bearing parts might have been detached and taken elsewhere. The most interesting feature of the Taylor's Hill dog remains, however, was the working of mandibles, presumably for fishhook point manufacture (Leahy 1991: 61). Taylor's Hill is also the only nearby site where bird bones have been identified:⁹ pūkeko, harrier, little blue penguin, grey duck, teal and kākā (Leahy 1991: 62). The pūkeko is thought to be a recent arrival in New Zealand (Worthy 1999: 133). However, it was clearly established in Auckland by the time Maungarei and Taylor's Hill were occupied. It has recently been reported from a relatively early site on the Auckland west coast, just north of the Manukau Heads, in association with moa bone, which may, however, be industrial (Turner *et al.* 2010: 207–209).

The relatively large size of the Maungarei bird and mammal assemblage compared with other sites in the vicinity is partly a reflection of the extent of the midden deposits on the site, and is a further clear indication that Maungarei was a place where people were living and eating, not merely a storage facility or refuge.

Landsnails

No attempt has been made to extract landsnails from the various soil samples and residues of quantitative midden samples. However, landsnails large enough to be noticed were found in small concentrations and hand-picked from a number of layers in squares U16, U18 and U21 in Area D. These are almost all an introduced species of *Oxychilus*. However, one example of a native landsnail of the genus *Climocella* (not determined to species) was found amongst these introduced snails.

Landsnails, including both indigenous and introduced species, have been identified from several sites in this part of Auckland: Westfield (Furey 1986: 13), Fisher Road (Foster & Sewell 1988: 60) and Cryers Road (Fredericksen & Visser 1989: 114). The indigenous species in these sites indicate a

mostly scrubby environment, but with some bush or rotting logs in the vicinity.

Discussion

The various excavations on Maungarei were concerned primarily with the chronology and structural history of this large and complex site. Nevertheless, the faunal material collected in 1960 and 1971–72 and retained for many years has provided useful insights into aspects of the economy of the people of Maungarei. Advances in faunal analysis since the excavations took place, particularly in the study of fish remains, have enabled old samples to provide interesting results.

The study of relative abundance of shell species at Maungarei has merely added to an already consistent picture of shellfish-gathering in the vicinity of the Tāmaki Estuary, developed by several previous researchers, in which there is a major focus on cockles and a secondary focus on pipi. It is clear that in sites like Maungarei, relatively small bulk samples (1–3 kg) will usually give an adequate picture of the relative abundance of shells brought to the site.

However, samples of this size are not adequate for metrical analysis of the shells. The amount of measurable shell varied considerably in the Maungarei samples: AM344 and AM345, subsamples of one layer, yielded only 617 complete right cockle valves from 9.6 kg of total sample, whereas AM341 yielded 561 from 2.3 kg. Of the samples measured from Maungarei (Table 9 and Fig. 49), the sample of 250 right valves was barely adequate and that of 97 right valves quite inadequate for discerning size differences between one archaeological horizon and another. At Pauatahanui, a minimum of 1000 measurements for each context was considered adequate (Leach *et al.* 2009). The amount of measurable shell per kilogram is actually high at Maungarei, where the shells are so small, compared with sites such as Pauatahanui and Raumati Beach (Leach *et al.* 2000). It is always advisable to err on the side of caution. An unsieved sample of 20 kg would be advisable at Maungarei for adequate measurements to be obtained.

In a site like Maungarei and in a salvage context, even a number of large bulk samples will not provide adequate amounts of fish and other bone, and hand-picking during excavation, unrepresentative though it may be, will always be necessary. No fish at all were identified in the 16.2 kg of bulk samples analysed from the Lower Terrace in Area D, and only five in about 20 kg of samples from the Upper Terrace.

Size reconstructions add an important dimension to our knowledge of the exploitation of shellfish and snapper in this part of Auckland. Measurements of individual shells from relatively large samples provide statistically reliable comparative data and can reveal slight but significant changes, as is the case here. The study documented the small size of Maungarei cockles and identified a trend from small to very small, but the interpretation of these findings is not so easy. The small size of cockles in the Tāmaki Estuary today is not just a result of modern pollution. Both archaeological and modern cockles show the effects of human impact, but still earlier archaeological cockles and better data about vegetation clearance and its possible effects on the Tāmaki Estuary are needed, before the history of cockles and other shellfish in the estuary can be fully understood.

Live fork length reconstruction of snapper from Maungarei has revealed a rather unusual pattern with interesting implications for the fishing methods of Maungarei people. They carried not only a great many small cockles up the hill, but large numbers of very small snapper and some very big ones as well. The small size of much of the protein foods gathered seems to suggest an impoverished environment in the vicinity of the site, with people hard pressed to gather adequate meat. In particular, the gathering of large quantities of shellfish before sexual maturity is a strategy doomed to failure in the long term.

The study of birds and mammals adds considerably to the existing picture in the area. The bird remains are most comparable to those from Taylor's Hill, a site excavated even longer ago than Maungarei and studied and published long after the excavations. Both sites indicate sporadic and probably opportunistic capture of birds of various habitats in a landscape from which significant populations of both colonial nesting seabirds and forest-dwelling species had long disappeared. Maungarei stands out from other sites in the area in the large number of rat bones found. This may be partly due to good preservation and ease of recovery in the loose scoria deposits, but is also rather surprising given the small size of the bones and the salvage nature of the excavations. The rats were presumably brought to the site as food or actually caught there, raising interesting questions, as yet unanswered, about their ecological position in this environment.

There is little doubt that most of the faunal remains reflect exploitation of the adjacent Tāmaki Estuary and readily accessible fishing grounds nearby. There are,

however, a few indications of more distant contacts and possible interactions with other communities. The single toheroa shell could not have come from anywhere in the vicinity and must reflect a visit by Maungarei people to the west coast beaches where it occurs, or a gift brought to Maungarei by visitors from afar. Scallop shells and some fish remains, notably of a very large snapper, also hint at possible interactions with other communities. The question of access to resources, including fishing grounds, is discussed below. The differential distribution of the body parts of dogs, not only at Maungarei but at Taylor's Hill and at Pig Bay on Motutapu Island (Smith 1981: 98–99), suggests a particular kind of interaction: not one where an item is sourced from far away, but one where communities sometimes shared meat that was available to all of them, or took meat away with them on trips elsewhere. This kind of information can add to that on the sources of stone found in archaeological sites to develop a picture of community interactions.

Charcoal analysis

The study of charcoal from the excavations was carried out almost 20 years ago by Rod Wallace and is described in Appendix 2. Wallace has updated his report in the light of his more recent research in this field. The samples are grouped in Appendix 2 according to contexts determined by my own recent evaluation of the excavation data.

The charcoal study supports the evidence from faunal analysis in showing that the areas excavated on Maungarei were occupied at a time when the impacts of humans on the local environment were already marked and the vegetation was much modified by human activity. Wallace describes a landscape dominated by bracken and shrubs, and probably kept in this state by repeated burning. Pūriri (*Vitex lucens*) trees were abundant and there may have been a few small stands of forest in the vicinity, but basically this was already a landscape similar to that found by the first Europeans to visit the area.

It is noteworthy that there is more charcoal from large trees in what are thought to be early contexts on the unmodified slopes below the Lower Terrace in Area D and in the crater in Area A. This may suggest that although the landscape was already considerably modified when people first occupied these areas, there was a further reduction in forest trees as occupation of the site progressed. The large quantities of bracken were found in Area A and on the Upper Terrace in Area D, the two parts of the site

where burn layers were common, reinforcing the view that there were burn-offs of the surface when these parts of the site were reoccupied after fairly brief intervals of disuse. The almost entire absence of kānuka (*Kunzia ericoides*) in the charcoal samples suggests that periods of disuse, not only of the site, or this part of it, but of the surrounding garden areas were not long. Kānuka was a useful timber, made into various kinds of artefacts (Wallace 1989: 224) and burned as firewood, and should appear in the charcoal from the site if it was available in the vicinity.

It is interesting that the ponga, or tree fern (*Cyathea* sp.), which was often used in the superstructure of storage pits, and kauri, popular for house timbers and beaters, were found only in what appeared to be hāngi contexts, despite the fact that, as Wallace (Appendix 2) notes, ponga burns poorly.

Discussion

This section draws together what has been learned about the life of the people of Maungarei and then considers the wider interpretations and implications that can be drawn from these findings.

The people and their lifestyle

Nothing is known of the health and longevity of the people, or of individual life histories, as the few human remains encountered were reinterred without study. Isolated primary burials were made on the mountain, evidenced by discoveries during reservoir and road construction. One person was buried in a crouched position in a small pit on the Lower Terrace in Area D, and most of the bones were subsequently dug up and taken elsewhere. It is also known that human remains have been found in a lava tube on the western side of the mountain, equated with the traditionally remembered Rua-ā-Pōtaka.

Although evidence of houses was minimal (a stone-edged hearth and traces of a house-like structure on the Upper Terrace in Area D), there can be little doubt that people were living on Maungarei, not just preparing and storing food there. The amount of food refuse is in striking contrast to what may be expected in a specialised food store, as exemplified by Taniwha Pā (Law & Green 1972), and although the artefactual assemblage is small, it shows that people were repairing if not making stone adzes, working bone for artefacts, using obsidian and greywacke tools for a variety of tasks, and carrying out tattooing. The small

number of artefacts can be at least partly attributed to the fact that no actual undisturbed house sites or working areas were found.

The people of Maungarei appear to have enjoyed a diet of root crops such as kūmara (*Ipomoea batatas*) and perhaps also taro (*Colocasia esculentum*) and yams (*Dioscorea* spp.), grown in the gardens surrounding the mountain and stored in the numerous pits on the site. This diet may well have been supplemented by fern root – the starchy rhizome of bracken, which apparently grew on parts of the mountain during periods when it was not actually occupied and would also have grown on gardens left fallow. Most of the protein in the people's diet came from shellfish and fish, supplemented by the opportunistic capture of birds, mostly of coastal or open country habitat. The apparently inexhaustible cockle beds in the nearby Tāmaki Estuary were showing signs of human exploitation when people first moved onto the parts of the mountain investigated archaeologically. During the period of occupation, small cockles became even smaller. The main fish caught was snapper, and the fish varied greatly in size from very small to very large. While some fish could have been taken in the estuary, others must have been caught further afield, in the Waitemātā Harbour or around the nearby islands of Motutapu, Motuihe and Rangitoto.

The resource zones of Maungarei

The immediate resource zone of Maungarei consisted of the area of fertile volcanic soils at its base, which extended west to Waiatarua, east to the Tāmaki Estuary and beyond the Panmure Basin to the south, just meeting the zone of volcanic soils extending north from Ōtāhuhu/Mt Richmond. To the north there was a gap in fertile soils before the much smaller area around Taurere/Taylor's Hill, while across the estuary, Ohuiārangi/Pigeon Mountain was also surrounded by a small area of volcanic soils. The soils around the Maungarei-Tauomā volcanic complex appear to have been the largest such area associated with a single eruptive centre in the Auckland volcanic field. The Waiatarua wetland, on the edge of the Mt Wellington lava flow, probably also came within the resource zone of Maungarei.

Estuarine resources in the Panmure Basin and along part of the Tāmaki Estuary would also come within the territory of those living on Maungarei. However, the productive shellfish beds at Farm Cove today are closer to Ohuiārangi/Pigeon Mountain, and those further out towards the

entrance are closer to Taurere/Taylor's Hill. There is at present no archaeological evidence to indicate whether these two smaller cones were occupied at exactly the same time as Maungarei, although two radiocarbon dates from Taylor's Hill (Leahy 1991: 65) suggest that it was occupied in the same period; traditions hint that Maungarei was occupied but not attacked by Te Taoū when they took Taurere in the eighteenth century (Graham 1980: 5).

Access to fishing grounds and to Motutapu Island with its stone resources would have been by canoe down the Tāmaki Estuary. This would have been easy if the sites nearer the heads were unoccupied at the time but may not have been contested even at other times. Stone has described how this was thought to have been managed in the period when Maungarei was no longer occupied:

Tribal leaders, perhaps in a mood of excessively roseate nostalgia, spoke of a tradition of peaceful co-existence in Tāmaki during the pre-musket-war era, a tradition that had roots extending deep into the eighteenth century and possibly further. They testified to long-standing, overlapping rights of ownership, to a sharing of fishing grounds with outside hapu, or at least with elements within those hapu bonded with tangata whenua by kinship; they also spoke of uncontested criss-crossing of tribal territories. (Stone 2001: 34)

It is likely that a similar situation obtained during the period when Maungarei was occupied (although, as noted above, there was sometimes dissension over shark-fishing grounds, in particular). But for much of the time, the people of Maungarei could probably have had access to almost all the resources they needed. The outstanding exception for them, as for most pre-European Māori, was obsidian. This they obtained from a number of different sources, although by far the most came from Great Barrier Island (Aotea Island). At the time of the settlements on Maungarei, Great Barrier was occupied by closely related people, some of whom lived both on Great Barrier Island and at Tāmaki (Graeme Murdoch, pers. comm. 2010), so the relative abundance of obsidian from the Great Barrier sources in Auckland mid-sequence sites is not surprising. Murdoch also points out that the Tainui and Arawa connections of people in Tāmaki would have facilitated access to Coromandel, Mayor Island (Tuhua) and central North Island sources. No obsidian from the Northland sources was identified at Maungarei. In contrast, Northland obsidian was present in the much smaller and probably more recent assemblage from Kauri Point, Birkenhead (Davidson 1990: 11–12).

Maungarei as a settlement and as a pā

Maungarei was one of a number of volcanic cones in Tāmaki Makaurau terraced and occupied, according to tradition, by the Waiōhua people. According to Stone (2001: 31), 'it is a commonplace of tribal traditions that Tāmaki, in the years of Waiōhua ascendancy, was one of the most settled and extensively cultivated regions in Aotearoa, and that it was, in Māori terms, extremely wealthy'. He suggests that its prosperity was sustained by horticulture, primarily of kūmara, and argues that the extensive gardens 'betokened a stable social order' (2001: 33) and, further, that 'what was distinctive to Tāmaki, and this in spite of the received wisdom of historians to the contrary, was the fact that tribes enjoyed long periods of relative peace' (2001: 34). This is also the view of Murdoch (n.d.). We may ask then, how can Maungarei be seen, on the one hand, as one of 'three great pa' (Stone 2001: 25), and one which, according to tradition, was sacked at least twice, and on the other, as a prominent feature of the landscape in an often peaceful, golden age of Waiōhua ascendancy? The answer may be that, as Murdoch (n.d.) points out, almost all conflict before the mid-1700s was internal and localised. In other words, it was the result of sporadic bickering amongst relatives. The move to occupy the volcanic cones must surely have had a defensive motive, but this does not mean that a site like Maungarei was a huge fortification. It is more likely that only the two summit areas were actually fortified, giving people living on the slopes below the opportunity to retreat to their citadel when threatened.

As noted above, traditional accounts suggest that when Maungarei was taken, it was by invaders from outside the area of Waiōhua ascendancy: first Ngāti Maru, perhaps in the late 1600s; and then Ngāti Maniapoto, probably in the early 1700s. It was prepared for a possible attack by Te Taoū in the mid-1700s, which did not eventuate. The relatively late remodelling of the crater rim, with its apparent extension of the defended area, may relate to one of these episodes. Irwin (1985: 100, 109) has argued that the three largest pā at Pouto, on the northern head of Kaipara Harbour, reflect a united response by the people of Pouto to external threat, in contrast to the smaller pā in the study area, which would have been built by smaller social groups. The three largest pā at Pouto are all on the boundaries of the settlement area. Although a parallel with Pouto can be suggested, the Auckland case is more complex, with more large sites, not all of them on the peripheries of the Auckland volcanic field. Maungarei is the largest site on the eastern boundary and

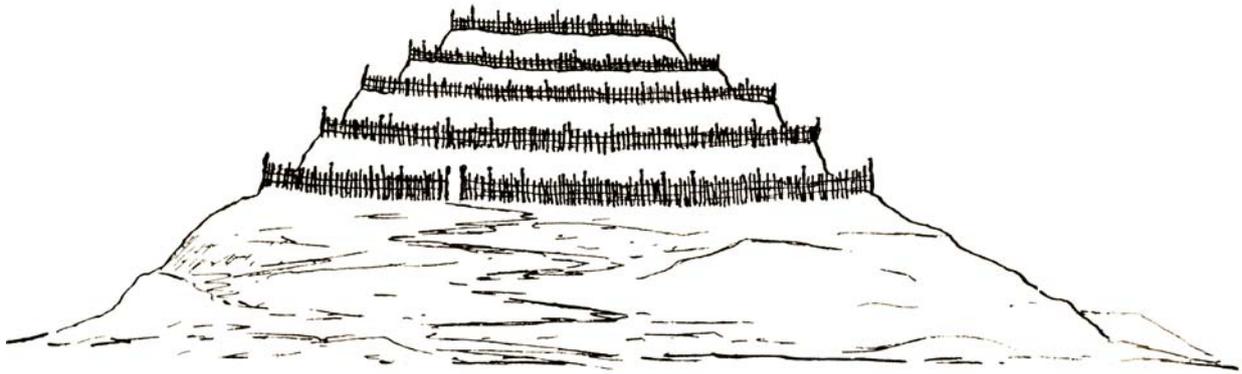


FIG. 84.—THE OLD STOCKADED HILL FORTS MUST HAVE PRESENTED SUCH AN APPEARANCE AS THIS.



Fig. 53 An idealised and an actual terraced hill site. Upper, from Best (1927: 234); lower, the discontinuous terraces on the eastern slopes of Maungarei, which have not been investigated by archaeologists. The line of the road can be seen rising diagonally from left to right (photo: Anthropology Department, University of Auckland).

Māngere Mountain (Te Pane ā Mataaho) the largest in the south, but Mt Eden (Maungawhau) and One Tree Hill (Maungakiekie) are central, with no really large sites on the western and northern boundaries.

The most easily defended areas on Maungarei are the southern part of the crater rim, from the main tihī westward (citadel 1), and the second tihī and its terraces (citadel 2) directly above and to the west of Area A. Both have strong natural defences in the form of very steep slopes around much of their perimeter, and each has a defensive transverse ditch at the weakest point. The easiest approach to citadel 1 is along the crater rim past Areas C and B, where there are what might be described as two outworks. Citadel 1 extends for almost 150 m from the innermost ditch east of the tihī to the outermost terrace at the western tip. It is relatively narrow. This puts it in the same general size category as the fortified area encompassing Areas I to IV and beyond at

Pouerua (Sutton *et al.* 2003: 25), and a number of pā that are not on volcanic cones, such as Kauri Point (Tauranga Harbour), which in its earlier defended phase was almost as long as and somewhat wider than citadel 1 at Maungarei. Citadel 1 at Maungarei is thus of a size appropriate for the sort of warfare that might be expected to have been practised in the Auckland area during the Waiōhū era. Citadel 2 is smaller but more easily defended, as it has no long, flat approach from any direction. It would be a suitable refuge for a smaller group of people than would be needed to defend citadel 1.

Maungarei can thus be viewed as comprising two pā in a landscape of living and storage areas. In contrast to most archaeological landscapes, some of the living and storage areas are on the slopes of the hill, adjacent to the pā, and so not as far from refuge as if they were down among the gardens. There is little doubt that there were also living and

storage areas down on the flat, but most if not all of these have been destroyed in relatively recent times.

The number and size of the pits on Maungarei suggest that the fields that once surrounded the cone were very productive. The most common use of the terraces seems to have been for pit storage, assumed to have been of kūmara, and many of the pits are both large and deep. But in the areas investigated, nothing was found to suggest that these stores were protected by palisades. No evidence of palisading was found anywhere in the excavations, despite the fact that the Lower Terrace in Area D was clearly the arrival point of a repeatedly beaten access path up to this part of the cone. This all suggests that Maungarei, like Pouerua during much of its history, was not a large-scale fortification, bristling with palisaded terraces, as some previous writers have imagined the Auckland volcanic cones to have been (Fig. 53). Clearly, there was at least one episode, late in the history of the site, when defensive ditches were built across parts of the crater rim, and this may well have obliterated earlier defensive works. However, even without deep trenches and extensive palisades, Maungarei could still have presented a strong statement of power and wealth in the landscape. The highly visible presence of large terraces housing structures containing stored food wealth would make that statement, without the added menace of strong fortifications.

Another way of seeking to understand Maungarei is to examine whether it can be considered as the location of a number of repeated short-term settlements. Walter *et al.* (2006) have extended the earlier ideas of Anderson & Smith (1996a, 1996b) and Smith (1999) about transient villages in southern New Zealand, arguing that this form of settlement was widespread and persistent in New Zealand prehistory. Maungarei certainly meets their criteria (Walter *et al.* 2006: 281–282) for a repeatedly occupied village; it was a place where people lived and worked for a time, adjacent to their gardens, and to which they frequently returned. For Walter *et al.* (2006), the distinction between pā and open settlement is not the primary concern; sites may be undefended at some times and defended at others, although they recognise that pā may reflect community solidarity and make a bold statement in the landscape.

Maungarei in time

The identification of charcoal from the excavations and the study of shellfish size both suggest that occupation of Maungarei, or at least of the various parts investigated,

began well after people had made their presence felt in the area with significant impacts on both terrestrial and marine resources. There was little if any forest remaining in the vicinity of Maungarei and the cockle populations in the Tāmaki Estuary were apparently far removed from virgin biomass. The five pooled radiocarbon dates on shell suggest that much of this occupation could have taken place between about AD 1580 and 1660. The three pooled charcoal dates, one of which is from a stratigraphically very early context in Area A, suggest that initial activity could have taken place in the late 1400s, or at the period indicated by the shell dates.

Smith & James-Lee (2009) have grouped a number of excavated sites in what they describe as the greater Hauraki Area into the categories of Early (AD 1250–1450), Middle (1450–1650) and Late (1650–1800), with some described as Early/Middle or Middle/Late. Most of the occupation on Maungarei as revealed by excavation would probably fall into their Middle category. In their study they include several sites in this part of Auckland: Hawkins Hill, the Fisher Road sites, the Tamaki River pā, and some of the Cryers Road sites are Middle; while Hamlins Hill, Westfield, the Tamaki River undefended site and part of Cryers Road are Middle/Late. These sites are all to the south of Maungarei, and most were probably associated with the volcanic cones of Ōtāhuhu/Mt Richmond and Te Apunga ō Tainui/McLennan's Hills rather than with Maungarei. Nevertheless, this shows that undefended occupation and storage sites and a small palisaded pā were present in the same general area during the period when Maungarei was occupied.

The Waipuna site, closer to Maungarei, was not included in the study by Smith and James-Lee. It has shell dates towards the end of its occupation, which fall in their Middle Period; and a charcoal date on tree fern from an early storehouse, which falls in their Early Period (Clough & Turner 1998: 19–20). The possibility that initial occupation of the Waipuna site began before occupation on Maungarei gains support from the fact that much of the charcoal identified at Waipuna is from forest trees. However, apart from a single apparently worked piece of moa bone, there is nothing else about Waipuna to confirm early occupation.

Two radiocarbon dates for Taylor's Hill/Taurere (Leahy 1991: 65) and one from Te Apunga ō Tainui/McLennan's Hills (Sewell 1992: 47) show that these smaller cones were also occupied in the same general time period as Maungarei.

It can be concluded, then, that the main occupation on the northern side of Maungarei took place during the mid-

sequence of Auckland prehistory. There is plenty of evidence of contemporary activity along the west bank of the Tāmaki Estuary during this period, including open settlements, a small pā, and use of the smaller cones, but very little indication of what went before. The move onto Maungarei may well have coincided with a perceived need for defence, perhaps as a result of increasing population and periodic quarrels among the various closely related groups of Waiōhua. This was also the time when the idea of earthwork fortification spread rapidly throughout much of New Zealand (Schmidt 1996).

Maungarei in a wider context

As noted above, Maungarei existed in a landscape of undefended settlements, several smaller cones and at least one small palisaded pā along the west bank of the Tāmaki Estuary. However, it also existed in the broader context of many other volcanic cone sites in the Auckland volcanic field, several larger than Maungarei and many smaller. Each of these was also surrounded by garden areas and, presumably, undefended settlements and small pā, as at Pouerua.

Bulmer (1994: 64–66) lists 27 radiocarbon dates from eight other volcanic cone sites in the Auckland volcanic field. Some of these are from rescue excavations of very limited scope (one date each for Te Apunga ō Tainui/McLennan's Hills and Ōtāhuhu/Mt Richmond, and three each from Maungawhau/Mt Eden and Maungakiekie/One Tree Hill). The contexts of the two dates from Taurere/Taylor's Hill, four from Puketāpapa/Mt Roskill and five from Manurewa or Matukutūruru/Wiri Mountain have been described in some detail (by Leahy 1991, Fox 1980 and Sullivan 1975, respectively), but there is little information about the important series of eight dates from Maungataketake/Elletts Mountain. It is not easy to derive a clear picture of occupation of the volcanic cones from these dates; the dates on charcoal, like those from Maungarei, tend to have multiple intercepts on the calibration curve and some, on unidentified wood, may have significant inbuilt age. There appears to be a possible problem of fossil shell mixed with cultural shell at Maungataketake/Elletts Mountain.

The best that can be said is that most or all of these sites certainly appear to have been occupied at some point during the 1500s and 1600s, some possibly a little earlier and some into the 1700s, as at Maungarei. Two charcoal dates from Matukutūruru/Wiri Mountain, originally published by Sullivan (1975), and a shell date from Maungataketake/Elletts Mountain have been recalculated and calibrated

(95% confidence) and published by Bulmer (1994: 65) as AD 1001–1490 (NZ1888), AD 632–1955 (NZ1909) and AD 977–1179 (NZ6476), respectively. There is also a shell date from Maungataketake/Elletts Mountain with a conventional radiocarbon age of $11\,205 \pm 138$ yrs BP. The currently accepted understanding is that 'humans have been present in New Zealand since 1250–1300 A.D.' (Higham & Jones 2004: 232). This view is reinforced by more recent studies (Wilmshurst *et al.* 2008, 2011). These apparently earlier dates from Auckland cones should not be accepted unless they can be supported by additional dates from the same contexts processed to the latest standards.

More than 100 years ago, Percy Smith guessed the population of one of the most prominent volcanic cone sites, Maungawhau/Mt Eden, as follows: 'It is probable that, in its day, Mt Eden *pa* would hold a population of at least 3000 people' (Smith 1896 & 1897: 78). This comment was cited by Best (1927: 211) and has been influential ever since. Moon, for example, when discussing the traditional story of the capture of Maungawhau/Mt Eden by warriors from Hauraki, cites Best as the authority for the figure of 3000 and goes on to ask 'how was it possible to assemble a force capable of taking a pā containing over three thousand people?' (Moon 2007: 66). The answer may be that there was a much smaller population of people, occupying a much smaller defended area.

Brown (1960) estimated the populations of 34 Auckland pā, including all the major cones, on the basis of 45 persons per chain of defended circumference. He arrived at a population of 2250 for Maungawhau/Mt Eden and 2385 for Maungarei. Fox (1983: 15) estimated the populations of seven pā, including four Auckland cones, using two measures: number of terraces and numbers of pits, assuming a family of six adults occupying a terrace and using two pits. She arrived at 710+ (terraces) and 510+ (pits) for Maungarei compared with 570+ and 510+ for Maungawhau/Mt Eden. She noted that these figures are much lower than previous estimates and that her reassessment 'obliges us "to think small"'. Even so, her figures relate to the final occupation of each site, apparently assuming that the entire site was occupied at the time. Her figures also do not recognise that the complex of Maungarei, Tauomā and the northern tuff ring was much larger than the area shown on the archaeological map of Maungarei. Bulmer (1996: 645) suggested that using a larger family size of 12 to a terrace would give the three largest cones (in her view, Maungakiekie, Maungawhau and Māngere, but not

Maungarei) about 2000 people. This kind of calculation led to total population estimates for Auckland in the eighteenth century of 13,400–14,000 (Brown 1960: 22) and 15,000–20,000 (Bulmer 1996: 645). How this large population was overcome and dispersed by invaders from the north is not explained. It seems more likely that considerably fewer than half the cones, and only parts of each, were occupied at any one time.

Pool (1991: 57), after a thorough review, concluded that ‘the population [of Māori in New Zealand] would have reached barely 100,000 before it suffered the shock of European contact’. He considered the population of the Auckland region (a considerably wider area than just the Auckland volcanic field) in 1801 to have been 7% of the North Island Māori population. Based on these figures, the total population of Tāmaki during the period when Maungarei was occupied is unlikely to have reached 5000.

Phillips (2000: 163, 180), in her detailed study of Māori life and settlements along the Waihou River in the Hauraki Plains, argues persuasively that on average, only five of the 49 known pā in her study area would have been occupied at any one time. She suggests an average of 200 people per pā. Some of her sites, such as Oruarangi and Raupa, are comparable in size to the suggested area of citadel 1 on Maungarei; others are smaller and more comparable to citadel 2. The Auckland cones would probably have been occupied more frequently, if for shorter periods, than Phillips suggests for Waihou, with some of the occupations involving fortification and others not. In an apparently optimum area for Māori gardening and settlement, as in Tāmaki, there was probably a larger population over a longer period than along the Waihou.

Marshall reviewed various settlement typologies developed by New Zealand archaeologists and combined them into five classes of settlement, based on criteria of size, complexity, distribution and, to a lesser extent, function (Marshall 2004: 77). She saw Maungarei and other large Auckland cone sites as probably belonging to her Class 5 category of exceptional sites. In the case study areas she considered, Pouerua is the only Class 5 site. This raises the question of whether Maungarei is a ‘site’ or part of an archaeological landscape containing many ‘sites’ of different kinds. In the context of whether to lump or split when recording sites, I have previously suggested that when probable garden areas are included, the whole of Motutapu Island could be considered one huge archaeological site (Davidson 1987: 232). The same can be said of parts of the

Auckland volcanic field, where archaeological remains continued down the slopes of the cones into extensive garden areas dotted with residential and storage components and occasional small palisaded pā. In this respect, the volcanic cone of Pouerua is also part of a much larger ‘site’ occupying the whole of the surrounding lava field. Specific components should perhaps be considered ‘features’ rather than ‘sites’.

If Maungarei and the other volcanic cones were transient sedentary villages or settlements of the kind described by Walter *et al.* (2006), occupied and reoccupied by populations numbering a few hundred or less, rather than thousands, the reasons for transience must be examined. It has been widely accepted that kūmara horticulture depleted soil fertility fairly rapidly and gardens could not be used for more than two or three years, after which they would be left fallow for many years (Simmons 1969: 26; Leach 1984: 61; Sullivan n.d.: chapter 4, f. 6). However, recent experimental research has suggested that kūmara yields, while fluctuating from year to year primarily for climatic reasons, do not deplete soil nutrients significantly over a 10-year period (Burtenshaw *et al.* 2003 and authors’ subsequent unpublished data). Both Simmons and Sullivan, when discussing garden rotation, cited nineteenth-century sources about gardening practices, which probably related at least in part to white potato gardens and need not necessarily apply to pre-European kūmara gardens. If the population on Maungarei and other volcanic cones was smaller than previous estimates, and gardens could be used for a longer period before being left fallow, what was the impetus to move fairly frequently to other village locations? Walter *et al.* (2006: 282), while emphasising resource depletion as a major cause of transience, also allow for movement ‘as a result of political contingencies’. The explanation for movement within the Auckland volcanic field may rest in the complex ebb and flow of hapū growth, decline and constant realignment. But this is beyond the reach of archaeological documentation. Future archaeological research and more precise dating methods may reveal more clearly the pattern of movement from cone to cone and back again.

Although the concept of the transient village can certainly be applied to Maungarei, and by extension to other Auckland sites, the density and size of these sites is dramatically different from those of southern New Zealand, to which the concept was first applied. Does this have implications for our understanding of the social organisation

of the people who lived on Maungarei and other large Auckland cones? Do these large sites reflect a more hierarchical kind of organisation? Unfortunately, while we have the big sites, equivalent to Marshall's (2004) Class 4 and 5 sites, we have only a fragment of the total landscape. We can be reasonably certain, however, that the Auckland area had a full range of all classes of sites, from small single-purpose sites, such as the Alberon Park pit site (Law 1970), through larger pit complexes to open settlements and pā. A vast array of archaeological evidence is crammed into a very small area, in contrast to southern New Zealand, where what may be a similar amount of evidence is very widely and thinly spread. Yet there is little in the traditional or historical evidence to suggest the development of a more hierarchical social organisation in Auckland than in other parts of the country where population density was lower and sites more widely distributed.

Conclusions

The various excavations on Maungarei revealed a complex history of terrace construction, the digging and filling of roofed storage pits, and the deposition of various kinds of midden and fill layers on the slopes. The earliest radiocarbon dates are ambivalent when calibrated to calendrical ages; forest clearance may have begun in the crater and on the western toe of the cone in the 1400s or in the 1500s. Repeated episodes of terrace construction and pit-building on the lowest part of the crater rim and adjacent slopes, the locations of the main archaeological excavations, probably took place between about AD1580 and 1660, in what may be described as the mid-sequence of Auckland prehistory. There was activity at this time also on the smaller citadel, above Area A, and the northeast part of the crater rim. Soon after a major remodelling of much of the crater rim, probably in the early or mid-1700s, occupation of the site ceased. No investigations have yet taken place on the more extensively terraced eastern slopes (Fig. 53), and it is possible that an equally complex but more extended sequence of occupation would be found there.

The subsistence economy of the Maungarei people was compatible with what is thought to be typical of Māori life in this part of New Zealand during this period: the growing of plant foods, particularly kūmara; the gathering of bracken rhizomes; fishing, in this case particularly for snapper; and the gathering of shellfish, in this case particularly cockles. A few birds were taken, opportunistically rather than

systematically. Dogs and, probably, Polynesian rats, which were numerous in the site, also contributed to the diet.

The limited range of material culture recovered is typical of what has been found in other Auckland mid-sequence sites. Waipapa series greywacke and chert, probably obtained from Motutapu or adjacent islands, was an important local stone resource. Obsidian was obtained from various sources further afield, including Mayor Island (Tuhua), Coromandel, Rotorua and Taupo, but predominantly from Great Barrier Island (Aotea Island).

Maungarei was well placed for access to good garden land, a large freshwater swamp and marine resources. By the time of the main occupation of the cone revealed by the excavations, the environment was already much modified by human presence in the region: there had been extensive forest clearance, presumably for gardens, and impact on shellfish beds was apparent in the small size of most shells gathered.

I have argued that only the two high points or citadel areas were actually fortified; the area of these was appropriate for hapū-level conflicts. No evidence of fortification or fencing was found on any of the excavated terraces, although excavation revealed a series of well-beaten access paths to the lowest of the northern terraces. It is unlikely that most or all of the site was occupied at one time; rather, what we see today can be regarded as the end result of a long series of repeated village- or sometimes hamlet-sized occupations, most of which required the lowering of terrace surfaces and the digging of new pits to allow repeated use of the unstable scoria slopes. Maungarei was thus the location of repeated settlements, which were sometimes fortified, particularly late in the sequence, but often not.

Maungarei is only one of many volcanic cone sites in Auckland and not the largest (although the inclusion of its destroyed sister cone of Tauomā and adjacent tuff rings might bring it up to second place after Maungakiekie/One Tree Hill). It is unlikely that as many as half of these cones were occupied at one time, or that the population of the Auckland area during the mid-sequence was anything like as large as some writers have claimed. Even so, an immense amount of human effort went into the creation of the volcanic cones sites, giving credence to the often repeated claims that Tāmaki some 300 to 400 years ago was a highly populated and wealthy area in Māori terms, just as it is now in modern terms.

Much has been learned from the rescue excavations on Maungarei, but the surface has only been scratched. Its

history cannot be fully understood without knowledge of what was happening on the eastern slopes. It is even more important to find evidence of earlier occupation of the area. When did people first step ashore on the banks of the Tāmaki Estuary and how long did it take for them to clear forest, start to affect shellfish beds, take up residence on the mountain and feel the need to defend themselves? In the large metropolitan area that is modern Auckland, most evidence of initial Māori settlement is probably already lost, and any surviving fragments will be precious indeed.

Maungarei and the other surviving Auckland volcanic cones, although they are damaged and battered, and largely deprived of their surrounding settlements and gardens, are still remarkable monuments not only in the New Zealand context but on the world scene. They are of great significance to Māori; they deserve the World Heritage status that has been suggested for them. Protection and appropriate management of what remains should be a top priority.

Acknowledgements

Many people and institutions have contributed to the study of Maungarei over a long period. The then National Historic Places Trust provided a grant to support the 1960 excavations. The 1971–72 excavations were facilitated by the Department of Lands and Survey and the Mt Wellington Borough Council; the interest at that time of Darcy O'Brien, Commissioner of Crown Lands in Auckland, and Jack Fitzgerald, Mt Wellington Borough Engineer, is gratefully acknowledged. The New Zealand Historic Places Trust and the Auckland Institute and Museum enabled Jim McKinlay and me to carry out the excavations in 1971–72 and provided a great deal of support. The excavations in 1960 and 1971–72 would not have been possible without the work a large number of volunteers. The material from the 1960 excavations was returned to New Zealand from Canberra for analysis, and Jack Golson made available all the records relating to those excavations.

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Notes

- 1 The Māori name Maungarei is used throughout this paper for the archaeological site and the volcanic cone on which it is situated. The term Mt Wellington is retained for the former Domain, the former local body that administered it, and the lava field around it.
- 2 The name means 'the feeding place of Hiku', after the taniwha (mythical monster) who was the guardian of the basin. The full name of the taniwha was Moko ika hiku waru, later shortened to Mokoia (G. Murdoch, pers. comm. 2010) – hence the modern Māori name for the basin, Waimokoia.
- 3 Tauomā is sometimes given as the name for the entire district on the western side of the Tāmaki Estuary (Stone 2001: 50; Sullivan n.d.: chapter 3).
- 4 These and other events were previously described by Fenton (1879) and Smith (1896 & 1897), among others; Stone's excellent 2001 account is more readily accessible.
- 5 Kyowa with 10× eyepiece, 0.5 objective and zoom of 0.7–4.5. The resulting range is 3.5–22.5× magnification. When appropriate, photographs were taken with a ME1300 dig-

ital camera inserted into one eyepiece at 1280 × 1024 pixel resolution and USB output.

- 6 Faunal material was catalogued in a separate series from artefacts and unworked stone, with the prefix AM. The faunal material is held in the Auckland War Memorial Museum.
- 7 Although research on contemporary and archaeological specimens of the blue mussel currently suggests that all are best regarded as *Mytilus galloprovincialis*, some specimens from warmer North Island waters exhibit greater affinity to *M. edulis* than to *M. galloprovincialis* and archaeological specimens are significantly different from contemporary populations in New Zealand (Gardner 2004). In addition, nuclear DNA markers suggest that specimens from the Auckland Islands are a hybrid between the two species (Westfall *et al.* 2010; Westfall & Gardner 2010, n.d.; Gardner & Westfall n.d.). Clearly, the last word has yet to be written on the origin and taxonomic relationships of blue mussels in New Zealand and archaeological specimens have an important role in future research on this subject.
- 8 An exception is the study by Cofman-Nikoreski in Fredericksen & Visser (1989: 93–102), which demonstrated small cockle size by size classes and hinted at a decrease in size through time.
- 9 It is unclear whether some probable *Diomedea* (albatross or mollymawk) bones from Cryers Road derive from pre-European or historic deposits (Fredericksen & Visser 1989: 103).

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Appendix 1: Mammal and bird remains from Maungarei

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Mammal and bird remains were recovered from excavation Areas A, C and D at Maungarei. These were analysed in the archaeological laboratories of the Department of Anthropology and Archaeology at the University of Otago, using the faunal reference collections housed there.

All specimens were identified to the most precise taxonomic class to which they could be assigned with confidence, the anatomical element represented and portion present, along with any indications of developmental age, taphonomic condition, and presence of cut marks or other notable features. The number of identified specimens

(NISP) that the identification represented was recorded and two quantification measures were derived: the minimum number of anatomical elements (MNE) and the minimum number of individual animals (MNI). These measures were calculated initially by aggregating the identification data in terms of the discrete archaeological contexts from which the faunal remains derived. This represents the primary analytical units for reconstructing human activity at the site, but risks inflating counts of vertebrate fauna because anatomical elements from a single individual could be distributed through more than one context. To

Table A1.1 Mammal and bird number of identified specimens (NISP) from Maungarei.

	Area A	Area C	Area D	Total
Mammal				
Sheep (<i>Ovis aries</i>)	77	—	—	77
Pig (<i>Sus scrofa</i>)	1	—	—	1
Cow (<i>Bos taurus</i>)	—	—	2	2
Rabbit (<i>Oryctolagus cuniculus</i>)	—	—	29	29
Rat (<i>Rattus</i> sp.)	124	34	565	723
Dog (<i>Canis familiaris</i>)	72	2	139	213
Human (<i>Homo sapiens</i>)	—	—	4	4
Mammal ?sp.	26	—	—	26
Total	222	36	739	1075
Bird				
Pied stilt (<i>Himantopus himantopus</i>)	1	—	2	3
Kingfisher (<i>Todiramphus sanctus vagans</i>)	1	—	—	1
Red-legged partridge (<i>Alectoris rufa</i>)	—	—	1	1
Australasian harrier (<i>Circus approximans</i>)	—	—	1	1
Black backed gull (<i>Larus dominicanus</i>)	—	—	1	1
Common diving petrel (<i>Pelecanoides urinatrix</i>)	—	—	1	1
Grey teal (<i>Anas gracilis</i>)	—	—	1	1
Pūkeko (<i>Porphyrio melanotus melanotus</i>)	—	—	1	1
North Island brown kiwi (<i>Apteryx mantelli</i>)	—	—	1	1
Kiwi?	—	—	1	1
Moa ?sp	—	—	1	1
Bird ?sp	3	—	21	23
Total	5	—	32	36

Table A1.2 Minimum number of anatomical elements (MNE) and minimum number of individuals (MNI) of mammals aggregated by discrete context and by excavation area.

	Area A		Area C		Area D		Total	
	MNE	MNI	MNE	MNI	MNE	MNI	MNE	MNI
By context								
Rat	90	14	25	7	401	77	516	98
Dog	33	21	2	2	100	68	135	91
Human	—	—	—	—	4	4	4	4
Mammal ?sp	2	2	—	—	—	—	2	2
Total	125	37	27	9	505	149	657	195
By area								
Rat	77	5	20	2	332	22	429	29
Dog	23	3	2	1	73	3	98	7
Human	—	—	—	—	3	1	3	1
Mammal ?sp	—	—	—	—	—	—	0	0
Total	100	8	22	3	408	26	530	37

assess the extent to which this may have occurred, data were also aggregated at the excavation area level.

Total NISP of 1075 mammalian bone and tooth specimens, and 36 bird bones were identified (Table A1.1). About 10% of the mammalian assemblage is from species introduced after European contact and likely to have entered the deposits in recent time. The majority are from sheep. Almost half (49%) of these were recovered from the topsoil and layer 2 in squares E2 and E3 of Area A, and are almost certainly parts of a single animal. Another 46% were parts of a second skeleton from layer 1 and the layer 2–3 interface in Area A squares E9 and E10, and two further bones were from layer 1 in Area A square F6. Similarly, the two cow bones were from the topsoil and layer 1 of two squares in Area D, and the single pig bone from layer 1 in Area A. Rabbit bones were found in two clusters: more than half (55%) from the turf of Area D squares R13 and R15, and the remainder from a rabbit hole and adjacent contexts in Area D squares L11 and L12 and M11 and M12. All of these items are excluded from further analysis. Nearly all of the material identified as mammal ?sp appears to be from medium-sized mammals, so could derive from dogs, sheep or pigs.

Rats dominate the remaining fauna, making up three-quarters of the identified items. They have been identified here as *Rattus* sp. because of significant size overlap between kiore (*R. exulans*), introduced to New Zealand

by Polynesians, and the European introductions *R. rattus* and *R. norvegicus*. However, all bones complete enough to tell fall towards the smaller end of the size range, making it likely that they are *R. exulans*. When aggregated by discrete archaeological context, a minimum of 516 anatomical elements and 98 individual animals are represented (Table A1.2). These numbers decrease when aggregated by excavation area but, for reasons outlined below, this almost certainly provides a better reflection of the relative importance of rats as by far the most common mammalian species, contributing 78.3% of MNI. More than three-quarters of these are from Area D.

Dogs are the other main component of the mammalian fauna, making up 22% of non-intrusive mammalian NISP, with nearly two-thirds of these from Area D, most of the remainder in Area A and only two items from Area C. When data are aggregated by discrete archaeological context, dogs contribute 20.5% of mammalian MNE, but make up almost half of mammalian MNI (46.7%) (Table A1.2). In contrast, both MNE (18.5%) and MNI (18.9%) are at a similar level when aggregated by excavation area. This comparison indicates that there is a high likelihood that skeletal parts from the individual dogs are distributed through multiple archaeological contexts, so that individual animals are counted multiple times when data are aggregated by minimal units. This is further emphasised when

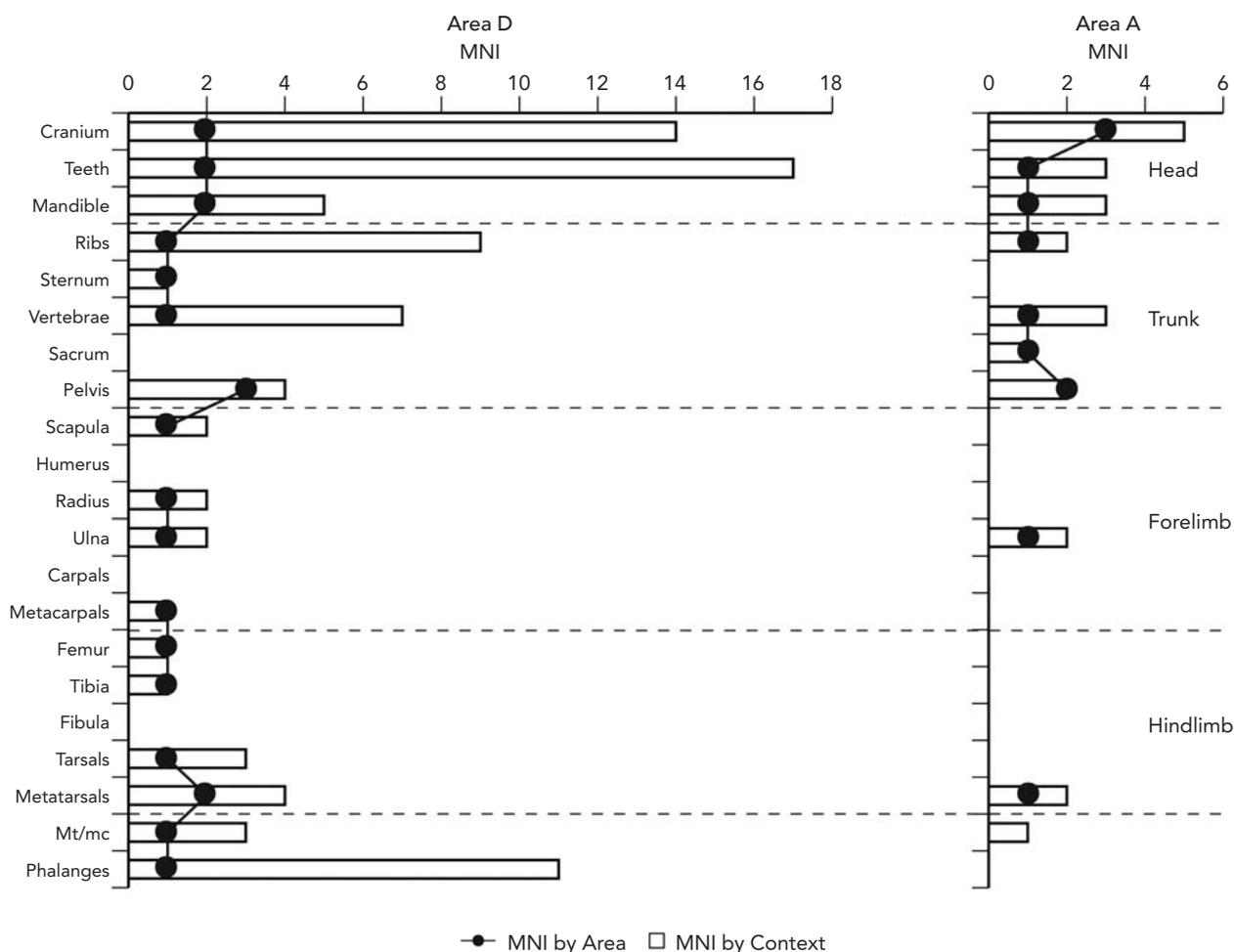


Fig. A1.1 Dog minimum number of individuals (MNI) per skeletal element calculated by archaeological context and excavation area at Maungarei.

comparing what the two aggregation methods indicate as values for the MNI represented by each skeletal element (Fig. A1.1). This shows that the higher MNI values when aggregating by context derive almost exclusively from element classes with numerous members, such as teeth, ribs, vertebrae and phalanges, along with crania, which often fragment into many pieces. It is difficult to imagine that such element classes were separated and distributed around the site for a deliberate purpose, suggesting that their dispersal was post-depositional, presumably as a result of pit-building, terrace construction and other earthworks on the site. These observations suggest that aggregation of data by the larger areal units provides the most reliable indication of the relative abundance of faunal classes.

One notable feature of the dog assemblage, irrespective of how the data are aggregated, is the relative scarcity of the main bones of both forelimbs and hind limbs. In Area D,

the humerus, radius, ulna, femur and tibia are together represented by an MNE of 6, which is only 20% of the potential number if three dogs are represented, or 0.9% if there had been 68 dogs. The two ulnae present in Area A are likewise at most 7% or only 1% of the potential number of main long bones. There are two potential explanations for this pattern. Allo (1970: 170-175; Allo Bay-Petersen 1979: 174-175) has suggested that dog long bones are typically underrepresented in sites because they were sought after as raw material for bone tools. This proposition is hard to assess, as it is generally difficult to identify the taxonomic source of completed tools, but it should be noted that a recent study found that where identifications were possible, bird bones were used much more often than dog bones for tools such as awls, needles and all but the heaviest bone points (McPherson 2008). Furthermore, there are now a number of well-studied dog assemblages in which the main

Table A1.3 Minimum number of anatomical elements (MNE) and minimum number of individuals (MNI) of birds aggregated by discrete context and excavation area.

	By context						By area					
	Area A		Area D		Total		Area A		Area D		Total	
	MNE	MNI	MNE	MNI	MNE	MNI	MNE	MNI	MNE	MNI	MNE	MNI
Pied stilt	1	1	2	2	3	3	1	1	2	2	3	3
Kingfisher	1	1	—	—	1	1	1	1	—	—	1	1
Red-legged partridge	—	—	1	1	1	1	—	—	1	1	1	1
Australasian harrier	—	—	1	1	1	1	—	—	1	1	1	1
Black backed gull	—	—	1	1	1	1	—	—	1	1	1	1
Common diving petrel	—	—	1	1	1	1	—	—	1	1	1	1
Grey teal	—	—	1	1	1	1	—	—	1	1	1	1
Pūkeko	—	—	1	1	1	1	—	—	1	1	1	1
NI brown kiwi	—	—	1	1	1	1	—	—	1	1	1	1
Kiwi?	—	—	1	1	1	1	—	—	1	—	1	—
Moa ?sp.	—	—	1	1	1	1	—	—	1	1	1	1
Bird ?sp.	3	3	14	12	17	15	2	—	5	—	7	—
Total	5	5	25	23	30	28	4	2	16	10	20	12

long bones are represented at least as well as, or better than, those from other body parts (e.g. Smith 1981b: 118-119, 1996: 194; Furey 2002: 114). The second possibility is that the fore and hind limbs of dogs were detached from carcasses and removed for consumption and subsequent disposal elsewhere. Similar evidence at Pig Bay on Motutapu Island has been interpreted as indicating the sharing of dog carcasses (Smith 1981a: 98-99). The relative scarcity of major limb bones makes it difficult to assess the age at death of dogs properly, but as far as can be determined all of the animals are osteologically mature.

Human remains are confined to four specimens, all from squares J11 and L11 in Area D. They include a tooth, a patella and two cranial fragments, one of which has been cut along one or possibly two edges, and has striations on the surface, indicating that it was being worked into some form of artefact.

Bird remains are very scarce in comparison to those of mammals. Aggregation by area rather than context has no impact on the number or relative proportions of positively identified species, but it dramatically reduces the total number of birds that appear to be present, by eliminating all the individuals that were not identifiable to species (Table A1.3). One species, the red-legged partridge, is clearly intrusive, having been introduced to New Zealand



Fig. A1.2 Moa long bone shaft fragment from Maungarei, showing extensive weathering on all surfaces.

unsuccessfully in the late nineteenth century and again after 1984 (Heather & Robertson 2005). The remaining species are all native, and thus potentially exploited during the pre-European period. However, none is common, with only the pied stilt being represented by more than one individual. The identified species derive from a diverse range of marine, estuarine, wetland, grassland and forest habitats, and this

along with their very low numbers suggests no more than occasional and opportunistic use of avifauna. The single piece of moa bone, a long bone shaft fragment, is extensively weathered on both internal and external surfaces, indicating long periods of exposure to the elements (Fig. A1.2). It almost certainly derives from a period earlier in time than the occupation of Maungarei.

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Appendix 2: Identification of charcoal from excavations on Maungarei, Auckland

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Introduction

Charcoal samples recovered from archaeological excavations in Areas A, C, D and E on Maungarei are identified and the results discussed.

Materials and methods

The charcoal arrived in 120 plastic bags with provenance details written on the labels recording the stratigraphic unit involved. All pieces in the smaller bags were identified but only a representative sample was identified from larger bags. The numbers of pieces of each species identified from each bag are summarised in Tables A2.1 to A2.5. Common and scientific names are listed in Table A2.6. These results provide an estimate of the proportion of each species in each sample bag but are not minimum numbers, as in many cases a single piece of burnt wood may have broken up into many fragments, which are all identified and counted separately.

The charcoal was prepared for microscopic examination by snapping pieces across and cleaving along the grain. They were then mounted on microscope slides so the cleaved/snapped surfaces faced upwards. The cell structure was examined using a Zeiss compound microscope equipped for incident illumination at magnifications of 50, 100, 250 and 500 diameters.

In the nearly 20 years since this material was originally examined, I have made some improvements in species identification. I now realise that pieces originally tentatively identified as patē (*Schefflera digitata*) and rangiora (*Brachyglottis repanda*) are both almost certainly tutu (*Coriaria* sp.). The data have been altered accordingly. Another case is the realisation that pūriri (*Vitex lucens*) branch wood is often thin-walled and develops strongly banded axial parenchyma, both properties making it very similar to kohekohe (*Dysoxylum spectabile*) in its cell structure. In Tables A2.1 to A2.5, these two species show striking covariance, strongly

suggesting that only one species is present. I now regard these samples as being almost all pūriri.

Charcoal is the partially combusted remains of woody tissues and is composed of elemental carbon. Although it is not biodegradable, charcoal is rapidly destroyed by weathering if exposed on the ground surface and will be preserved in site sediments only if it is rapidly buried. It can enter deposits as the consequence of several quite different firing events. The most obvious is from domestic fires; we can assume most charcoal found in layers consisting of shell midden and oven stones will derive from domestic firewood. This will have been collected from the local landscape at the time the site was occupied and is likely to reflect the local vegetation quite accurately. Another major source of charcoal is bracken fern (*Pteridium esculentum*) and shrubs that have colonised a recently abandoned occupation area that has been set alight. Repeated firing of such vegetation by Māori was common. Charcoal from such fires will collect in old kūmara pits, hāngi and ditches, etc., and be quickly buried. Such material appears to be a significant component of many archaeological charcoal assemblages, including this one. These post-occupation fires will also burn down the remains of abandoned timber structures such as palisades, fences, houses, cooking shelters, kūmara pit roofs, etc. The species involved here will be dictated by their specific structural uses, but will typically be conifers for dressed timbers and broadleaf tree species for round posts. In only two cases is the inferred specific structural element recorded on the bag label. One was labelled 'Upper terrace – K10 – wooden stake vertical in pit 2 fill'. The charcoal was later identified as rimu (*Dacrydium cupressinum*) or tōtara (*Podocarpus totara*). The other was labelled 'Mt Wellington – 1960 – E9 – Post cut from under L.3' and was found to contain hebe (*Hebe* spp.), coprosma (*Coprosma* spp.) and mataī (*Prumnopitys taxifolia*) charcoal. This sample is clearly not one item, but mataī is potentially the remains of a structural element.

Table A2.1 A summary of the Maungarei charcoal assemblages (ID = individual identifications).

Plant groups	Species	Area D Upper Terrace		Area C Crater rim		Area A		Area D Lower Terrace	
		Species IDs	%	Species IDs	%	Species IDs	%	Species IDs	%
Ferns	Bracken	42	16%	—	0%	45	12.7%	2	0.8%
Shrubs and small trees	Hebe	124		105		102		86	
	Coprosma	6		24		32		16	
	Tutu	15		3		2		8	
	Mānuka	—		—		—		1	
	Olearia	—		—		1		—	
	Akeake	1		—		—		—	
	Fivefinger	—		3		1		—	
	Pseudopanax	—		—		3		—	
	Kawakawa	1	74%	—	83.5%	—	47%	—	50%
	Ngaio	—		—		3		—	
	Pittosporum	—		—		6		—	
	Toro	3		—		—		2	
	Māpau	2		—		7		—	
	Porokaiwhiria	1		1		—		—	
Kaikōmako	—		—		1		—		
Māhoe	2		6		7		6		
Kānuka	42		—		1		—		
Tree ferns	Ponga	—	0%	—	0%	10	3%	4	1.7%
Vines	Vine species	—	0%	—	0%	1	0.3%	4	1.7%
Broadleaf trees	Tītoki	—		4		—		—	
	Tarairē	—		—		1		2	
	Tawa	—		—		—		2	
	Rewarewa	—		—		2		8	
	Mangeao	2	8%	—	14.7%	1	32.6%	—	31%
	Tōwai	—		—		2		—	
	Pōhutukawa	—		—		9		3	
	Kohekohe	—		7		30		24	
Pūriri	19		14		70		36		
Conifers	Tānekaha	4		—		—		—	
	Rimu	—		—		3		5	
	Tōtara	1	2%	—	1.8%	9	4.5%	7	15%
	Rimu/tōtara	1		—		1		1	
	Mataī	—		3		2		7	
Kauri	—		—		1		16		
Totals		266		170		353		240	

Table A2.2 Charcoal identifications from Area A at Maungarei by context.

Species	Early	Pits/ scarps	Hāngi	Late	Upper Terrace	Lower Flat	Totals	Plant type
Bracken	—	36	5	—	4	—	45	Fern 12.7%
Hebe	3	35	51	—	8	6	103	
Coprosma	4	11	15	—	—	2	32	
Tutu	—	1	—	—	—	1	2	
Olearia	—	1	—	—	—	—	1	Shrubs or small trees (47%)
Pseudopanax	1	3	—	—	—	—	4	
Ngaio	—	3	—	—	—	—	3	
Pittosporum	1	3	2	—	—	—	6	
Māpau	—	7	—	—	—	—	7	
Kaikōmako	—	1	—	—	—	—	1	
Māhoe	4	2	—	—	1	—	7	
Kānuka	—	—	1	—	—	—	1	
Ponga	—	—	10	—	—	—	10	Tree fern (3%)
Vine	—	1	—	—	—	—	1	Vine (0.3%)
Taraire	—	1	1	—	—	—	2	
Rewarewa	—	1	—	—	1	—	2	
Mangeao	1	—	—	—	—	—	1	Broadleaf trees (32.6%)
Tōwai	—	2	—	—	—	—	2	
Pōhutukawa	2	—	7	—	—	—	9	
Kohekohe	12	7	—	—	11	—	30	
Pūriri	12	27	7	2	22	—	70	
Rimu	1	—	1	—	1	—	3	Conifers (4.5%)
Tōtara	—	8	1	—	—	—	9	
Rimu/tōtara	—	1	—	—	—	—	1	
Mataī	—	1	—	—	—	1	2	
Kauri	—	—	1	—	—	—	1	
Totals	41	152	102	2	48	10	355	

Charcoal from diverse firing events will commonly be inextricably mixed. Five pit fill samples from the Upper Terrace in Area D are labelled 'burnt layer' and are dominated by bracken root and stem charcoal. Other pit fill samples from this area are labelled 'midden fill – not burnt layer' but also contain large amounts of bracken charcoal that again clearly derive from the burning of the same vegetation type.

Discussion of results

The abundance of bracken fern in the Maungarei assemblage suggests that it was a very important component of the

local prehistoric vegetation cover. It is usually absent or underrepresented in most assemblages, as its charcoal is fragile and can be easily destroyed during sieving. The species colonises bare ground after fire or other disturbance. It is very easy to set alight but rapidly regenerates and becomes semi-permanent until repeated firing of the landscape is discontinued.

The establishment of woody species in such fernland is limited by the firing interval. Three woody shrubs – hebe, coprosma and tutu – are typically associated with bracken in the numerous charcoal assemblages from archaeological sites in the northern North Island that I have dealt with over the last 20 years. At Maungarei these four plants between

Table A2.3 Charcoal identifications from Area C at Maungarei by context.

Species	Early	Pit fill	Pit fill/hāngi	Hāngi	Totals	Plant type
Hebe	—	44	17	44	105	Shrubs or small trees (83.7%)
Coprosma	—	11	7	6	24	
Tutu	—	—	—	3	3	
Mānuka	1	1	—	—	2	
Fivefinger	—	—	2	1	3	
Porokaiwhiria	—	—	1	—	1	
Māhoe	2	1	3	—	6	
Titoki	4	—	—	—	4	Broadleaf trees (14.5%)
Kohekohe	3	—	3	1	7	
Pūriri	12	—	1	1	14	
Mataī	3	—	—	—	3	Conifer (1.75%)
Totals	25	57	34	56	172	

Table A2.4 Charcoal identifications from the Upper Terrace in Area D at Maungarei by context.

Species	Early	Pit 1			Pits			Late hāngi/ midden	Totals	Plant type (%)	
		bottom	burn	top	2/2a	4	5/6				
Bracken	—	2	18	19	—	—	—	3	42	Fern (15.5%)	
Hebe	12	10	35	26	17	5	—	18	123	Shrubs or small trees (74.6%)	
Coprosma	—	—	—	3	—	2	—	1	6		
Tutu	—	7	—	1	—	—	—	4	12		
Mānuka	—	—	—	—	—	—	—	1	1		
Akeake	—	—	—	—	—	—	1	—	1		
Kawakawa	—	—	—	—	1	—	—	—	1		
Toro	—	—	—	—	—	—	3	—	3		
Māpau	—	1	—	—	—	—	—	1	2		
Porokaiwhiria	—	—	1	—	—	—	—	—	1		
Māhoe	—	—	—	9	1	—	—	1	11		
Kānuka	—	—	—	—	42	—	—	—	42		
Mangeao	—	—	—	1	—	—	—	1	2		Broadleaf trees (7.7%)
Pūriri	—	—	—	3	5	2	7	2	19		
Tānekaha	—	4	—	—	—	—	—	—	4	Conifers (2.2%)	
Tōtara	—	1	—	—	—	—	—	—	1		
Rimu/tōtara	—	—	—	—	1	—	—	—	1		
Totals	12	25	54	62	67	9	11	32	272		

Table A2.5 Charcoal identifications from the Lower Terrace in Area D at Maungarei by context.

Species	Early	Slope debris	Dump	Terrace use	Hāngi	Pit fill	Totals	Plant type
Bracken	—	—	2	—	—	—	2	Fern (0.8%)
Hebe	5	2	24	—	47	8	86	Shrubs or small trees (50%)
Coprosma	—	—	2	3	9	2	16	
Tutu	—	—	—	—	6	2	8	
Mānuka	—	—	1	—	—	—	1	
Toro	—	—	2	—	—	—	2	
Māpau	5	—	1	—	—	—	6	
Ponga	—	—	—	—	4	—	4	Tree fern (1.7%)
Vines	—	—	1	—	3	—	4	Vines (1.7%)
Taraire	—	—	—	2	—	—	2	Broadleaf trees (31%)
Tawa	2	—	—	—	—	—	2	
Rewarewa	—	—	5	3	—	—	8	
Pōhutukawa	3	—	—	—	—	—	3	
Kohekohe	3	1	—	—	20	—	24	
Pūriri	3	—	14	5	14	—	36	
Rimu	—	—	—	—	5	—	5	Conifers (15%)
Tōtara	—	—	—	—	7	—	7	
Rimu/tōtara	1	—	—	—	—	—	1	
Mataī	—	—	4	3	—	—	7	
Kauri	—	—	—	—	16	—	16	
Totals	22	3	56	16	131	12	240	

them supplied 47–77% of the charcoal from the four excavation areas (Tables A2.1–A2.5). In fact, hebe alone supplied about 40% of the total assemblage. Combined with all other smaller woody shrubs, this charcoal represents nearly 70% of the total material identified.

Nearly 23% of the charcoal at Maungarei was from large broadleaf trees, the commonest being pūriri. If we assume that most of the material originally identified as kohekohe was, in fact, pūriri branch wood, then 85% of broadleaf tree charcoal was from this one species. Pūriri is a large, long-lived tree strongly associated with the fertile soils sought out by both Māori and early European settlers of the northern North Island (Dykgraaf 1992, 1994). The lowland forests where it originally grew were largely cleared during Māori settlement but, unlike many other species, pūriri has a remarkable ability to survive clearance and to persist on the landscape (Dijkgraaf 1994: 111–113). I have identified pūriri from about 100 charcoal assemblages from archaeological

sites in the northern North Island, where it is usually both abundant and one of the only large tree species present in samples otherwise dominated by scrub and shrub species. At European arrival, pūriri was common in most coastal areas, even where bracken fern and scrub otherwise dominated the vegetation. It remains the most common mature native tree on the Auckland volcanic cones today. Other broadleaf tree species are present in only quite small numbers. These are tītoki (*Alectryon excelsus*), taraire (*Beilschmiedia tarairi*), tawa (*Beilschmiedia tawa*), rewarewa (*Knightia excelsa*), mangeao (*Litsea calicaris*), tōwai (*Weinmannia silvicola*), pōhutukawa (*Metrosideros excelsa*) and (probably) some kohekohe. This suggests there were at least some small stands of broadleaf bush in the vicinity.

Only 6% of the charcoal in the assemblage was from conifers. These were tānekaha (*Phyllocladus trichomanoides*), rimu, tōtara, mataī and kauri (*Agathis australis*). All are substantial trees and important sources of timber for

Table A2.6 Common and scientific names of species identified from Maungarei charcoal samples.

Common name	Scientific name
Bracken	<i>Pteridium esculentum</i>
Hebe	<i>Hebe</i> spp.
Coprosma	<i>Coprosma</i> spp.
Tutu	<i>Coriaria</i> sp. (probably <i>C. arborea</i>)
Kawakawa	<i>Macropiper excelsum</i>
Olearia	<i>Olearia</i> spp.
Fivefinger	<i>Pseudopanax arboreus</i>
Pseudopanax	other <i>Pseudopanax</i> spp.
Pittosporum	<i>Pittosporum</i> spp.
Mānuka	<i>Leptospermum scoparium</i>
Akeake	<i>Dodonaea viscosa</i>
Ngaio	<i>Myoporum laetum</i>
Kaikōmako	<i>Pennantia corymbrosa</i>
Porokaiwhiria	<i>Hedycarya arborea</i>
Toro	<i>Myrsine salicina</i>
Māpau	<i>Myrsine australis</i>
Māhoe	<i>Melicytus ramiflorus</i>
Kānuka	<i>Kunzia ericoides</i>
Ponga	<i>Cyathea</i> sp.
Vine	<i>Metrosideros</i> sp. (?)
Tawa	<i>Beilschmiedia tawa</i>
Taraire	<i>Beilschmiedia tarairi</i>
Rewarewa	<i>Knightia excelsa</i>
Mangeao	<i>Litsea calicularis</i>
Tītoki	<i>Alectryon excelsus</i>
Tōwai	<i>Weinmannia silvicola</i>
Pōhutukawa	<i>Metrosideros excelsa</i>
Kohekohe	<i>Dysoxylum spectabile</i>
Pūriri	<i>Vitex lucens</i>
Tānekaha	<i>Phyllocladus trichomanoides</i>
Rimu	<i>Dacrydium cupressinum</i>
Tōtara	<i>Podocarpus totara</i>
Mataī	<i>Prumnopitys taxifolia</i>
Kauri	<i>Agathis australis</i>

construction purposes. While in most cases it is impossible to determine if this charcoal derived from building timbers, it seems to be a likely scenario given the general composition of the assemblage.

There are small amounts of ponga trunk charcoal in the site. This material burns very poorly so is not likely to have been firewood but may well have been used as construction

material for kūmara pits. A vine species, probably a *Metrosideros*, also occurs in the site. Given the numbers of fences and other structures that would have needed to be lashed together, this is not a surprising occurrence.

Some of the most interesting aspects of the charcoal data are the absences from the assemblage. Pōhutukawa is a very common species in coastal Auckland today but is rather rare in the assemblage. If it had been a significant part of the local vegetation, it was no longer so during the occupation of the excavated areas of Maungarei. Its abundance in modern times on Auckland's cones may be due to deliberate planting.

Kānuka is another species that was not common in the assemblage. It is extremely common in native bush in the Auckland area today, where it has the role of the main pioneering woody species, which, as it matures, provides a nursery for regenerating forest. Clearly, forest regeneration was not a feature of the Maungarei landscape at the time the site was occupied. It is suspected that repeated firing of a bracken-dominated vegetation cover suppressed kānuka growth locally.

In summary, the charcoal assemblages from Maungarei strongly suggest that bracken fern and a limited suite of small woody shrubs dominated vegetation in the local area over the period when the site was occupied. While pūriri trees were abundant in the vicinity, only a few stands of bush that could be described as forest seem to have been present locally. It is clear that human modification of the vegetation had resulted in a largely open, non-forested landscape at this time.

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Exploring ‘the Rock’: Material culture from Niue Island in Te Papa’s Pacific Cultures collection

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ABSTRACT: The Pacific Cultures collection of the Museum of New Zealand Te Papa Tongarewa (Te Papa) holds around 300 objects from the island of Niue, including textiles, costumes and accessories, weapons, canoes and items of fishing equipment. The history of the collection is described, including the increasing involvement of the Niue community since the 1980s, key items are highlighted, and collecting possibilities for the future are considered.

KEYWORDS: Niue, material culture, collection history, collection development, community involvement, Te Papa.

Introduction

The Pacific Cultures collection of the Museum of New Zealand Te Papa Tongarewa (Te Papa) comprises objects from island groups extending from Hawai‘i in the north to Aotearoa/New Zealand in the south, and from Rapanui in the east to Papua New Guinea in the west. The geographic coverage is immense and, since the opening of the Colonial Museum (Te Papa’s first predecessor) in 1865, the collection has grown to around 13,000 objects. Since 1993, it has been separated from the Foreign Ethnology collection, of which it was previously part in both the Dominion and National museums, successors of the Colonial Museum (Davidson 1991). This was in recognition of the growing population of Pacific Islands people in New Zealand, and the need for the museum to represent their cultures and history in a significant way.

A long-term project to survey the Pacific Cultures collection began in 2007. This involves upgrading catalogue records, and describing, measuring and photographing each collection item for public access via the Internet through Te Papa’s Collections Online.¹ The survey of the Cook Islands collection has recently been described by Hutton *et al.*

(2010). Here, we take the opportunity to document and publish some of the rich and untold stories resulting from the Niue collection survey, offering a new resource for researchers and the wider Pacific community.

The Niue collection comprises 291 objects. The survey has revealed an interesting history of collecting and provided insight into the range of objects that make up Niue’s material culture. This paper surveys this small but significant collection, and identifies key objects and acquisitions over the 145 years of the museum’s history.

From 1865 until the mid-twentieth century, acquisitions of artefacts from Niue were passive and largely consisted of donations. Niue material was not systematically sought until the 1970s, when a scientifically focused expedition to the island resulted in a major collection of natural environment specimens and a few cultural items. By the 1980s, Niueans themselves were beginning to contribute to the collection, and to their own representation within the museum context.

Objects in the collection represent different aspects of Niuean life and culture from more than 150 years ago to the present, and from fishing to warfare and dance. The collection, from various sources, consists mainly of katoua



Fig. 1 Maka (throwing stone), Niue, c. 1800s, stone. Artist unknown. Gift of Reverend John Inglis, 1869 (Te Papa FE002241).

(clubs), kato (baskets), lei (necklaces) and tao (spears). Hiapo (tapa cloths) and tiputa (ponchos), both made from the beaten inner bark of the paper mulberry tree (*Broussonetia papyrifera*), also called hiapo, are significant rare examples of textiles. Historically, research interest in Niuean objects has centred mainly around such textiles.

The acquisition of Pacific objects by explorers, visitors, missionaries, officials and traders was part of the documentation of cultures in the region, which began in the eighteenth century. The amount of information about individual objects in the collection varies considerably. For the most part, we are fortunate to have information about the previous owner(s), how and where the object was acquired, and whether it was sold or donated to the museum. The earliest documented Niuean object in Te Papa's collection is a maka (throwing stone), a weapon that was historically used in warfare (Fig. 1). This was presented by Reverend John Inglis (1808–91) in 1869, four years after the opening of the Colonial Museum in 1865 under the directorship of Sir James Hector (1834–1907).

Most of the Niuean objects are made from natural materials that are also present in other Pacific Islands, such as pandanus (*Pandanus* spp.) leaves, paper mulberry bark, wood and bast fibre from the fou, or hibiscus (*Hibiscus tiliaceus*). However, some items are uniquely Niuean and have important cultural associations and functions. Although some objects are ordinary in composition and their value is not always recognised by collectors, it is important to explore their functions and value within Niuean culture. As this paper will show, Te Papa's Niue holdings present stories of people, places and intersecting histories.

Geography and history of Niue

Niue is an elevated coral atoll with fringing coral reefs encircling steep limestone cliffs (Kinsky & Yaldwyn 1981: 7). It has a landmass of 259 km² and its coast is peppered with many caves and beautiful chasms (Lay 1996: 23). The small island nation lies 2400 km northeast of New Zealand in a triangle between Tonga, Samoa and the Cook Islands (Fig. 2). The name Niue translates as 'behold the coconut'. The island was formerly known as Niue fekai (Savage Island) as a result of an acrimonious meeting in 1774 between Captain James Cook and local people. It is now popularly called 'the Rock of Polynesia'.

Niueans are Polynesians whose language is most closely related to Tongan. Archaeologists believe the island was first settled about 2000 years ago, probably from Tonga, although place-names and traditions suggest some arrivals from Samoa as well, perhaps a little later (Walter & Anderson 2002: 119).

Reverend John Williams of the London Missionary Society (LMS) visited Niue in 1830 and attempted, unsuccessfully, to introduce native teachers from Aitutaki (Smith 1903: 83). After several further unsuccessful visits, Niuean Peniamina returned to the island in 1846 to begin work after training at the LMS school in Samoa, and was joined in 1849 by Samoan missionary Paulo (Lange 2006). The first resident European missionary, Reverend William Lawes, arrived in 1861. A year later, Peruvian slave ships descended on the small island and kidnapped 109 people to work in guano mines and on plantations in Peru (Lal & Fortune 2000; Scott 1993: 24).

Between 1888 and 1889, King Fata'aiki and King Togia, fearing annexation by other colonial powers, petitioned Queen Victoria three times for Niue to be declared a British protectorate. The offer was formally accepted in 1900 but was short-lived, and in 1901 the island was placed under New Zealand rule (Thomson 1902; Scott 1993). In May 1900, Premier Richard Seddon and some of his family had visited several Pacific Islands, including Niue (Tregear 1900: 93), where he met King Togia (Fig. 3). His visit was carried out to draw support for the anticipated annexation of Niue and the Cook Islands in 1901.

Though Niue had been grouped with the Cook Islands for the purpose of administration, this was not acceptable to Niueans. A Council of Representation of the 11 villages of the island was established in 1901 and passed Niue's first draft ordinances. The first Resident Commissioner arrived

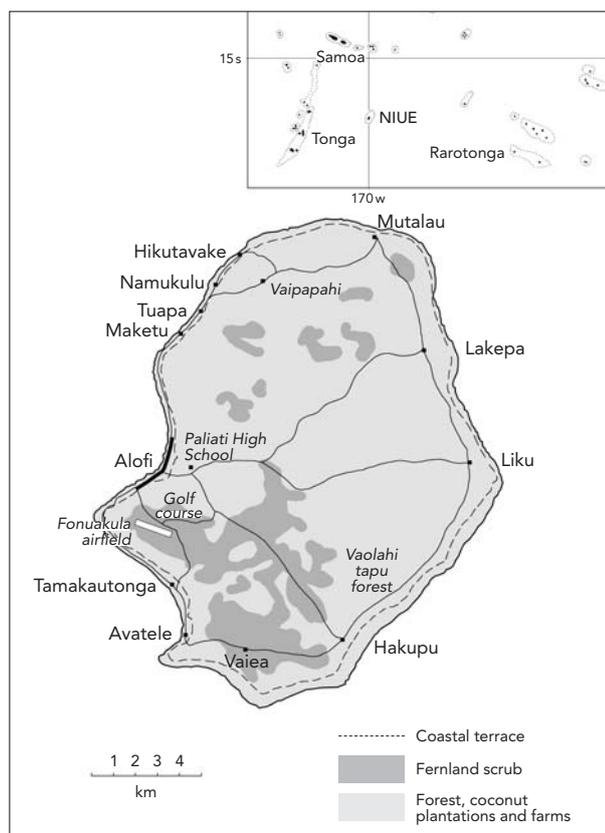


Fig. 2 Map of Niue (sourced from Kinsky & Yaldwyn (1981)).

in 1902 (Scott 1993) and became President of the Island Council.

In 1914, Niue became involved in the First World War. Some 149 men of the Niuean contingent eventually became part of the New Zealand Expeditionary Force, which served in Egypt and France (Pointer 2000: 29). In 1974, Niue became politically independent in free association with New Zealand, under the 1974 Niue Constitution Act. In 2006, the Niuean population was the fourth-largest Pacific Island group in New Zealand, numbering 22,476 (Statistics New Zealand 2006). There are now more Niueans living in New Zealand than on Niue itself.

Taoga Niue (Niue treasures) – key objects and acquisitions

Historically, research on Niue has involved a number of disciplines: botany (Yuncker 1943; Sykes & Yuncker 1970; St John 1976; Mabberley 1989), ornithology (Kinsky & Yaldwyn 1981; Watling 2001), terrestrial vertebrate biology (Wodzicki 1969), ichthyology (Rensch 1994), history (Ryan

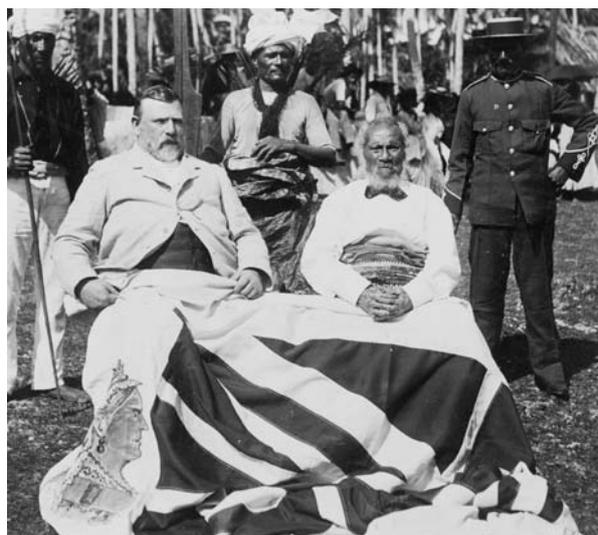


Fig. 3 Premier of New Zealand, Richard Seddon, and King Togia, Niue, 1900 (photo: Frederick W. Sears (active 1890s and early 1900s); Alexander Turnbull Library, Wellington, PA1-q-633-19-1).

1984), economic development studies (Haas 1977), human conflict studies (Pointer 2000), political science (Thomson 1902; Chapman 1976), archaeology (Trotter 1979; Walter & Anderson 2002), language studies (Tregear 1893; Tregear & Smith 1907; McEwen 1970) and ethnography (Smith 1903; Loeb 1926; Kooijman 1972). However, studies of material culture have been limited to some mentions in the ethnographic and archaeological studies, and in a recent study of hiapo by Pule & Thomas (2005). The present paper is the most recent survey of material culture since Loeb's study in 1926, although it is restricted to material culture as represented in Te Papa's Niue collection.

Te Papa's database records for the Niue collection are far from complete, thus cross-referencing with the museum archives and collection registers has been essential to ascertain as much information as possible about each object, person or institution. Fortunately, we have been able to find new information that has been added to the database records and provided invaluable insight into Niue's history, and its historical relationship to New Zealand and other Pacific Island countries.

As mentioned above, Niuean objects have made their way to the museum's collections since 1865 from various sources and by various means rather than through active collecting (see Appendix). In the early twentieth century, these sources included auction houses such as J.H. Bethune & Co. Ltd in Auckland and J.F. McKenna in Wellington.

The 1930s, when the museum was under the directorship of Walter R.B. Oliver, was a formative acquisition period, with many artefacts acquired from government officials working in the colonial territory of Niue, and in departments such as the Cook Islands Department and the Department of External Affairs. Between 1940 and 1965, there were five acquisitions, including Niuean objects sourced from private collector William Oldman (1948), T.W. Kirk from the Masonic Lodge in Paraparaumu (1950), the Wellcome collection (1952), William Perry (1955) and P. Bowman (1964).

In the 1970s, the Dominion Museum Niue Science Expedition resulted in new acquisitions of Niuean objects, when John Cameron Yaldwyn (1929–2005), a museum staff member and later Director in the 1980s, returned with a number of cultural items. In addition, local New Zealand schools donated items. For example, in 1973 Wellington College gifted several artefacts from Captain Seddon's collection, which included a small number of Niuean objects.

Since the late 1980s, the Niuean community has featured more prominently in the development of the museum collection, with donations from Niuean groups and individuals, namely the Newtown-based Sia Kata Niue Women's Weaving Group; Reverend Langi Sipeli² and his wife, Mokatafoou; Moale Etuata; Moka Poi; and the Auckland-based Falepipi He Mafola Niuean Handcraft Group Incorporation. A number of objects gifted to the museum in 1999 by the late Jock McEwen, former Niue Resident Commissioner, greatly increased the Niuean collection. More recently, in 2005, a set of garments was acquired from New Zealand fashion designer Doris de Pont, the product of her collaboration with Niuean/New Zealand artist John Pule.

The following sections discuss Te Papa's Niue collection according to object type, and highlight the most significant acquisitions within each category. Although some of the items have never been displayed, the histories behind their acquisitions and journeys to the museum add important context to their presence in Te Papa.

Tekesitaila (textiles)

Textiles in the Niue collection are made from a range of fibres that give an indication of changes in Niue's textile industry. For example, textiles made from the inner bark of the hiapo tree were produced following Samoan missionary influence from the 1840s until the artform declined at the end of the nineteenth century. Examples of garments in



Fig. 4 Tiputa (poncho), Niue, c.1800s, bark, dye. Artist unknown. Purchased 1914 (Te Papa FE000289).

the collection made from bast fibre of the fou (hibiscus), date from the early 1900s and 1970s. Although there is a continuation in the use of fou, subtle changes were introduced with the application of commercial dyes around the turn of the twentieth century. In the same way, potu (mats) made from pandanus and banana (*Musa* spp.) fibre have undergone subtle changes with the use of wool as applied decoration, examples of which were acquired sporadically in the 1930s, 1980s and in 2001. In New Zealand in the last 20 years, raffia has become a widely used material incorporated into the design of Niuean costumes. The variation in materials over time provides insight into the continuity and change in Niuean textile tradition and creativity.

Hiapo (tapa cloths) and tiputa (ponchos)

In the mid-nineteenth century, Samoan missionaries from the London Missionary Society are said to have taught Niueans Samoan methods of making tapa (Neich & Pendergast 1997: 69). Little is known about Niuean hiapo

before that time, although there are accounts of Niueans wearing hiapo as a loincloth (Erskine 1853: 26). Niueans made hiapo by felting and layering pieces of tapa cloth together. The Tahitian-style tiputa (Fig. 4), introduced to Niue by the Samoan missionaries, were worn as a form of modesty to cover the upper body (Thomas 1999: 10).

By the late 1800s, Niueans had created their own indigenous style of decoration, using a distinctive freehand approach in applying dye (Kooijman 1972: 288). Dyes were extracted from trees or plants, such as the soot of the tuitui, or candlenut tree (*Aleurites moluccana*). Hiapo makers incorporated motifs and designs representing shapes of plants and humans into their compositions, which invoked human interaction with the natural environment. There are also abstract designs comprising chevron and geometric patterning. Some hiapo were very large, as shown by an example from the Oldman collection, which measures 3650 mm long by 1820 mm wide.³ The use to which hiapo such as this were put is unclear, and they were virtually non-existent by the early 1900s. Following his visit to Niue in 1901, Percy Smith (1840–1922) attributed the decline in tapa making to the disappearance of the paper mulberry owing to the lack of cultivation of the tree, and to the introduction of European cloth to the island (Smith 1903: 64). Several attempts have been made in recent years to revive the art of tapa making, including an attempt by the University of the South Pacific in the 1970s, when a competition was held to encourage the revival of hiapo (Anonymous: 1979). In the 1990s, further attempts were made to revive hiapo and several pieces were made.⁴

Augustus Hamilton (1853–1913), Director of the Dominion Museum from 1903 to 1913, privately collected some important examples of Niuean hiapo and tiputa.⁵ These extraordinary pieces were acquired by the museum from his wife, Hope, following Hamilton's sudden death in 1913, although there is no record of how he had acquired them. They were probably created in the mid- to late nineteenth century, and although the natural materials are fragile, they have remained largely intact. It is possible that some of these examples were collected when Hamilton attended the New Zealand International Exhibition of Arts and Industries (1906–07) in Christchurch, because a Niuean group had travelled to New Zealand (along with Cook Islands and Fijian groups) to participate in the exhibition (Davidson 1997). Among the Niuean contingent was Frank Fata'aiki, whose father had been king of Niue (Anonymous: 1906).

Another possible source of Hamilton's pieces is the New Zealand and South Seas Exhibition held in Dunedin in 1889–90, as Hamilton had moved with his family to the city in 1890 to take up his position as registrar of the University of Otago (Dell 2007). The catalogue of the South Seas Exhibition includes, amongst other objects from Niue, a 'Splendid piece of figured tapa, waist-belt made from human hair, coconut-leaf fans bound with human hair' from Reverend Frank E. Lawes (Hastings 1891: 245). Frank, brother of Reverend William Lawes, the first European missionary to settle in Niue, in 1861, himself arrived in Niue in 1868 (Garrett 1982; Lange 2006). Over a century later, at the opening of the Niue International Airport in 1971, a hiapo that had been presented to Reverend William Lawes in Niue during the 1860s was returned to the island, where it was presented to Niue Premier Robert Rex by Duncan MacIntyre, New Zealand Minister of Island Affairs (Anonymous: 1972, 29 January). The hiapo had been kept by a family in the Port Chalmers area and had been acquired by Roger Duff, then Director of Canterbury Museum, from an American working at the University of Otago. It is interesting to note that the hiapo had been sourced from Dunedin, and may well have been obtained at the South Seas Exhibition, where Hamilton might have also acquired some of his hiapo.

In 1988, the National Museum purchased a rare hiapo made in the 1860s from the London auction house Christie's (Fig. 5). This rectangular-shaped piece was collected by British politician Cecil George Savile Foljambe, 1st Earl of Liverpool (1846–1907), on 29 June 1865, when he was an officer on board the HMS *Curacoa*, the second British naval ship to visit Niue (Ryan 1994: 154). In his account of the visit, Liverpool recorded that, on returning to Alofi village, 'I had some calico and fish-hooks, and buttons with me, so I exchanged them for a fan, and some tappa [tapa] or native cloth, which is made from the bark of the paper mulberry' (Liverpool 1868: 148). This example shows what was important in terms of commodities at the time, and perhaps provides an explanation for the presence of a large number of hiapo outside Niuean shores. Distinctive chevron and cross-hatching designs feature on this cloth. Recurring signatures are also visible on one corner: Iakopo and Kile Maleta. These names offer a clue about the possible makers or people who were once associated with the hiapo.

Another stunning hiapo in the Te Papa collection, probably made in the nineteenth century, was collected in the early 1900s by James Mason (1864–1924), a New



Fig. 5 Hiapo (tapa cloth), Niue, c.1860, bark, dye. Artist unknown. Purchased 1988, acc. no. 1988/37 (Te Papa FE008655).

Zealand medical doctor and public health administrator (Dow 2007). Eventually, it was acquired by the National Museum from Suzanne Duncan in 1987. This very fine hiapo, predominantly brown in colour, has a freehand decoration consisting of diamond-shaped motifs arranged in a concentric fashion. It is possible that Mason visited Niue on health duties for the New Zealand government.

These important examples of hiapo are inscribed with iconography that is now difficult to decipher. Nonetheless, Te Papa's small but significant collection has contributed to exhibitions and research on nineteenth-century Pacific textiles and clothing, such as Te Papa's exhibition *Traditional Arts of Pacific Island Women* (Davidson 1993). In 2005, hiapo from the museum's collection featured in *Hiapo: Past and present in Niuean barkcloth*, written by anthropologist Nicholas Thomas and artist John Pule, who refers to hiapo in his artwork (Pule & Thomas 2005). More recently, hiapo and tiputa were displayed in the exhibitions *Tapa: Pacific style* (September 2009–September 2010), and *Paperskin: The art of tapa cloth* (June–September 2010). Today, hiapo from

Niue are still some of the most rare and unusual examples of Pacific textiles and clothing.

Potu (mats)

In the nineteenth century, woven mats (generally called potu) had different functions, including use as sleeping and floor mats. There is very little documentation about the historical use of potu in Niue. However, from the early twentieth century Niuean weavers integrated wool into their work, as did mat weavers in Samoa. Over the years, the incorporation of woollen fringing has enhanced the aesthetic quality of the potu. For example, in 1936 Mrs S. Stirling gifted two mats to the museum. One is made primarily of banana leaf with sewn hibiscus-fibre attachments. The other, made from pandanus fibre, has double fringing of black, red, blue and purple wool.

In 1989, the Wellington Sia Kata Niue Women's Weaving Group presented to Te Papa a woven floor mat made of pandanus with blue, red, pink, and yellow woollen fringing. This was followed by more recent collecting from the



Fig. 6 Potu tanini (mat with a two-coloured pattern), Niue, 1997, pandanus leaf, wool. Artist Fasa Tongakilo. Purchased 2001, acc. no. HY2001/021 (Te Papa FE011676).

Niuean community, when four mats were purchased in 2001 from Mokatafoou Sipeli, wife of the late Reverend Sipeli, who had been a community advisor to the museum since the mid-1980s. Three of these are sleeping mats (Fig. 6) made by Mokatafoou's mother, Fasa Tongakilo, her sister Samoa Tohovaka, and her sister-in-law Fa'amatau Holo, while the floor mat was made by her sister Lapasi Paki. The most visually striking example is a potu tanini (mat with a two-coloured pattern) that was made by Tongakilo, with its array of blue and pink strips arranged in waves of colours. Mokatafoou had visited Niue in 1997 and received these mats as gifts. From these recent examples, it is clear potu continue to have an important use in Niue.

Tapulu (dance costumes)

The collection has several colourful Niuean costumes dating from around the turn of the twentieth century. Examples of titi (skirts) (Fig. 7) from the late 1920s were acquired from T.H. Cockerill in 1973. They had been collected by his father, H.W. Cockerill (Cockerill to National Museum, 30 May 1973), a telegraphic engineer for the General Post Office who helped install a wireless telephone station on

Niue (Anonymous: 1924). The titi he collected are made of natural hibiscus bast fibres dyed in pink, red and green, and decorated with rosettes. They indicate a preference at the time for dyeing natural materials. This is similar to Cook Islands dance costumes from the same period.

In the early 1990s, a child's female dance costume made of red-dyed hibiscus bast fibres was acquired. It had been made in Niue by Moale Etuata around 1970 (Fig. 8). A similar adult costume, woven from synthetic raffia by the same maker in 1993, was also acquired. Both costumes comprise a sleeveless, loosely woven bodice decorated with rosettes, to which are attached long tassels that cover the legs. Akele Etuata, Moale's daughter-in-law, described the process of making the tapulu in Niue:

it begins with the cutting of the fou (*Hibiscus tiliaceus*) branches, at about 2 metres in length. The bundle of sticks is then taken to the seacoast, where the sticks are placed in a deep pool to soak for two to four weeks. The fibre is then stripped and dried out. Once dry, each strip is rolled into a wheel. Natural or commercial dyes can be applied, after which the strips are dried before use, and made into a titi or used in combination with other materials for decoration. (Etuata to Hutton, 14 December 1998)



Fig. 7 Three titi (skirts) Niue, c. 1920s, hibiscus bast fibre, dye. Artist unknown. Purchased 1973, acc. no. 1973/39 (Te Papa FE006396, FE006397, FE006399).

The costumes are excellent examples of both the creative dyeing of natural materials and the incorporation of synthetic fibres by Niuean costume makers in recent years. With the increasing number of Niueans in New Zealand, weaving provides a chance to showcase creative work at events such as festivals, a source of income and a continued connection with home (Pereira *in* Mallon & Pereira 2002).

Fashion collaboration

Just as Pacific Islanders have incorporated western techniques and materials in their work, so Pacific designs and materials have also inspired European contemporary fashion designers and artists. In 2005, the museum purchased garments and accessories from the 2004 winter collection of Doris de Pont, a New Zealand fashion designer of Dutch heritage (Lassig 2010: 82). De Pont collaborated with artists John Pule and Margo Barton, using Pule's tapa print *Let's gather here* as the signature piece for the collection. Pule's print speaks of New Zealand's cultural mix and of the ingenuity and cooperation between artists. Now in Te Papa's collection, de Pont's garments and accessories provide a memorable example of high-end fashion with a contemporary Pacific artistic flavour.



Fig. 8 Tapulu fou (dress), Niue, c. 1970, hibiscus bast fibre, dye. Artist Moale Etuata. Purchased 1998, acc. no. HY1999/013 (Te Papa FE011197).

Tau kola fakamanaia sino (accessories)

Examples of accessories include the highly valued kafa lauulu (belts of human hair) that were made prior to European contact in the eighteenth century. There are also examples of kato (baskets), iliili (fans) and pulou (hats), dating mainly from the twentieth century. In 1960, the Niue Weavers' Association was established, involving a network of women in Niue and businesses in New Zealand through which the woven items they made were sold (McBean 1961). Since then, various Niuean community groups have been established around New Zealand, particularly in the main urban centres of Wellington and Auckland.

Kafa lauulu (belt of human hair)

Nineteenth-century accounts indicate that kafa lauulu (Fig. 9) were worn in Niue by toa, or warriors, as a sign of status (Loeb 1926: 93). These were highly valued items (Smith 1903: 63), displaying intricate work by their makers, as the plaited strands of hair fibre are extremely narrow. Kafa lauulu were also used to carry maka, as observed by missionary John Williams in 1830 (Moyle 1984: 40). The most valued belt was the kafa palua, made with feathers twined into the hair, which could take years for a skilled woman to complete (Smith 1903: 63). Kafa lauulu were wound tightly around the wearer, and for a more elaborate design, egg cowrie (*Ovula ovum*) shells were attached as a sign of status. Te Papa has four examples of kafa lauulu; two are from the Oldman collection, one of these (Fig. 9) measuring 800 mm in length. Another kafa lauulu, which belonged to Alexander Turnbull (1868–1918), comprises 180 strands of plaited hair (a single strand is just under 2 mm thick).⁶ Although their condition is delicate, the association of the kafa with battle and their skilful construction make these taoga significant pieces in the collection.

Kato (baskets)

The collection has around 30 kato, each with a specific function and its own distinctive design. Some are cylindrical in shape while others are oblong or rectangular. Two baskets that are unique in design were collected by Captain John Peter Bollons (1862–1929), whose extensive collection was purchased by the Dominion Museum from his widow in 1931 (McLean 2007; Hutton *et al.* 2010). Most likely made during the early twentieth century, one of these kato is circular in shape with a lid and is made using the tia (open-weave) technique from pandanus strips and coconut-leaf



Fig. 9 Kafa lauulu (belt of human hair), Niue, c. 1800s, human hair. Artist unknown. Oldman collection. Gift of the New Zealand government, 1992 (Te Papa OL002138/1).



Fig. 10 Kato (basket), Niue, c. 1930s, pandanus fibre. Artist unknown. Purchased 1931 (Te Papa FE007907).

midrib (Cole *et al.* 1996: 38). The other kato is narrow, elongated and oval-shaped, with red designs (Fig. 10).

During the 1970s Dominion Museum Niue Science Expedition, J.C. Yaldwyn acquired 13 kato, which are great examples of the style of that time (Fig. 11). Most of these baskets have price tags attached, indicating that they were acquired from a market in Niue. Some are Niuean-style



Fig. 11 Three kato (baskets), Niue, 1970s, pandanus, coconut midrib, hibiscus bast fibre. Artist unknown. Purchased 1971, acc. no. 1971/44 (Te Papa: left, FE006150; middle, FE006156; right, FE006157).

kato tupe (money purses), while others are oblong in shape with a folded-over lid. There are also strong oval ribbed baskets with 'V' handles for carrying heavy goods. In 1997, two unique kato laufa baskets were acquired, made by Elena Ikiua and Eseta Pati'i using harakeke (New Zealand flax; *Phormium* spp.) in a twill weave design.⁷

Iliili (fans)

Eleven of the 12 Niuean iliili in the collection are leaf-shaped in form, and were most probably made in the nineteenth century. These are made of coconut-leaf midrib and young coconut leaf. Braided human hair interwoven with fine pandanus strips has been lashed into the handle and base of the fans. Although Niuean in style and composition, iliili like these are very similar to those made in Samoa, probably because, as Loeb stated, the modern weaving of baskets had been taught by Samoans (Loeb 1926: 94).

In the 1970s, the Dominion Museum was involved in reviving the weaving technique of the old style of iliili, when an example from the Bollons collection was rediscovered by ethnologist Christine Mackay (Mackay 1972). At the time, that particular style of weaving no longer existed in Niue but, through a photograph shown to several Niuean villagers,



Fig. 12 Iliili (fan) replica of an old style, Niue, 1970s, coconut-palm leaf, wood, hair. Artist unknown. Gift of John Yaldwyn, 1972 (Te Papa FE006210).

an elderly lady recalled the forgotten skill. Subsequently, several replicas were made of Bollons' iliili, and Te Papa has one of the first of these in the collection (Fig. 12). The skilful preparation of the plant material to obtain the white colour is a lengthy task that involves drying the leaf over several weeks (Cole *et al.* 1996).

In 1999, the museum acquired a slightly different iliili, very similar to the Samoan style, made by Molima Pihigia, a member of the Falepipi He Mafola Niuean Handcraft Group Incorporation based in Otahuhu (Auckland). The circular fan is ornamented with feathers and is made from coiled coconut midribs lashed together by strips of dark brown pandanus. Falepipi was set up in 1993 as a way of reviving Niuean culture. In 2009, the group was awarded the Creative New Zealand Arts Pasifika Awards for its contribution to Pacific heritage arts (Anonymous 2010).

Pulou (hats)

A highlight of contemporary Niuean objects in the Te Papa collection is a pulou that often features in public talks given by museum staff. The panama-style pulou, made of woven plastic bread bags (Fig. 13), was acquired in 1999 from maker Moka Poi, who is based in Auckland. Poi designed the pulou using the flexible weave known as lalaga. She had worn the hat for many years before it was acquired by the museum. However, the development and introduction of biodegradable bread bags and their subsequent deterioration in storage has restricted the purchase of similar objects in recent years. As this example shows, the durability of modern materials can impact on acquisitions, and will require ongoing negotiation and further research by museum conservators.

Palahenga (feather adornment headpiece)

George Forster, in his account of Captain Cook's second voyage (1772–75), observed a toa wearing a feather ornament: 'His body was blackened as far as the waist; his head was ornamented with feathers placed upright, and in his hand he held a spear' (Forster 1777: 164). Percy Smith published the first ethnological survey of Niue, shortly after its annexation by New Zealand. Following his four-month stay on the island, he donated a palahenga to the museum,⁸ describing it as:

a sort of plume worn at the back of the head, and kept in position by a band of *hiapo* round the head. They are made with a core of dried banana bark, round which is wound strips of *hiapo* having scarlet feathers of the Hega parrot fastened on to them, and at top and bottom the yellow feathers of the Kulukulu dove are lashed on with



Fig. 13 Pulou (hat), Auckland, 1990s, plastic, nylon. Artist Moka Poi. Purchased 1999 with New Zealand Lottery Grants Board funds, acc. no. HY1999/030 (Te Papa FE011299).



Fig. 14 Skins of kulukulu, purple-capped dove (*Ptilinopus porphyraceus porphyraceus*) from Niue, held in the Te Papa bird collection (photo: Jean-Claude Stahl; Te Papa: top, OR.016392; bottom, OR.015827).

hair braid. From the top springs a plume of red and white Tuaki and Tuaki-kula feathers, making altogether rather a handsome ornament. (Smith 1903: 64)

The combination of feathers from the kulukulu (purple-capped dove, *Ptilinopus porphyraceus porphyraceus*; Fig. 14), henga (blue-crowned lorikeet, *Vini australis*) and tuaki (tropicbird, *Phaethon* sp.; Fig. 15, top left) would have made a striking headpiece (Kinsky & Yaldwyn 1981: 10). We were unable to locate this palahenga during the survey, but much of Smith's collection was presented to the Puke Ariki Museum in New Plymouth, where he lived until his death in 1922.⁹ Apart from Smith's 1903 description, not much else is known about the function of the palahenga in Niuean society, although it does appear to have been worn by men of rank (Kooijman 1972: 296).



Fig. 15 A selection of bird skins from Niue, held in the Te Papa bird collection. Left case, bottom left to top right: buff-banded rail, *Gallirallus philippensis goodsoni* (OR.017764, OR.017763); tuaki/tavake or white-tailed tropicbird, *Phaethon lepturus dorotheae* (OR.017773, OR.017778); purple swamphen, *Porphyrio porphyrio samoensis* (OR.016387, OR.016388). Top right case, upper: kulukulu or purple-capped dove, *Ptilinopus porphyraceus porphyraceus* (OR.017747, OR.017744, OR.017745, OR.017743, OR.016392, OR.016391, OR.015827); top right case, lower: white tern, *Gygis alba candida* (OR.016396, OR.016397). Bottom right case: Pacific pigeon, *Ducula pacifica* (OR.017749)(photo: Jean-Claude Stahl; Te Papa).

Lei (necklaces)

There are 15 lei in Te Papa’s collection. Three, all made from dyed fou, were part of the Cockerill collection. The remaining lei are more contemporary in design and are made from a combination of plastics. These were acquired from the Sia Kata Niue Women’s Weaving Group in 1996. On some of the lei, the women have incorporated plastic drinking straws using a variety of brightly coloured plastic strips. One lei in particular has intricate petal designs, made of white plastic.

Kanava akau (weapons)

The Niuean warfare collection consists of hand-held weapons that are made primarily from wood and stone. These objects suggest that in the nineteenth century Niue was a complex society familiar with warfare. When he visited Niue in the 1850s, Admiral John Erskine observed weapons that were ‘ornamented with a few feathers, the arrangement

of which ... represented the owner’s name, and enabled him to claim the credit of a successful throw in battle’ (Erskine 1853: 27). Loeb (1926: 131) states the feather decoration was made after the weapon had been used to kill someone. During the survey, similar ornamentations were discovered on a number of the Niuean weapons.

Maka (throwing stones)

When Captain Cook and his crew landed briefly on Niue in 1774, a stone thrown by a Niuean struck Swedish botanist Anders Sparrman on the arm:

At last a young man, to all appearance without a beard, stepped forward, and joined the first. He was like him blackened, and had a long bow, like those of Tonga-Tabboo, in his right hand. With the left he instantly flung a very large stone, with so much accuracy, as to hit Dr. Sparrman’s arm a violent blow, at the distance of forty yards. (Forster 1777: 164)

Sparrman described the stone as 'a large lump of coral' (Sparrman 1953: 129). It was most probably a *maka*, which were usually made of stalactite material found in caves, and thrown without the use of a sling (Smith 1903: 60). These lemon- and oval-shaped stones were made in Niue prior to European contact, and were painstakingly polished to be used as effective weapons. *Maka* were the first weapons used against an enemy, followed by *katoua* (clubs) at close range (Loeb 1926: 130). Names given to *maka* depended on the material used and/or the place of extraction, such as the forest or caves (Loeb 1926: 129).

The Te Papa collection includes 12 *maka*. Eleven were collected by New Zealander Sir Joseph Kinsey, who was a member of the Polynesian Society in the early twentieth century. On his death in 1936, his collection was gifted to the museum by his wife, Lady Sarah Kinsey. The twelfth *maka*, described above (Fig. 1), is made of highly polished calcite. It was probably collected during Reverend Inglis' brief visit with Reverend George Turner to several Pacific Islands, including Niue, in 1859 (Turner 1861: 516). Inglis and his family were from Scotland and worked in New Zealand for the Reformed Presbyterian Church of Scotland and the Free Church of Scotland in the 1840s, before moving to Vanuatu in 1852 (Inglis 1887).

Tao (spears)

Te Papa's Pacific spear collection totals 1074 items, not all of which are identified and attributed to island groups. The Niuean collection of *tao* ranges from points to full-length spears. Captain Cook narrowly escaped injury when a *tao* was thrown at him during his encounter with Niueans (Forster 1777: 166). At least by the early twentieth century, the spear point was often made of a different piece of wood from that used for the shaft, and each *tao* had its own name (Loeb 1926: 129). Usually made from heavy dark wood (Fig. 16), the *tao* could measure up to 2 m long, and at times barbs were attached to the tapering point (Montague 1921: 82). During warfare, *tao* were hurled at the enemy, this requiring tremendous skill and accuracy (Loeb 1926: 131). If the thrower missed his target, the spear point would sometimes break off, thus making the weapon ineffective and preventing the enemy from reusing it (Edge-Partington 1996: 64).

In 1935, G.O.L. Dempster, a medical doctor who worked in Niue in the early 1930s, gifted five *tao* to the museum (Oliver to Dempster, 19 September 1935; Dempster to Oliver, 21 September 1935). In 1973, eight spear points and two full-length *tao* were acquired from Wellington College, some of which National Museum Director Richard K. Dell



Left Fig. 16 Tao (spear), Niue, c. 1800s, wood, feather, sennit, hair. Artist unknown. Oldman collection. Gift of the New Zealand government, 1992 (Te Papa OL002092/1).

Right Fig. 17 Katoua (club), Niue, c. 1800s, wood, sennit, human hair. Artist unknown. Gift of William Perry, 1955 (Te Papa FE002988).

noted were 'of high quality' (Dell 1974). The collection had been donated to the college at the turn of the twentieth century by Richard John Seddon (1845–1906), New Zealand's Premier from 1893 to 1906 (Hamer 2007), in memory of his son Thomas Edward Youd Seddon, who had been a pupil at the school (National Museum 1973–74).

Katoua (clubs)

In recent times, the katoua, a long club or cleaving club, has become an iconic symbol representing identity and culture for many Niueans. Used in festival and school performances, it is a Niuean object unique to the island (Fig. 17). These weapons measure between 900 mm and 1800 mm in length and were used like the Māori taiaha (Smith 1903: 60). Miles (1938: 19) described the katoua as a 'formidable' weapon, though he questioned how 'one could cleave a man's head' with it. According to Loeb (1926: 130), the katoua was a piercing weapon, used after the initial throwing of the maka. Made from brown wood, katoua have a central sharp ridge along the length of the blade on both sides; the butt end is pointed, with a collar on the rounded shaft (Montague 1921: 82). Shark teeth were often inserted into the katoua (Loeb 1926: 130), although we have not observed any examples of this type.

In 1948, the New Zealand government purchased a number of important Pacific objects from English collector William Ockelford Oldman (Neich & Davidson 2004; Waterfield & King 2006), including four Niuean katoua. Although provenance details associated with the objects are sketchy, the name 'Lavakula' is legible on one of them. Lavakula was a noted Tongan warrior, probably a descendant of Tongan invaders to Niue, who was alive at the beginning of the eighteenth century (Loeb 1926: 144). This particular katoua may have been associated with his family or village. Another of Oldman's katoua was associated with 'the giant chief Tareka', who was described as being 'seven feet' (2.1 m) tall. A label on this weapon specifies that it had been presented to 'General Wynyard',¹⁰ which may refer to Robert Henry Wynyard (1802–64), a soldier, administrator and provincial superintendent (Rogers 2007) who may have travelled to the island.

Upon inspection, a number of katoua were discovered to have incised designs at the butt end of the shaft, and a few had wrapped sennit (coconut-husk fibre), feathers, egg cowrie shells,¹¹ and braided human hair wound around the lower part of the shaft. According to archaeologist Michael Trotter, egg cowrie shells were commonly found in burial caves on Niue and were also used for ornamentation (Trotter

1979: 14). As a result of close examination of the feathers, Hokimate Harwood (Te Papa's Bicultural Science Researcher) was able to identify some of the feathers attached to both katoua and tao as being from the belly of the kulukulu, or purple-capped dove (Fig. 14), the tail of the henga, or blue-crowned lorikeet, and the back of the lupe, or Pacific pigeon (*Ducula pacifica*; Fig. 15).

One important aspect of the collection survey is that it provides an opportunity to initiate remedial treatment on damaged items. Previously, the katoua were individually stored in plastic bubble-wrap as a result of two movements of the collection between different storage locations in the 1990s. As each weapon was unwrapped for surveying, it was discovered that a number of them appeared to have mould. Using a soft-bristle brush, SP removed the mould and swabbed the entire katoua with ethanol and deionised water to prevent further outbreaks. Once the treatment was completed, the katoua were returned to the Pacific collection storage area and mounted on mesh racking, which ensures good air circulation and allows visual monitoring.

Feua faofao sino (recreation)

Some examples of tika (darts) are in the Niue collection, the majority acquired from Jock McEwen in 1999, Resident Commissioner to Niue in 1953–56. According to Loeb (1926:117), historically the game of tika was a favourite sport in Niue, and Davidson (1936) states that darts were used in a game in many parts of the Pacific. In the nineteenth century, tika was played by men and was considered a test of strength and skill. The dart is propelled like a javelin at a relatively low trajectory, the aim being to make it slide when it hits the ground, and can travel up to 100 m depending on the throw. In the late twentieth century, the game was played on Niue when villagers gathered on special occasions such as Mother's Day. At the beginning of the twenty-first century, tika is slowly being introduced to New Zealand by the Niuean community in Auckland.

Palau (drum)

In 1995, a palau made from a British Paints tin was acquired from Reverend Sipeli. The drum had been made on Niue by Jo Saulo, where it was used by children in the village parade on New Year's Eve. Like Moka Poi's bread-bag hat (see p. 111), the palau and the non-indigenous materials from which it is made has been a popular and surprising item for public talks and display.



Fig. 18 Model vaka (canoe), Niue, date unknown, wood, shell, sennit. Artist unknown. Provenance unknown (Te Papa FE012240).

Takafaga ika (fishing)

Fishing in the Pacific region has ceremonial associations, but it is also key to survival. During his four-month stay in Niue, Smith observed the tremendous fishing skill and expertise of Niuean people (1903: 65). Objects in Te Papa's Niue collection associated with fishing include canoe bailers, paddles, fishhooks, fish arrows, a fish-killing knife, fishing spears, octopus lures, a *Ruvettus* hook and sinkers. Although these objects cover a wide range of fishing methods, there is room to collect more material.

The single *Ruvettus* hook, acquired from the Wellcome collection in 1952, is made from a wooden hook (about 23 mm long) lashed to the shank with sennit. Hooks such as these in Niue and Tuvalu were generally used for catching large fish like sharks (Koch 1983: 39). Netting traps are not included in the collection, although at the turn of the twentieth century Smith observed Niueans engaged in making fishing nets called kupenga, night fishing using hulu (torches) to catch flying fish, and fishing in deep water with a hook and line (Smith 1903: 65). The torches were made from kafika wood (Loeb 1926: 96). Ika (fish and sea mammals) caught in Niue reported by Smith comprised a great variety of important species, including whale, shark, swordfish and bonito, and turtles, land and sea crabs and shellfish were also abundant (Smith 1903: 25). During the Dominion Museum Niue Science Expedition in the 1970s, Alan Baker observed a range of fishing methods, including gill netting, spear fishing, reef fishing and offshore fishing, although at times fishermen were using modern technology (Baker to Resident Commissioner, 8 February 1973).

Vaka (canoes)

Niuean vaka were typically dugouts, with a hama (outrigger) attached, and very similar to Samoan va'a (Smith 1903: 65; Haddon & Hornell 1975: 278). European visitors to Niue in the mid-nineteenth century observed the use of the vaka heke fa, a canoe that seated four people (Erskine 1853: 26; Liverpool 1868: 147). According to Te Rangi Hiroa (Sir Peter Buck), the vaka hull was made from the '*moota*, a dark-red wood of strain grain, resembling *totara*', although a tree with a bend was preferred as it was less likely to split (Hiroa 1911: 91). Historically, canoes called vaka heke ono that could seat six people were produced, although they had become rare by the twentieth century (Loeb 1926: 91).

As described by Loeb (1926: 92), the torpedo-shaped Niuean vaka comprises a main body, hama, kiato (outrigger supports) and 12 tutuki (small sticks) that are fastened to the kiato (Fig. 18). Two fulinafi (sticks) form a platform on the kiato, and five puke (inside supports) were used to break the force of the waves (Loeb 1926: 91). Oral history tells us that these vaka were used for travel to Tonga, Samoa and New Zealand (Loeb 1926: 91). However, Haddon & Hornell (1975: 279) argue that a trip of that length would have required a double vaka in order to carry sufficient provisions for the duration of the voyage.

Te Papa has four full-scale Niuean vaka. According to J.D. Gray, then Secretary of the External Affairs Department, three were deposited in the Dominion Museum in 1926 from the South Seas Exhibition held in Dunedin in 1925–26. Two of these belonged to the department and one was Gray's personal property (Gray to Director of the



Fig. 19 Tuapa Landing, Niue, 1886–87 (photo: Thomas Andrew; Te Papa C.001516).

Dominion Museum, 28 July 1926). The department had exhibited Pacific objects from its Island territories – the Cook Islands, Niue, Samoa and Tokelau – at the exhibition. These included fruits, woven items, adornment pieces and canoes (Thompson 1927: 74). Of the three full-scale vaka, we have been unable to determine which was Gray's personal property and which belonged to the department.

Government officials based in the Pacific Islands often accumulate collections over time, an indication of relationships formed with the locals and their interest in the culture. The late Jock McEwen, former Resident Commissioner to Niue from 1953 to 1956, donated the greatest number of acquisitions of Niuean artefacts, first in 1972 and later in 1999. Author of the *Niue dictionary* (1970), McEwen was a respected member of the Niuean community. One of the items gifted was a full-scale vaka that McEwen had collected in 1953. The canoe measures 4160 mm long, 490 mm wide and 750 mm high,¹² and has an attached hama and two detached kiato. Originally painted light blue, and later painted red, the vaka is a modern version of the more customary style.

Apart from the full-scale vaka in the collection, there are 11 models of torpedo-shaped canoes, with incised designs on the main body of the hull. Often, small cowrie shells are

laced along the length of the vaka, a typical Niuean design element. However, one model appears to have nautilus shells attached to the hull.¹³ Two of the models were purchased at J.F. McKenna's auction sale held in Wellington in December 1929 (McKenna 1929). One surprise discovery made during the collection survey was a postage stamp, possibly from Niue or the Cook Islands, which was adhered to one model.

Niue-related material in other Te Papa collections

Although this paper is primarily concerned with the material culture of Niue in the Pacific Cultures collection, this is a useful opportunity to note other Niuean-related material in Te Papa's Art, Photography, History, Archives and Natural Environment collections.

Art

John Pule is a leading New Zealand artist of Niuean descent who, since 1988, has exhibited widely in New Zealand and overseas (Mallon & Pereira 1997). He is also a poet and writer, and some of his writing is incorporated in his artwork. Te Papa owns 13 works by Pule. The first of these works, *Tukulagi Haaku* (1994), was purchased by the museum in 1997 after it was showcased in the landmark



Left Fig. 20 Vaka making in Niue, 1972 (photo: Friedrich-Carl Kinsky; Te Papa CT.027508).

Right Fig. 21 Vaka making in Niue, 1972 (photo: Friedrich-Carl Kinsky; Te Papa CT.027510).

exhibition *Bottled Ocean* (1994). Subsequently, in 1998, 10 prints titled *Burn my Head in Heaven* (1998) were acquired, which link to Pule's novel of the same title. More recently, in 2001, Te Papa acquired *I was Born in the Pacific Equinox* (2001) to document a shift in style in Pule's practice, in which the artist used new colour, composition and imagery. In 2010, a large-scale work was acquired for the collection titled *Shark, angel, bird, ladder* (2008). Pule's work continually references his heritage, which plays a key part in his art practice.

Recently, print works by Sale Jessop (an early contemporary of Pule, now based in Niue) were obtained as part of the Auckland-based Muka Studio archive acquisition. At the time of writing, these were undergoing processing.

Photography

Te Papa's collection of Niue-related photographs covers about 100 years, from the 1880s to the 1990s. Some of these images were taken by recognised New Zealand photographers who were residing in the Pacific. One of the foremost of these is Thomas Andrew (1855–1939), who was largely based in Samoa (McCredie in McAloon 2009: 85) but travelled to Niue, Swains Island, Lukunor, Manihiki, Majuro and Ponape on the voyage of the schooner *Southerly Buster* in 1886. The trip was documented by Moss (1889). Andrew's black and white photographs of Niue date to 1886, and include the landing at Tuapa (Fig. 19), the interior of a

church, a plantation area, and a large group of people in front of a Niuean house. In 1903, New Zealand photographer Henry Winkelmann (1860–1931) accompanied members of the General Assembly who were visiting Pacific Island territories while he was working for the *Auckland Weekly* (Edwards 2007). His images include a photograph of King Togia.

In 1954, five black and white slide images of Niue were gifted to the museum by medical doctor Alex Rutherford. The slides had initially been acquired by his father, D.A.R. Rutherford, between 1918 and 1936 while he was working in Samoa.

During the 1970s Dominion Museum Science Expedition, coloured images were taken of vaka making by J.C. Yaldwyn, F. Kinsky (Figs 20 and 21), and A. Baker at Lalokafika on the Alofi–Hakupu road. Some of these photographs are now part of Te Papa's photography collection and can be viewed on the museum's Collections Online. They include the cutting down and shaping of the mooto tree (*Dysoxylum forsteri*) in thick bush by local Niueans, including Piavale and Dr Harry Nemaia, formerly Director of Health in Niue and a respected vaka maker. There is also an image of food being prepared in the bush area, which Te Rangi Hiroa observed was an important Niuean custom (Hiroa 1911: 91). Food for the workers was placed on the ground to the right of the bow (mata ono vaka) and had to be eaten straight away so as to forecast a successful fishing

expedition. These images are a useful documentation of a process that has not hitherto been captured visually.

In 1999, Glenn Jowitt sold to the museum photographs relating to his documentary work with the Niuean community in Niue from 1982 to 1996. Some of these images were published in a book titled *Polynesia: here and there* (Jowitt 1983). Jowitt's images capture a number of places and special ceremonies in New Zealand and in the Pacific Islands. In 2001, images taken by renowned photographer Brian Brake (1927–88) were gifted to Te Papa by Raymond Wai-Man Lau (McCredie 2010). Brake *et al.* (1979) published the book *Art of the Pacific*, which includes images of Niuean hiapo from Auckland War Memorial Museum's Tamaki Paenga Hira collection.

History

Significantly, Te Papa's history collection holds two examples of the Proclamation of British Sovereignty over Niue, written in English and Niuean, and dated October 1900 and April 1901.¹⁴ Both documents were acquired from the Cook Islands Department in September 1931, as Niue was administered under that department until official separation in 1903. Made of paper and wood, the documents are fragile but remain important archival reference material.

Archives

Te Papa's archives section holds important documents, particularly about the 1970s Dominion Museum Science Expedition to Niue, and later work associated with another trip in the 1980s. A small exchange between Te Rangi Hiroa and Augustus Hamilton about possible Niuean acquisitions in 1913 is also documented in the archives, and there are documents and drawings relating to a Niue postage stamp design by Robert Conly (1920–95) from the 1970s.

Natural environment

The Dominion Museum Science Expedition to Niue in 1971–72 was organised by Dr John C. Yaldwyn, Assistant Director of the Dominion Museum (Baker to Resident Commissioner Niue Island, 8 February 1973; Anonymous 1972, 18 August). The team consisted of a number of scientists who, over a three-week period, collected biological specimens that were shipped back to New Zealand. Later research carried out on Niue was published in *The bird fauna of Niue island* (Kinsky & Yaldwyn 1981) and provided the Niue government with some recommendations on the local ecosystem.

The Natural Environment collection holds an extensive range of specimens from Niue, some of which were gathered

during the 1970s expedition: fishes (713), birds (167), crustaceans (150), fossil vertebrates (119), insects (6), land mammals (6), marine invertebrates (95), molluscs (675) and plants (2).

Engaging with the Niuean community

This survey of Te Papa's Niue collection has assessed objects relating to various aspects of Niuean life since the nineteenth century up to the present, such as textiles, fishing tackle, weapons, household goods and clothing. A Samoan influence seems evident in the design of vaka and in the development of mid- to late nineteenth-century tapa-cloth production. Although the collection has slowly expanded in each decade since the annexation of Niue by New Zealand in 1901, this paper reveals some noticeable gaps. One of them is material relating to the Niuean contribution to the First World War. Objects associated with this important event and the experiences of Niuean soldiers will be the focus of future acquisitions.

As we have seen, Te Papa's engagement with the Niuean community has influenced the collection. It began in the 1980s, with the acquisition of items such as costumes and mats. Wally Ranfurly and then Reverend Langi Sipeli made possible some collecting activity undertaken by museum staff following their roles as cultural advisors in the late 1980s. This engagement was further enhanced in November 2008, with the Nuku Tu Taha/Niue community day held at Te Papa to celebrate Niuean art and culture. The Te Papa events team, with the help of representatives from the Niuean community, organised the day's programme, which included a performance and workshop by the renowned Tau Fuata Niue dance group based in Auckland (Fig. 22). In the *Signs of a Nation* area of the museum, an arts and crafts village was organised for stallholders to sell goods and demonstrate some of their weaving. In order to reconnect the Niuean community with objects of the Niue collection, a community discussion panel was coordinated, involving elders who recalled the use and making of some of the items from the collections. It also provided a rare opportunity to display a full-scale vaka for visitors to view.

In 2009, the inaugural Niue Arts and Culture Festival was held on 'the Rock'. The organisation committee's hope is that the festival will continue an important dialogue between the homeland and the extended populations of Niueans abroad. Such festivals will provide an opportunity



Fig. 22 Tau Fuata Niue dance group performing at Te Papa, 2008 (photo: Jo Moore).

for the museum to collect and document contemporary changes in Niuean material culture. For example, in 2005 a complete Niuean female dance costume was acquired from Auckland Girls' Grammar School in Auckland. It had been worn in the ASB Bank Auckland Secondary Schools Māori and Pacific Islands Cultural Festival, the largest Polynesian dance festival of its kind in the world. Although not made in Niue, the costume is a significant representation of Niuean cultural practice and identity in New Zealand.

Conclusion

Te Papa's collection shows that Niue was, and is, far from being an isolated island. The survey has revealed the multiple relationships formed between people and the island in the last two centuries, some of which continue today. As we explored the Niue collection and the museum's stories, many surprises surfaced, showing that the survey has been a pivotal way of rediscovering history.

An interesting discovery was the lack of toki (adzes) in the Niue collection, but for one example, a toki ngenge (*Tridacna*-shell adze blade) donated by former Premier Robert Rex in 1972.¹⁵ According to Walter & Anderson (2002), toki in Niue were also fashioned from stone imported from places such as Samoa, while origins of other imported volcanic stones found in Niue archaeological sites are unknown. Although some of the material culture of Niue as represented in Te Papa's collection have links to Tonga and Samoa, this paper has highlighted that some material, such as the katoua, are uniquely Niuean.

A complete coverage of material culture from Niue in the collection is impossible, as museum collections are often influenced by staff interests and those of the wider community. Some gaps in the collection relate to the representation of examples of men's clothing, and musical instruments such as nose flutes and dance costumes. A challenge for curators and communities will involve finding ways to represent the Niueans living in New Zealand, whose cultural identities are often connected and expressed through school performance groups, church groups and sports clubs. The material culture of these associations will be an area of future collecting for the museum. Aspects of intangible culture are another important area where museums can improve their documentation. The Niue community day held in Te Papa in 2008 demonstrated that Niuean culture can be vividly expressed in intangible as well as tangible forms in the museum environment. The museum is a venue that can facilitate expressions of intangible culture, whether it is dance and song, story-telling or oral history, as well as displays of weaving and craft making. These activities will require an ongoing relationship with the Niuean community, including discussions around the recording and documentation of the events for future generations.

Although the main focus of collecting at Te Papa is on Niueans in New Zealand, it is important that the museum continues to track cultural events in Niue, which remain a rich source of history and culture for Niuean people. This survey of material culture reveals a long-term and well-documented relationship with Niue that bodes positively for the future. Further research could be extended to surveying Niue collections within other institutions in New Zealand and abroad, which would help to expand on the histories presented here and provide a better understanding of Niue and its people.

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Notes

- 1 See <http://collections.tepapa.govt.nz>.
- 2 The late Reverend Langi Sipeli was involved in consultations relating to the Museum of New Zealand development project in the 1980s. Later, he became a member of Te Papa's Wellington-based Pacific Advisory Group. During this time he facilitated some acquisitions of Niue material culture.
- 3 Hiapo (tapa cloth), Niue, nineteenth century, bark cloth. Artist unknown (Te Papa FE007754).
- 4 Examples of hiapo from a late 1990s revival were exhibited at the Arch Hill Gallery in Grey Lynn, Auckland, New Zealand (Cross to Mallon, 17 June 2010).
- 5 One of Hamilton's tiputa, made from the inner bark of the paper mulberry tree, featured in 2010 on *Tales from Te Papa*, a TVNZ6 documentary on selected items of the museum collection.
- 6 Kafa (belt), Niue, human hair, c. 1800. Artist unknown (Te Papa FE000861).
- 7 Kato laufa (bag), Wellington, 1997, flax, Elena Ikiua (Te Papa FE010938); Kato laufa (bag), Wellington, 1990s, possibly synthetic material, flax, Eseta Pati'i (Te Papa FE010939).
- 8 Palahenga (feather adornment headpiece), Niue, c. 1800s, feathers. Artist unknown (Te Papa FE000078).
- 9 During the research for this paper, contact was made with the Puke Ariki Museum, New Plymouth, New Zealand, about the possibility of viewing Smith's collection. However, the collection was inaccessible as an audit was in process.
- 10 Katoua (club), Niue, wood, c. 1800. Artist unknown (Te Papa OL000169.S/8).
- 11 Shells identified by Bruce Marshall, Collection Manager

Mollusca, Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand.

- 12 Vaka (canoe), Niue, wood, date unknown. Artist unknown (Te Papa FE006240).
- 13 Model vaka (canoe), Niue, wood, date unknown. Artist unknown (Te Papa FE002276).
- 14 Proclamation, October 1900 (Te Papa GH003144); proclamation, April 1901 (Te Papa GH003145).
- 15 Toki ngenge (*Tridacna*-shell adze blade), Niue, date unknown, shell. Artist unknown (Te Papa FE006233).

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Appendix: A timeline of 'documented' acquisitions of objects from Niue

Name	Year	Accession number	Number of Niue objects	Person/role/institution/location
Reverend John Inglis	1869	—	1	Missionary
New Zealand Philadelphia Exhibition Commission	1876	—	1	Wellington, New Zealand
Stephenson Percy Smith	1902?	—	1	Resident agent and scholar on Niue culture
Augustus Hamilton (purchased after his sudden death in 1913)	1914	—	3	Director, Dominion Museum
Hope Hamilton (gift of E. Vickery 1880)	1914	—	1	Wife of Augustus Hamilton
J.H. Bethune and Co. Ltd	1916	—	3	Auction house, Wellington, New Zealand
Alexander Horsburgh Turnbull	1918	—	1	Administrator, collector
Ellen Hutchin	1919	—	1	Wife of Reverend John Hutchin
Sir Francis Rose Price	1927	File 10/2/11	2	Unknown
J.F. Mckenna's Sale	1929	—	7	Auction house, Wellington, New Zealand
Cook Islands Department	1929	—	3	Government department, New Zealand
Otago Museum (exchange)	1930s?	—	11	Dunedin, New Zealand
Mrs Lilian Bollons	1931	1931/55	6	Wife of Captain John Bollons
Edward Ellison (deposited)	1931	—	9	Medical doctor
G. Dempster	1935	1935/103	5	Medical doctor
G. Dempster	1935	1935/112	2	Medical doctor
Lady Sarah Kinsey	1936	1936/113	2	Wife of Sir Joseph Kinsey
Mrs S. Stirling	1936	1936/19	2	Unknown
Department of External Affairs	1938	1938/42	5	Government department, New Zealand
W. Bell	1939	1939/23	1	Probably Captain William Bell, a military officer who was Resident Commissioner for Niue in 1931–41
William Oldman	1948	—	12	Collector, England
T.W. Kirk (Masonic Lodge, Paraparaumu)	1950	1950/123	1	Biologist, scientific administrator
Wellcome collection	1952	1952/193	1	Collection of Sir Henry Wellcome, pharmacist and collector
Ian Reid	1954	—	1	Unknown
William Perry	1955	1955/168	2	New Zealand politician
P. Bowman	1964	1964/174	1	Unknown
Wellington City Council (loan)	1968	1968/78	1	Wellington, New Zealand
John C. Yaldwyn	1971	1971/44	21/23	Museum curator

continued on following page

Continued from previous page

Name	Year	Accession number	Number of Niue objects	Person/role/institution/location
John C. Yaldwyn	1971	1971/80	2	Museum curator
John C. Yaldwyn	1972	1972/31	1	Museum curator
Robert Rex	1972	1972/65	1	Former Niue Premier
Jock McEwen	1972	1972/92	1	Former Niue Resident Commissioner
Thomas H. Cockerill	1973	1973/39	16	Son of H.W. Cockerill
Wellington College	1973	1973/82	12	Wellington, New Zealand
Gisborne Art Gallery and Museum	1975	1975/22	2	Gisborne, New Zealand
Lady Celia Rowley	1980	1980/4	3	Daughter of Viscount Galway, former Governor General of New Zealand
Erskine College	1986	1986/13	4	Wellington, New Zealand
Suzanne Duncan	1987	1987/28	3	Unknown
Christie's Auction House	1988	1988/37	1	Auction house, London, England
Niuean Women Weavers	1989	1989/21	1	Newtown, Wellington, New Zealand
Reverend Langi Sipeli	1995	HY1995/028	3	Cultural advisor to Te Papa
Flagmakers	1996	HY1996/042	1	Company, Wellington, New Zealand
Sia Kata Niue Women's Weaving Group	1996	HY1996/049	12	Newtown, Wellington, New Zealand
Missionary Sisters of the Society of Mary	1996	HY1996/052	1	Nukualofa, Tonga
Akele Etuata	1996/1999	HY1999/013	2	Daughter-in-law of Moale Etuata
Government House	1997	HY1997/065	4	Wellington, New Zealand
John C. Yaldwyn	1997	HY1997/064	4	Museum curator
Pacific Craft Centre	1997	HY1997/063	1	Porirua, Wellington, New Zealand
Moka Sipeli	1997	HY1997/067	5	Wife of Reverend Langi Sipeli
Reverend Langi Sipeli	1999	HY1999/012	1	Cultural advisor to Te Papa
Falepipi He Mafola Niuean Handcraft Group Inc.	1999	HY1999/020	3	Auckland
Moka Poi	1999	HY1999/030	1	Weaver, Auckland
Jock McEwen	1999	HY2000/011	26	Former Niue Resident Commissioner
Moka Sipeli	2001	HY2001/021	4	Wife of Reverend Langi Sipeli
Doris de Pont	2005	HY2005/004	11	Fashion designer
Mitchell Estate	Unknown	—	1	Unknown
Unknown	Unknown	—	53	Unknown
? Moore	Unknown	—	1	Unknown
L. Taylor	Unknown	Cross-reference 2695	1	Unknown
G. Dowling	Unknown	—	1	Unknown
Total			291	

Identification and description of feathers in Te Papa's Māori cloaks

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ABSTRACT: For the first time, scientific research was undertaken to identify the feathers to species level contained in 110 cloaks (kākahu) held in the Māori collections of the Museum of New Zealand Te Papa Tongarewa (Te Papa). Methods of feather identification involved a visual comparison of cloak feathers with museum bird specimens and analysis of the microscopic structure of the down of feathers to verify bird order. The feathers of more than 30 species of bird were identified in the cloaks, and consisted of a wide range of native and introduced bird species. This study provides insight into understanding the knowledge and production surrounding the use of materials in the cloaks; it also documents the species of bird and the use of feathers included in the cloaks in Te Papa's collections from a need to have detailed and accurate museum records.

KEYWORDS: Māori feather cloaks, kākahu, cloak weaving, birds, feathers, harakeke, microscopic feather identification, barbule, nodes, New Zealand.

Introduction

The Museum of New Zealand Te Papa Tongarewa (Te Papa) houses more than 300 Māori kākahu (cloaks), of which 110 incorporate feathers. Fully feathered cloaks such as kahu kiwi (kiwi-feather cloaks), kahu kura (kākā-feathered or red cloaks) and kahu huruhuru (feather cloaks) are documented. The remaining cloaks have feathers in the borders or in small bunches, such as in korowai (cloaks that may have hukahuka, or two-ply flax-fibre tassels) and korowai kārure (cloaks with unravelling two- or three-ply flax-fibre tassels) (Fig. 1). Feathers were also identified in kaitaka (finely woven cloaks with tāniko, or colour geometric patterns, along the borders) and pihepihe (cloaks with cylindrical flax tags) (Pendergrast 1987).

The finer Māori cloaks found in Te Papa's collections are generally produced by scraping the leaves of the harakeke (New Zealand flax, *Phormium* spp.), and then weaving the resulting muka (flax fibre) to create the foundation of the cloak (Pendergrast 1997: 6). The single-pair twining method (whatu aho pātahi) was employed for some coarser rain cloaks or capes, whereas the technique of double-pair twining

(whatu aho rua) was used to secure attachments such as feathers, and hence was chosen for more decorative cloaks (Pendergrast 1987: 14). The feathers were typically bunched or butted together and woven into the cloak as it was being made. By using the finger twining technique of whatu, the base of the feather shaft is secured to the vertical backing muka warps (whenu) using two pairs of smaller horizontal weft threads (aho rua), and the feather shaft is then bent back on itself to hold it in place (Te Kanawa 1992: 34).

Fragments of a seventeenth-century Māori cloak from a burial site in Strath Taieri in Central Otago were first described by Hamilton (1892: 487) and later discussed by Simmons (1968: 6), who suggested that, judging from the presence of weka (*Gallirallus australis*), albatross (family Diomedidae) and moa (order Dinornithiformes) skin and feathers sewn and roughly attached to the fragments, the cloak was a prestige item. The find also exemplifies the change of birds and feathers used in Māori cloaks over time, which is seemingly dependent on the materials available, the preferred bird species, and the knowledge, skills and innovation of the weaver at the time of production.



Fig. 1 Korowai kārure (cloak with unravelling flax-fibre tassels) (Te Papa ME014388).

Literature documenting nineteenth- and early twentieth-century Māori feather cloaks mentions primarily the following endemic New Zealand species: brown kiwi (*Apteryx* spp.), New Zealand pigeon (kererū, *Hemiphaga novaeseelandiae*), kākā (New Zealand bush parrot, *Nestor meridionalis*), parakeet (kākāriki, *Cyanoramphus* spp.) and kākāpō (night parrot, *Strigops habroptilus*) (Hiroa 1911: 84). Feathers from weka and the now extinct hūia (*Heteralocha acutirostris*) have also been used in kākahu (Te Kanawa 1992: 25). From the latter half of the nineteenth century onwards, striking geometric designs incorporating feathers from newly introduced exotic birds such as peafowl (*Pavo cristatus*), helmeted guinea fowl (*Numida meleagris*) and, later, pheasant (*Phasianus colchicus*) and domestic chicken (*Gallus gallus* var. *domesticus*) (Pendergrast 1987: 107) were sometimes mixed with feathers from declining native bird species.

Since the foundation of the Colonial Museum in 1865, Te Papa's cloak collection has grown, through gifts, loans, donations and acquisitions. Much of the information regarding the origins and materials used in these items was either not obtained or has been lost before their inclusion in the

collection. In addition, the origin of feathers used in a large number of cloaks has remained scientifically unverified until now. Various publications on Māori cloaks and bird lore indicate that at least 27 native and eight introduced bird species were used in kākahu after 1800. It is currently accepted that all of the cloaks with feathers studied were produced post 1800. The study and description of microscopic features of feathers from New Zealand birds and a comparison of cloak feathers against identified museum bird skins have facilitated the identification and verification of the bird species used in Te Papa's Māori cloaks for the museum's permanent records. It also enhances our knowledge of the avifauna utilised by Māori, as well as how this has changed with the protection of native bird species, and introduction of American and European game birds.

The identification of feathers from microscopic structures in the down was established by American scientists like Chandler (1916), who studied feather structure and its taxonomic significance among birds. Day (1966) examined feathers and hair microscopically from the gut contents of stoats in the British Isles to identify prey remains. More

recently, scientists from the Smithsonian Institution have used downy structures of feathers and comparisons with museum bird skins to identify feather remains resulting from US Air Force bird strikes (Laybourne & Dove 1994). Microscopic analysis of feathers has also been used to identify birds in textiles from international anthropological and archaeological studies (Dove & Peurach 2002; Rogers *et al.* 2002; Dove *et al.* 2005). It has also been applied successfully in museum collections to infer the possible provenance (or geographic origins) of collection items (Dove 1998; Pearlstein 2010). Dove & Koch (2010) have described the key diagnostic features of feathers for the major bird groups occurring in forensic ornithology.

Microscopic feather identification in New Zealand is still in its infancy. At the date of publication there is no national microscopic reference database of the features that characterise the feathers of New Zealand bird species. Fast alternative methods requiring less accuracy have been used over microscopic identification – such as studying reference collections of feathers to identify New Zealand falcon (*Falco novaeseelandiae*) prey remains (Seaton *et al.* 2008). A national molecular database of some New Zealand birds has assisted in the identification of birds from their DNA for historical and conservation purposes (Shepherd & Lambert 2008; Seabrook-Davison *et al.* 2009), and the identification of emu (*Dromaius novaehollandiae*) feathers in a rare Māori cloak (Hartnup *et al.* 2009).

Microscopic analyses and DNA profiling have been employed successfully to determine the origin of feathers in ethnological collections in overseas studies. Isotopic analysis of feathers, a science new to New Zealand, has also proven effective, with isotope mapping tools used to geo-locate bird origins in international research (Hobson *et al.* 2007). These scientific methods have varying degrees of accuracy and present conservation issues relating to the extraction of materials for analysis.

Materials, methods and conventions

In Te Papa's Māori collections, 110 feathered cloaks were examined using microscopic feather analysis and comparisons with museum bird skins. Feathers from at least 24 native and introduced birds, including species and subspecies, were identified in the cloaks (Table 1). Where possible, bird species were identified with accuracy by comparing whole cloak feathers against museum bird skins. For cloak feathers with

little or no morphological characters (i.e. white, black or brown feathers), and feathers that required verification, the bird groups they belong to were identified by comparing diagnostic microscopic structures. Finally, a combination of the two techniques – microscopic characters to determine the bird order and whole-feather identification from museum skins to identify the species/subspecies – were used. It was estimated that for each cloak the number of bird species from which feathers were obtained ranged between one and eight, with an average of three different bird species per cloak. The number of species, as well as the number of individual birds used, depended on the size of the birds, the types of feathers used, the number of feathers butted or bunched together, and ultimately the size and design of the cloak.

A list of potential bird species was prepared, and a database of feather images was created from museum skins, including species names, sex, age and colour variations (see Fig. 2). Owing to the size and fragility of the cloak and bird skin collections, and their location in separate buildings, it was logistically more suitable to use an image database to compare cloak feathers with birdskin images. This is contrary to other methodologies utilised by the Smithsonian Institution, where direct comparison of unknown feathers with the skins themselves is preferred.

Detached feathers from bird skins were collected, and the species and feather types recorded to create a reference database of microscopic images of the feather down, and to compare them with fallen cloak feathers. Detached cloak feathers that had been collected and bagged over time (a common museum practice) were used for microscopic identification of some cloaks. These feathers were checked and verified that they had originated from the corresponding cloak based on their size, colour and pattern, if applicable.

Identification methods utilising museum skins and microscopic feather analyses were favoured over other techniques owing to the accuracy required, and the time and monetary restrictions in identifying such a large number of cloaks. These techniques were also preferred as they did not involve any destruction of the collection items.

Downy barbs extracted from contour feathers of a verified museum skin were dry-mounted onto glass slides, and examined using light microscopy (Leica DM500 at 40×, 100× and then 400× magnifications). Images were captured using a fitted microscope camera (Leica ICC50), and the Leica LAS EZ program was employed for processing images and recording measurements. Similarly, detached cloak feathers

Table 1 Native and introduced (*) bird species/subspecies identified in Te Papa's Māori cloak collection, by numbers of cloaks with at least one feather of the listed species. (Total number of cloaks = 110)

Bird species	Number of cloaks with listed species
Brown kiwi – <i>Apteryx</i> spp. ^A	52
New Zealand pigeon, kererū – <i>Hemiphaga novaeseelandiae</i> (Gmelin, 1789)	45
Kākā, bush parrot – <i>Nestor meridionalis</i> (Gmelin, 1788) ^B	43
Tūi, parson bird – <i>Prosthemadera novaeseelandiae novaeseelandiae</i> (Gmelin, 1788)	35
Domestic chicken, heihei – <i>Gallus gallus</i> var. <i>domesticus</i> (Linnaeus, 1758)*	25
Common pheasant, peihana – ♂ <i>Phasianus colchicus</i> (Linnaeus, 1758)*	15
Peafowl (peacock) – ♂ <i>Pavo cristatus</i> (Linnaeus, 1758)*	13
Weka, woodhen – <i>Gallirallus australis</i> (Sparrman, 1786) ^C	12
Pūkeko, swamphen – <i>Porphyrio melanotus melanotus</i> (Temminck, 1820)	11
Parakeet, kākārīki – <i>Cyanoramphus</i> spp. ^D	10
Wild turkey – <i>Meleagris gallopavo</i> (Linnaeus, 1758)*	5
Albatross, toroa – family Diomedidae ^E	4
Mallard – <i>Anas platyrhynchos platyrhynchos</i> (Linnaeus, 1758) ^F	4
Banded rail – <i>Gallirallus philippensis</i> (Linnaeus, 1766)	2
Long-tailed cuckoo, koekoeā – <i>Eudynamis taitensis</i> (Sparrman, 1787)	2
California quail – <i>Callipepla californica</i> (Shaw, 1798)*	2
Helmeted guineafowl – <i>Numida meleagris</i> (Linnaeus, 1758)*	2
Hūia – <i>Heteralocha acutirostris</i> (Gould, 1837)	2
Australasian bittern, matuku – <i>Botaurus poiciloptilus</i> (Wagler, 1827)	1
Kākāpō, night parrot – <i>Strigops habroptilus</i> (G.R. Gray, 1845)	1
Morepork, ruru – <i>Ninox novaeseelandiae novaeseelandiae</i> (Gmelin, 1788)	1
Swamp harrier, kāhu – <i>Circus approximans</i> (Peale, 1848)	1
Shining bronze-cuckoo, pīpīwharaua – <i>Chrysococcyx lucidus</i> (Gmelin, 1788)	1
Yellowhammer – <i>Emberiza citrinella</i> (Linnaeus, 1758)*	1

A North Island, Okarito, South Island and Stewart Island brown kiwi are included.

B North Island kākā and South Island kākā are included.

C North Island, western, buff and Stewart Island weka are included.

D Red-crowned, yellow-crowned and orange-fronted parakeets are included.

E All albatross species of the genera *Diomedea* and *Thalassarche* are included.

F All varieties that interbreed with *Anas superciliosa* are included.



Fig. 2 Feather types from bird skins from Te Papa's collection used in comparisons with whole cloak feathers: (a) belly feathers from an albino North Island brown kiwi; (b) rump feathers from a common pheasant; (c) underwing covert feathers from a North Island kākā; (d) back feathers from a kākāpō; (e) vent feathers from a long-tailed cuckoo; (f) throat tufts from a tūi.

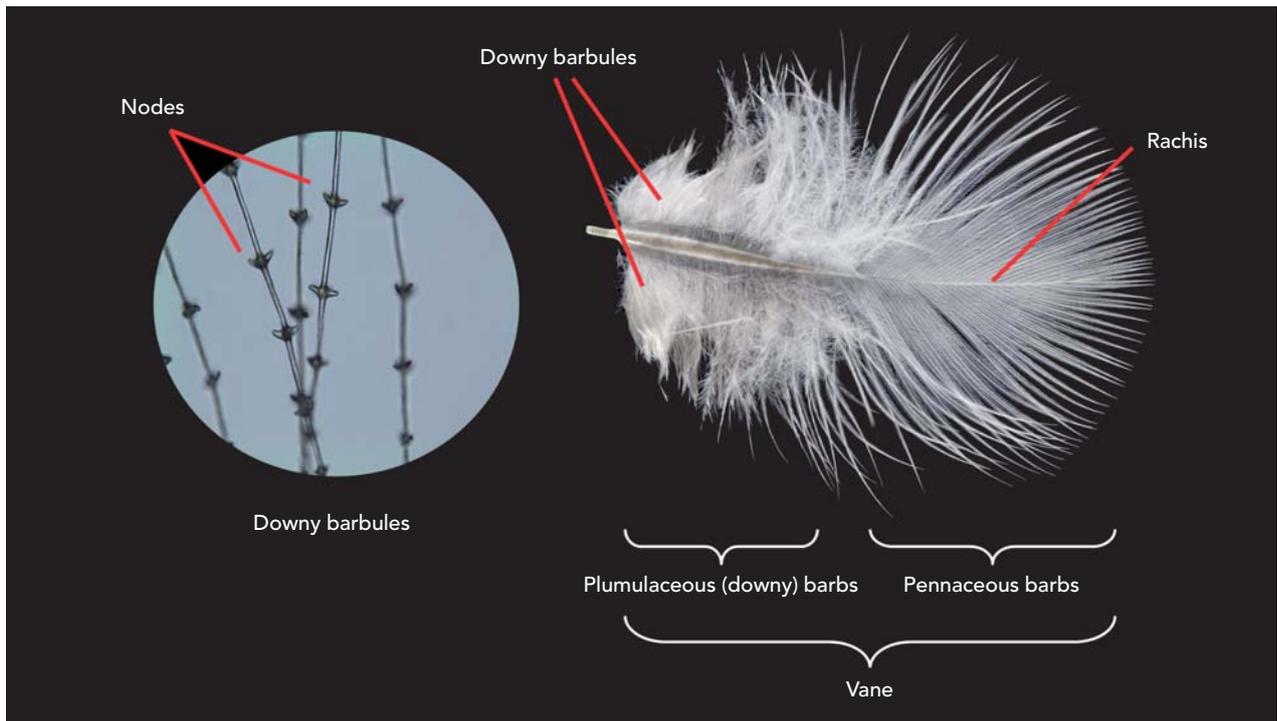


Fig. 3 New Zealand pigeon contour feather, showing pennaceous and plumulaceous (downy) barbs, and the nodes on downy barbules (photo: Raymond Coory).

were dry-mounted for microscopic analysis of their nodes, to place the feather within a bird order and, if possible, to identify the bird family or species/subspecies.

Contour feathers from adult skin specimens used for microscopic identification are described as feathers with ‘fluffy’ down at the base of the feather, a distinct central shaft or rachis, and vanes (barbs) on either side, covering the body of the bird (Marchant & Higgins 1990: 38; Dove 1997: 47) (Figs 3 and 4). Contour feathers can also be found in the wings and tail. The barbs at the tip of the feather are known as pennaceous barbs and have small hooklets that link together, providing structure to the feather. The downy structures at the base of the feather, the plumulaceous barbs, have perpendicular barbules attached (Dove & Koch 2010: 21), which provide insulation for the bird.

Most downy barbules have generally distinctive structures called nodes and/or prongs (see Figs 5–8). The length of the space between two nodes is measured as the internodal length (Dove 1997: 51). The average length and width of the downy barbules vary depending on the bird order. Additional parameters useful in systematic studies of feathers are size/shape, and, sometimes, the distribution of nodes

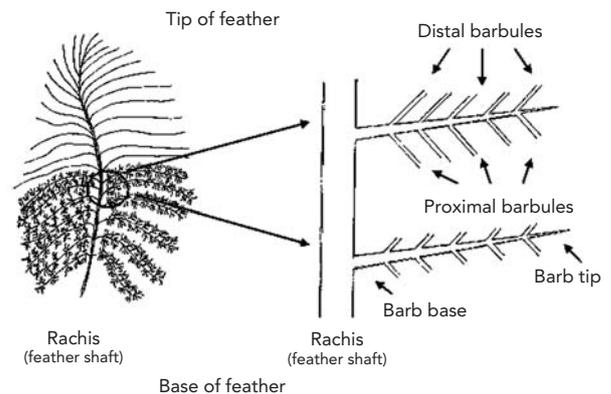


Fig. 4 Diagrammatic structure of a down feather, showing the orientation of barbules on barbs (modified from Day (1966) and Dove & Koch (2010)).

along the barbules. Pigmentation within the nodes and along the barbules is also variable among birds. These microscopic features were observed and recorded for each feather that was not identifiable by direct comparisons with museum skins.

Each feather sample was studied for nodal morphology, pigmentation patterns, length of barbules, presence of villi (transparent fringe-like projections on the base of barbules; Fig. 8e) and other diagnostic characters (e.g. rings, triangle-shaped nodes) that would allow identification of the group

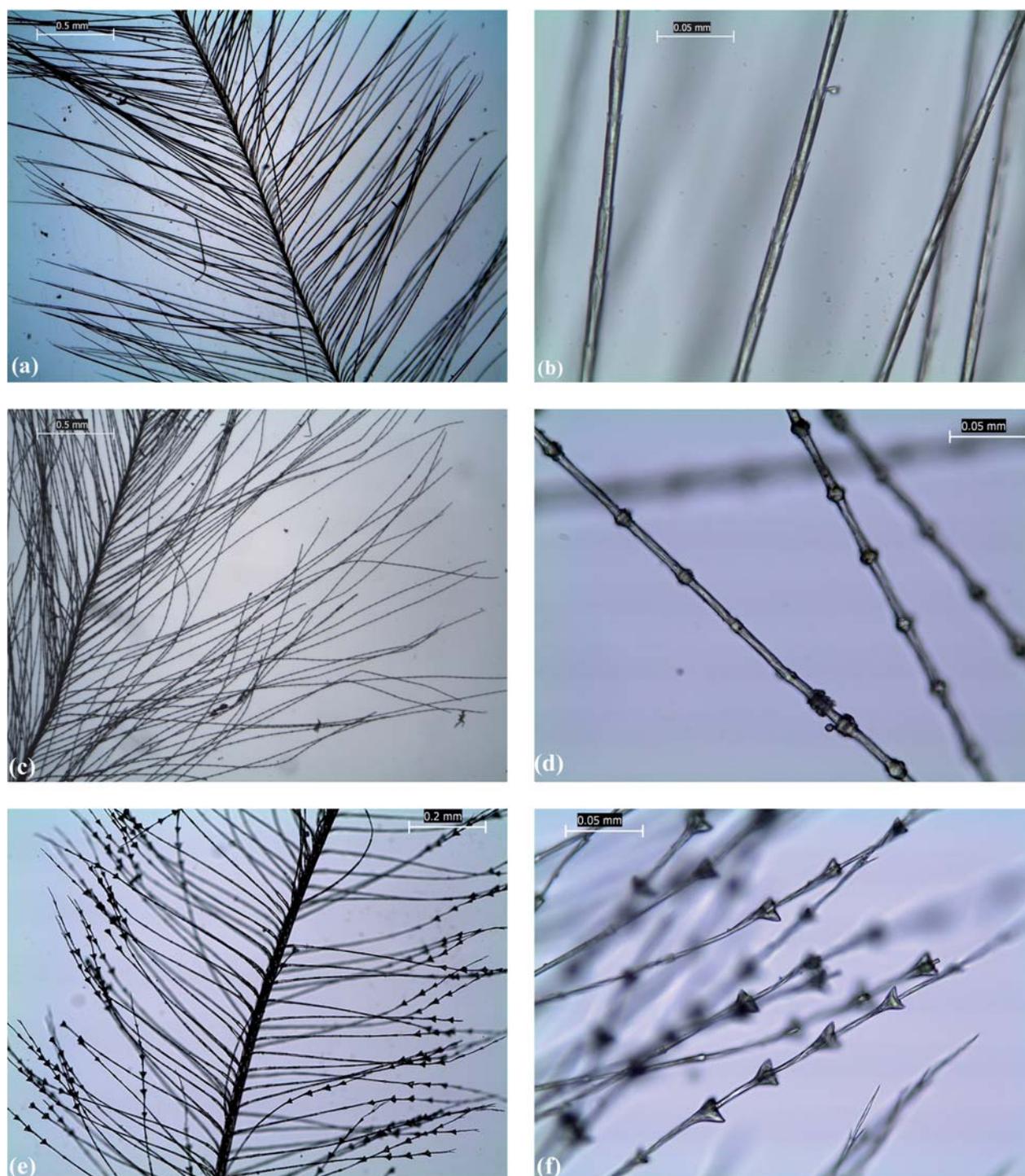


Fig. 5 Photomicrographs of downy barbules from New Zealand birds examined: (a) barbules from a North Island brown kiwi – Casuariiformes; (b) pronged nodes from a North Island brown kiwi – Casuariiformes; (c) barbules from a domestic chicken – Galliformes; (d) multiple ringed nodes from a domestic chicken – Galliformes; (e) barbules from a mallard – Anseriformes; (f) triangular nodes at the barbule tip from a mallard – Anseriformes.

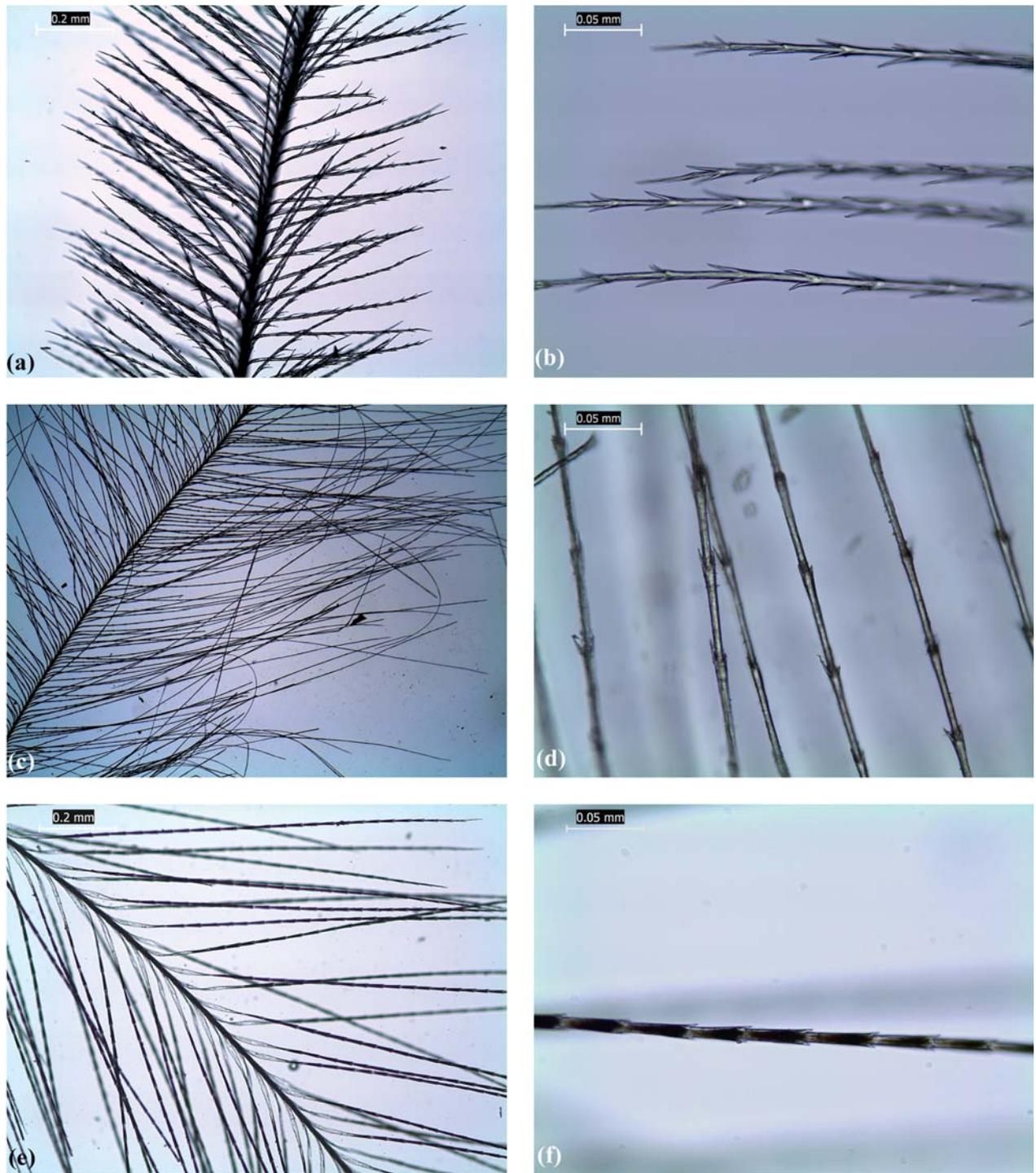


Fig. 6 Photomicrographs of downy barbules from New Zealand birds examined: (a) barbules from a Gibson's albatross – Procellariiformes; (b) pronged nodes from a Gibson's albatross – Procellariiformes; (c) barbules from a swamp harrier – Accipitriformes (40x); (d) asymmetric spined nodes from a swamp harrier – Accipitriformes; (e) barbules from a weka – Gruiformes; (f) internodal pigmentation from a weka – Gruiformes.

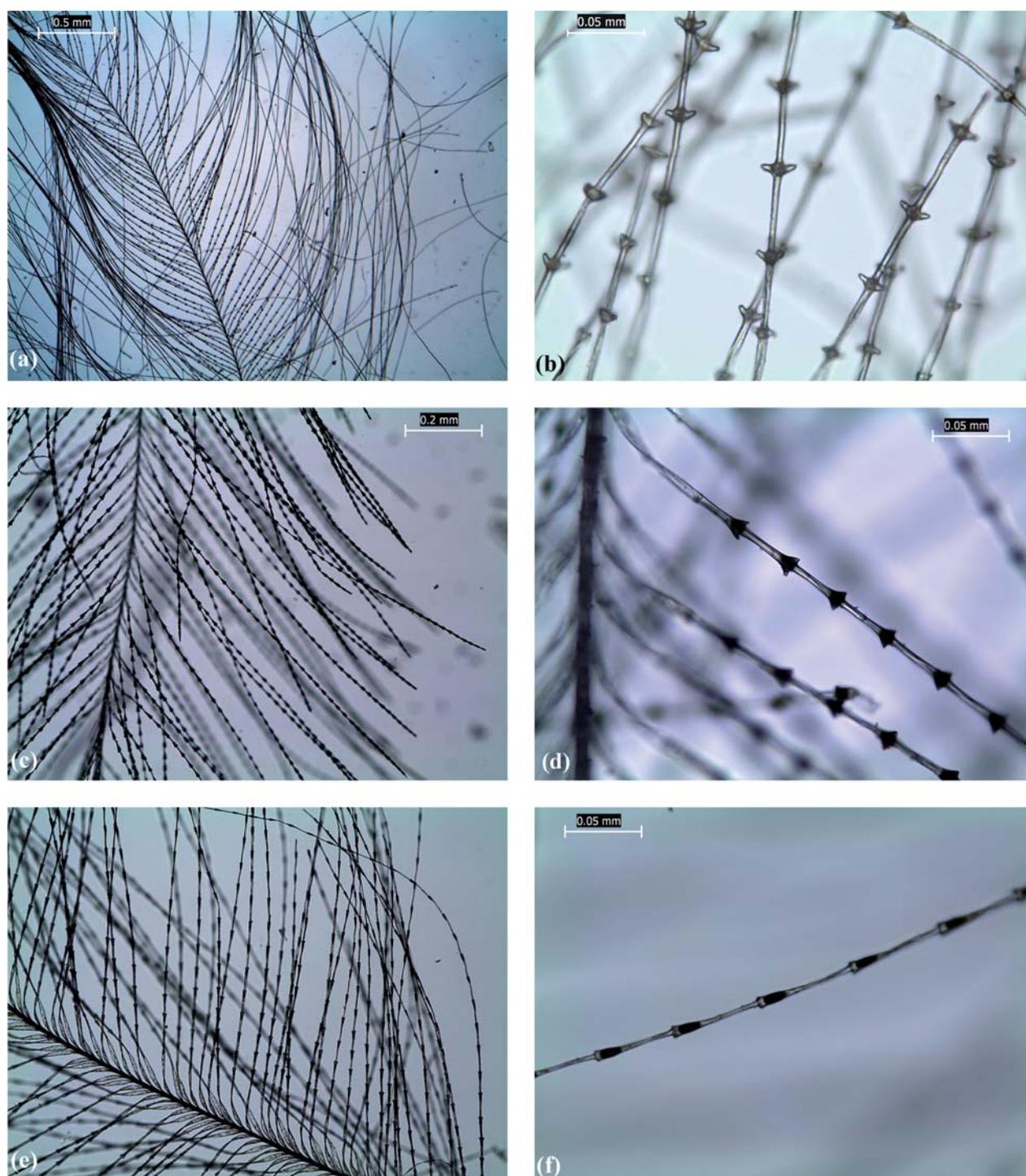


Fig. 7 Photomicrographs of downy barbules from New Zealand birds examined: (a) barbules from a New Zealand pigeon – Columbiformes; (b) crocus-shaped nodes at the barbule base from a New Zealand pigeon – Columbiformes; (c) barbules from a red-crowned parakeet – Psittaciformes; (d) expanded nodes at the barbule base from a red-crowned parakeet – Psittaciformes; (e) barbules from a long-tailed cuckoo – Cuculiformes (100x); (f) pre-nodal pigmented nodes from a long-tailed cuckoo – Cuculiformes.

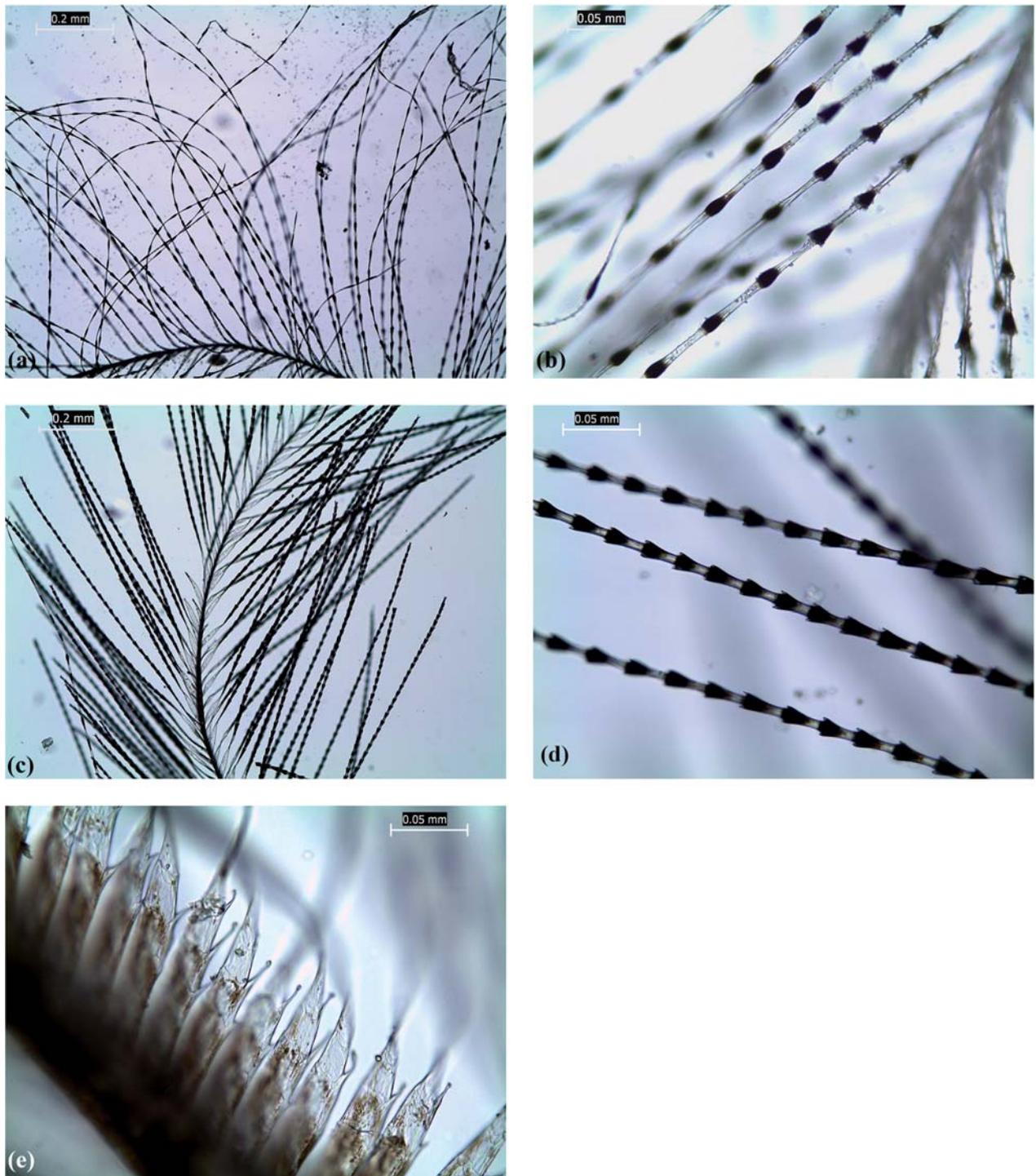


Fig. 8 Photomicrographs of downy barbules from New Zealand birds examined: (a) barbules from a morepork – Strigiformes; (b) large pigmented nodes at the barbule base from a morepork – Strigiformes; (c) barbules from a hūia – Passeriformes; (d) closely spaced pigmented nodes from a hūia – Passeriformes; (e) villi at the barbule base from a hūia – Passeriformes.

of birds to which it belonged (Dove & Koch 2010: 21). As diagnostic features for bird orders may vary among species, feather types, and even between barbs and barbules on a feather, it was important to take several samples, and to use whole feathers for microscopic and museum skin comparisons where possible.

Methods and conventions for the identification of feathers in Te Papa's Māori cloaks follow those described by Chandler (1916) and Day (1966), while descriptions of nodes and pigmentation follow Dove & Koch (2010). Descriptions of feather colour follow Svensson (1992), and descriptions of feather type follow diagrams from Marchant & Higgins (1990). Bird nomenclature, vernacular names and sequence of orders for New Zealand birds follow the *Checklist of the Birds of New Zealand* (Gill *et al.* 2010).

Microscopic feather descriptions and their use in cloaks

There are 21 bird orders present in New Zealand (Gill *et al.* 2010). Feathers from 12 bird orders were identified in Te Papa's cloaks, and the use of species from each order is discussed below. Feathers from 11 bird orders were examined and identified microscopically; key diagnostic features of 16 feathers belonging to 16 bird species/subspecies from those 11 bird orders are summarised in Table 2. The use of different feather types is discussed with respect to their presence in Te Papa's Māori cloaks only. Similar feather types from museum skin species and those recorded in the cloaks have been microscopically examined. This is an initial attempt to describe the feathers of New Zealand bird orders at a microscopic level, and to document diagnostic feather characteristics for replication in future identification research.

Order Casuariiformes, family Apterygidae – kiwi

Kiwi are part of a group of birds known as ratites, which includes emus, cassowaries and moa. Kiwi belong to the family Apterygidae and comprise five species, three species of brown kiwi (including two subspecies) and two species of spotted kiwi (Gill *et al.* 2010: 19). It is inferred that feathers from the North Island brown kiwi (*Apteryx mantelli*) and South Island brown kiwi (*A. australis australis*) are present throughout the cloak collection. However, it was not possible to identify accurately the feathers of brown kiwi to species level using microscopy and comparisons with

museum skins alone. A feather from a North Island brown kiwi was microscopically examined to represent this group of birds, and to determine general features of brown kiwi feathers for cloak identifications. Diagnostic characteristics unique to this order are given in Table 2.

Kiwi feathers are hair-like and the barbs are long and filamentous. Chandler (1916: 293) described the microscopic features of feathers from a great spotted kiwi (*Apteryx haastii*) as having some downy barbs at the base of the feather, with small but distinct nodes and prongs present on barbules. Barbules were measured at 2–3 mm long in well-developed downy regions (Chandler 1916: 294). The microscopic examination of *A. mantelli* for this research confirmed similar characteristics within the family Apterygidae. The barbules are medium to long, transparent and flat at the base, tapering to thin and spindly (hair-like) at the tip (Fig. 5a). Nodes are minute and flat, sometimes with four short, symmetrical prongs that point towards the tip of the barbule (Fig. 5b). The tips of some barbules also have large prongs.

Brown kiwi feathers were identified in 52 of Te Papa's cloaks, with feathers fully covering the cloak (kahu kiwi) or applied in strips or small bunches. Kiwi feathers from the body of the bird, roughly uniform in size and colour, were recorded, with the larger, strongly coloured back feathers being more prevalent. Hiroa (1911: 84) also noted the preference of back feathers for kākahu. Most of Te Papa's kahu kiwi are woven to show the ventral side of the feather facing outwards, referred to as whakaarara by Hiroa (1911: 84), but five cloaks have feathers placed as on the bird, referred to as tāmoe by Hiroa (1911: 84). The calamus, or quill, at the very base of the feather is generally woven into the cloak using the muka aho (weft threads). In three cloaks, the tip of a single feather was woven into the cloak with the calamus pointing outwards.

Natural kiwi feather colours in the cloak collection range from white (albino), faded cream or off-white, to light brown, medium brown, rufous (reddish brown), dark brown and black-brown. Pure white (albino) brown kiwi feathers are defined as lacking any kind of pigmentation in the shaft, barbs or barbules (Fig. 2a). Albino feathers were recorded in seven cloaks, observed in patterns as strips, or as single feathers among other brown feathers (Fig. 9). Albino kiwi birds were present but rare in pre-1900 brown kiwi populations, and white kiwi feathers would have been highly coveted by Māori for their inclusion in kākahu. Albinism in kiwi ranged from single feathers to patches of white feathers

Table 2. Summary of microscopic examination of bird feathers identified in Te Papa's Māori cloaks.

Order, family and species/subspecies of bird feather specimens	Feather type and down description	Diagnostic features of feather	Pigment and node distribution on barbules
Order Casuariiformes Family Apterygidae North Island brown kiwi – <i>Apteryx mantelli</i> (Bartlett, 1852)	Brown back feathers. Barb sample from middle of down. Barbs are long to very long.	Barbules are medium to long and hair-like (Fig. 5a). Minute but distinct nodes with four small symmetrical prongs all along barbules that decrease in size (Fig. 5b). Longer prongs at barbule tip.	Little or no pigment in nodes and barbules. Nodes flat with small prongs all along barbules, these becoming thinner and fewer towards barbule tips.
Order Galliformes Family Phasianidae Domestic chicken – <i>Gallus gallus</i> var. <i>domesticus</i> (Linnaeus, 1758)	Black and white barred belly feather. Barbs are long, fine and dense. Barb sample from middle of down.	Barbules are long (Fig. 5c). Multiple ring-like structures surround nodes in middle of barbules, in barbules at base of barbs only (Fig. 5d).	Little pigment in barbules and little to medium in nodes. Expanded nodes at barb base. In middle of barbules, bases of nodes detach and form multiple ring-like nodes.
Order Galliformes Family Phasianidae Common pheasant – <i>Phasianus colchicus</i> (Linnaeus, 1758)	Brown belly feathers. Down is fine and grey, and dense. Barb sample from middle of down.	Barbules are longer and thinner than in Gallus feather specimen. Considerably fewer multiple ring-like nodes compared with Gallus.	Medium pigment in barbules, with little to medium in nodes. Nodes are all along barbules, and are globular, or expanded with few multiple ring-like nodes.
Order Anseriformes Family Anatidae Mallard – <i>Anas platyrhynchos</i> (Linnaeus, 1758)	Brown and white speckled belly feather. Barb sample from base of feather.	Barbules are short, thread-like and thin (Fig. 5e). Two to four distinctive large triangular nodes are located at barbule tips only, in barbules at base of barbs (Fig. 5f).	Very tips of barbules have large prongs. Barbules from mid-barb to tip have prongs only from middle of barbule. Little or no pigment in barbules, nodes and prongs.
Order Procellariiformes Family Diomedidae Gibson's albatross – <i>Diomedea antipodensis gibsoni</i> (Robertson & Warham, 1992)	White underwing covert feather. Down is dense. Barb sample from middle of down.	Barbules are very short but slightly increase in length from barb base to tip (Fig. 6a). Four symmetrical transparent prongs at each interval along most barbules (Fig. 6b).	Little pigment in barbules or prongs. Two to four prongs at each interval, symmetrical in pairs. Prongs slightly curved outwards towards tip, decreasing in size from barbule base to tip.
Order Accipitriformes Family Accipitridae Swamp harrier – <i>Circus approximans</i> (Peale, 1848)	Cream belly feather with brown line down shaft. Barb sample from middle of down.	Barbules are long (Fig. 6c). Two pairs of asymmetrical pronged nodes at intervals at base and tips of barbule (Fig. 6d). Middle of barbules has small prongless nodes.	Barbules have little pigment. Nodes with light to medium pigmentation, small and bulbous, decreasing in size along barbules. Pronged nodes are closely spaced at barbule base and tip.
Order Gruiformes Family Rallidae Western weka – <i>Gallinulus australis australis</i> (Sparman, 1786)	Dark brown flank feather with medium brown mottling. White barb sample from middle of down.	Barbules are dark brown, straight and medium length (Fig. 6e). Nodes are indistinct. Small transparent prongs at node intervals, pigment is lacking around prongs (Fig. 6f).	Barbules are heavily pigmented and wide. Prong length is uniformly short all along barbules. Internodal spaces are uniform except at tips, where nodes are closely spaced.
Order Gruiformes Family Rallidae Pūkeko – <i>Porphyrio melanotus melanotus</i> (Temminck, 1820)	Iridescent black back feather. Barbs are long and white. Barb sample from middle of down.	Barbules are grey and short to medium in length. Barbules have four expanded nodes at base of distal barbules at base of barbs.	Barbules are thin, with medium to heavy pigmentation except around nodes.

Order, family and species/subspecies of bird feather specimens	Feather type and down description	Diagnostic features of feather	Pigment and node distribution on barbules
Order Columbiformes Family Columbidae New Zealand pigeon – <i>Hemiphaga novaeseelandiae</i> (Gmelin, 1789)	White belly feather. Down is white and dense. Barb sample from base of feather.	Barbules are long and 'wispy', tapering to very thin at tips (Fig.7a). Four to six expanded crocus-shaped nodes at base of barbules (Fig. 7b).	Barbules and nodes have little pigment. Quadrilobed crocus-shaped nodes at barbule base only, then they abruptly decrease in size towards barbule tips.
Order Psittaciformes Family Strigopidae North Island kākā – <i>Nestor meridionalis septentrionalis</i> (Lorenz, 1896)	Red-tipped belly feather. Down is grey and white. Barb sample from middle of down.	Barbules are long to very long, with shorter barbules at barb tip. Expanded nodes occur at medium intervals, larger at barb base, globular at mid-barb, and with small prongs at barb tip.	Barbules have little to medium pigmentation and nodes medium to heavy pigmentation, except in node extremities. Pigmented nodes present along barbules become closer and thinner towards barbule tip.
Order Psittaciformes Family Psittacidae Red-crowned parakeet – <i>Cyanoramphus novaeseelandiae novaeseelandiae</i> (Sparman, 1787)	Light green breast feather. Down is dense. Barb sample from middle of down.	Barbules are medium to long, decreasing in length towards barb tip (Fig.7c). Expanded pigmented nodes at base of barbule (Fig.7d), smaller nodes at medium intervals along remainder. Nodes can have small transparent extremities.	Nodes are pigmented except in lobes. Nodes become longer and thinner towards barbule tip, and some have prongs.
Order Cuculiformes Family Cuculidae Long-tailed cuckoo – <i>Eudynamis taitensis</i> (Sparman, 1787)	White belly feather with a brown line down shaft. Down is dense and grey. Barb sample from middle of down.	Barbs are short and barbules are medium to long in length (Fig.7e). At base of barbules are long, thin, bell-shaped nodes with pre-nodal pigmentation (Fig.7f).	Pigment limited to top of nodes in barbules at middle and base of barb. Nodes decrease in size at base and mid-barb. Nodes at barbule tip are very thin, long and closely spaced.
Order Strigiformes Family Strigidae Morepork – <i>Ninox novaeseelandiae novaeseelandiae</i> (Gmelin, 1788)	Brown, cream and white mottled belly feather. Down is soft and dense. Barb sample from base of feather.	Barbs are long, and barbules are medium to long (Fig.8a). Dark, expanded nodes occur at medium intervals at barbule base (Fig.8b), globular nodes at mid-barbule, and thin, long nodes at tip.	Large pigmented triangular nodes at barbule base, with a gradual decrease to smaller nodes at middle, and very thin nodes at barbule tips, these with some prongs.
Order Passeriformes Family Meliphagidae Tūi – <i>Prosthemadera novaeseelandiae novaeseelandiae</i> (Gmelin, 1788)	Iridescent black breast feather. Down is grey. Barb sample from middle of down.	Barbules are medium to long. Nodes are heavily pigmented and quadrilobed, with small prongs. Villi are present at base of barb and barbules.	Barbules are wide, pigmented only at nodes. Internodal spaces are short, becoming very short at barbule tip. Nodes are present all along barbules, gradually decreasing in size along barbule.
Order Passeriformes Family Callaeidae Hūia – <i>Heteralocha acutirostris</i> (Gould, 1837)	Black breast feather. Down is dense. Barb sample from base of feather.	Barbules are short to medium in length (Fig.8c). Nodes are heavily pigmented and quadrilobed, with short internodal spaces (Fig.8d). Villi with distinctive knobbed ends occur at base of proximal barbules (Fig.8e).	Barbules are wide, width gradually decreases along barbule. Heavy pigment in nodes except in prongs, little to medium pigment in internodal spaces. Nodes triangular, gradually decreasing in size at barbule tip.
Order Passeriformes Family Emberizidae Yellowhammer – <i>Emberiza citrinella</i> (Linnaeus, 1758)	Canary-yellow flank feather. Down is dense. Barb sample from middle of down.	Barbules are short to medium length. Nodes are pigmented and quadrilobed, with rudimentary prongs at base of barbules. There are few villi at base of barbules.	Little to medium pigmentation in barbules, heavy in nodes. Internodal spaces of medium length, shorter towards barbule tips.



Fig. 9 Close-up of albino brown kiwi feathers in a kahu kiwi (kiwi-feather cloak) (Te Papa ME002701).

amongst brown feathers (partial albinism), and to pure or full albinism (Buller 1873: 310, 322).

For Māori, kahu kiwi represent mana (status and prestige). They are the most common type of feathered cloak in Te Papa's collections. At least five different kahu kiwi have hidden feathers from other birds, including hūia, kākā, and weka, which can be viewed only when the surrounding feathers are lifted. One kahu kiwi has concealed chicken and pheasant feathers as well a loop of green wool. Brown kiwi feathers were also woven to form a word on one feather cloak.

Order Galliformes, family Phasianidae – introduced game birds

Feathers from a domestic chicken (*Gallus gallus* var. *domesticus*) and a common pheasant (*Phasianus colchicus*) were examined microscopically (Table 2) for the identification of cloak feathers.

Chandler (1916: 340) observed that down from Galliformes is dense and that barbules are long, potentially reaching 5 mm. The barbules have characteristic ring-like multi-nodal structures, found on closely situated distal barbules near the base of the barb, sometimes totalling two to three nodes linked together on the barbules (Day 1966: 213). Microscopic examination of *Gallus* feathers showed the distinctive ring-like nodes in the middle of the barbules at the base of the barb. The barbules are long (Fig. 5c). Ring-like nodes are sometimes multiple and appear to move freely along the barbule, having detached from the base of small

nodes in the middle of the barbules (Fig. 5d). At the middle and tip of the barb, smaller nodes appear along the barbules.

The pheasant barbules in this study were generally longer and thinner than those from *Gallus*. Node shapes varied from expanded to small nodes with detaching sections, seen as multiple 'rings' on barbules. Pheasant barbules have considerably fewer multiple rings than those from chickens, averaging one to two barbules with rings per barb. Multiple ring-like nodes appeared on distal barbules only. Barbules on turkey feathers were described by Day (1966: 213) as having neither characteristic shapes nor multi-nodal structures.

Chicken feathers of various types, breeds and colours were recorded in 25 Māori cloaks. Many feather colour combinations were present, from single to multiple feather colour combinations in various patterns. Feather colours ranged from white, cream and gold to crimson, scarlet, brown, grey and iridescent black, as well as dyed feathers. The bicoloured hackle feathers from the neck and back, as well as the breast and belly feathers of the chicken, are widespread in the cloak collection. Chicken feathers are arranged in strips, bunches and on borders in cloaks.

Strikingly coloured and patterned feathers from male pheasants were identified in the cloak collection. Breast and back feathers, as well as those from the belly, flank, nape and rump, were recorded in 15 cloaks from museum skin comparisons (Fig. 2b). Pheasant feathers are displayed in the cloaks in small bunches, as strips, or as single feathers mixed with those from other species.

Identifications of feathers from peafowl, turkey (*Meleagris gallopavo*), California quail (*Callipepla californica*) and guinea fowl present in Te Papa's cloaks were made from comparisons against birdskin images, and without microscopic analysis. Peacock (male peafowl) feathers were observed in 13 cloaks. Iridescent blue feathers from the neck, green 'peashell' feathers from the back, and black and white mottled feathers from the scapular were recorded. The iridescent 'eyes' and herl (barbs) from the tail were also visually identified in one kahu huruhuru, in which they created a unique and stunning effect (Fig. 10). Striking iridescent turkey feathers were identified in five cloaks. The most common turkey feathers in the cloaks were white-tipped, barred brown and black feathers from the upper tail, and iridescent black feathers from the breast. Different turkey feathers were incorporated into cloak patterns, in bunches or strips, or as single feathers mixed with those of other species.

Vertically striped brown and white side belly feathers of California quail, together with mottled brown, cream

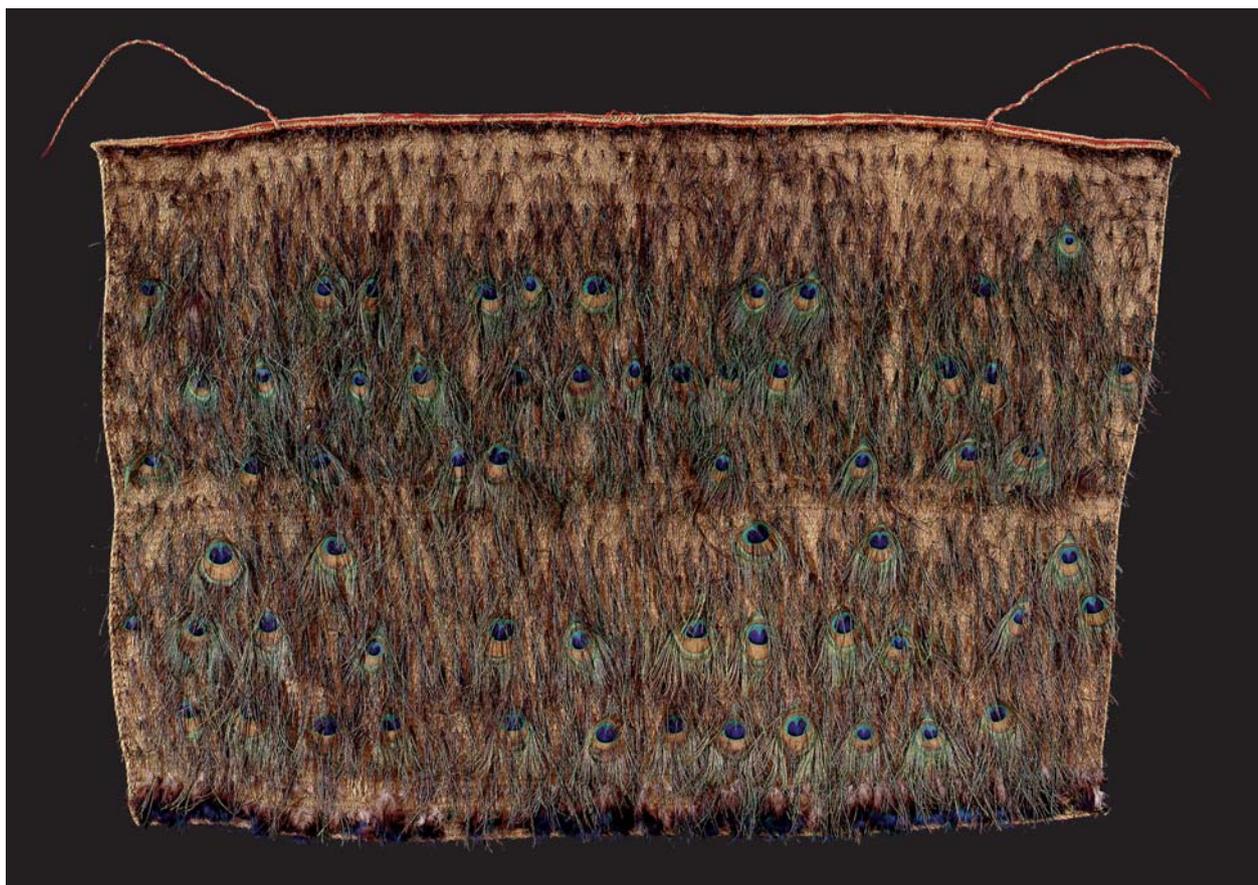


Fig. 10 Kahu huruhuru (feather cloak) with peacock-tail feathers (Te Papa ME003723).

and white belly feathers, are displayed in small bunches as contrasting colours against surrounding feathers of other species. The distinctive white-spotted grey feathers of the guinea fowl are easily identifiable in two of Te Papa's cloaks, attached as small and large bunches within cloak patterns.

Order Anseriformes, family Anatidae – ducks, geese and swans

While this order includes numerous native and introduced bird species (Gill *et al.* 2010: 30), to date only feathers of the introduced mallard (*Anas platyrhynchos platyrhynchos*) have been identified in Te Papa's cloaks. Mallards were initially introduced from the United Kingdom in 1865 (Long 1981: 55), and have since widely hybridised with native grey duck, or pāpera (*A. superciliosa*). A feather specimen from the belly of a mallard was studied microscopically to identify cloak feathers to this order. Key characteristics are summarised in Table 2.

Duck barbules are described by Chandler (1916: 329) as generally less than 1 mm long and distinctive only at the tip, where he noted between two and eight large, well-developed nodes followed by a slender tip. According to Day (1966: 214), anatids have easily recognisable, large triangular-shaped nodes, located only at the tips of the barbules and barbules can measure 1.5–2 mm long. *Anas* barbules situated at the base of the barb are simple, short, thin and thread-like, with two to four characteristic large nodes at the tips (Fig. 5e). The nodes at the tips are significantly expanded and triangular, and are followed by two to four large pronged nodes (0.01 mm long) (Fig. 5f). The distal tip of a barbule is usually a single thin point.

Mallard feathers were identified in four cloaks, originating from the underwing (white feathers), the sides (brown and black feathers) and the belly (black and white speckled or vermiculated feathers) of the bird. A single mallard feather was found concealed alongside a single white (albino) brown kiwi feather in a kahu kiwi. Mallard feathers were also found in strips on borders and in geometric patterns.

Order Procellariiformes, family Diomedeidae – albatrosses

The family Diomedeidae is represented in New Zealand by 17 species of albatross (Gill *et al.* 2010: 64). A feather specimen from the underwing of a Gibson's albatross (*Diomedea antipodensis gibsoni*) was studied and its characteristics are recorded in Table 2.

Chandler (1916: 305) described barbules from the wandering albatross (*Diomedea exulans*) as short, reaching only 1 mm long, and having forward-curved, asymmetrical prongs, either single or double, sometimes measuring up to 0.04 mm long. Microscopic examination of a feather from a Gibson's albatross confirmed that the barbules are short and wide at the base, and longer and spindly towards the tip of the barb. There are prongs all along most barbules (Fig. 6a), these being longer at the base of the barbule. Most barbules have two to four prongs at intervals, with one pair sometimes longer than the other (asymmetrical) (Fig. 6b).

White albatross body feathers, particularly from the breast and belly, were observed in Te Papa's cloaks arranged in small bunches within patterns, in strips, in borders, and as single feathers alongside those of other species.

Order Ciconiiformes, family Ardeidae – herons and bitterns

Large, mottled cream and dark brown feathers from the rump, flank, breast and upperwing of the Australasian bittern (*Botaurus poiciloptilus*) were identified in one cloak by comparisons with museum skins, without the use of microscope examination. These distinctive body feathers are large and, judging from their placement in the cloak as vertical strips, it is estimated that only one bird would have been used for the cloak (Fig. 11).

Order Accipitriformes, family Accipitridae – eagles and hawks

In New Zealand, the family Accipitridae includes only one breeding species, and few occasional visitors and extinct species (Gill *et al.* 2010: 169). A microscopic study of a feather specimen from a swamp harrier (*Circus approximans*) was made, and its diagnostic features are summarised in Table 2.

Barbule nodes are inconspicuous in the down of hawks, and often have long, asymmetrical prongs and little pigmentation, while barbules are short, 1.5–2 mm long (Day



Fig. 11 Close-up of swamp harrier and Australasian bittern feathers in a kahu huruhuru (feather cloak) (Te Papa ME014385).

1966: 215). Chandler (1916: 336) observed a more definite distinction, noting that in hawks the barbules are long and slender with small nodes and short prongs at the tips, whereas in falcons they have larger, heavily pigmented nodes, with slight kinks in the barbules. Dove & Koch (2010: 39) suggest that the diagnostic features of hawk feathers are long to very long barbules, with little pigment in the barbules and no pigment in the nodes. The nodes also have some spines (prongs) that appear asymmetrical in length. Barbules of the swamp harrier are long, with light to medium stippled pigment (Fig. 6c), and have lightly pigmented pronged nodes that appear asymmetrical and are closely spaced at intervals on the barbule base and tips (Fig. 6d).

Multiple bicoloured swamp harrier feathers (white and brown or brown and light brown) were identified in one of Te Papa's cloaks. White, brown and light brown feathers from the belly, vent and flanks were also identified using comparisons with museum skins. Swamp harrier feathers are woven in small bunches in vertical strips on a kahu huruhuru, alongside Australasian bittern, kākā and New Zealand pigeon feathers, as well as undyed wool in horizontal strips (Fig. 11).

Order Gruiformes, family Rallidae – rails, gallinules and coots

Feathers of species of weka and pūkeko (*Porphyrio melanotus melanotus*) were identified in the Te Papa cloaks. Table 2 summarises microscopic characteristics observed in a feather of a western weka (*Gallirallus australis australis*), and in one from a pūkeko.

Chandler (1916: 353) measured rallid barbules at 1.5–3.5 mm long, and described them as having short internodal spaces that are heavily pigmented along most of the barbule. Day (1966: 214) described typical rallid barbules as short and stout, 1.5–2 mm long, with two to four swollen, heart-shaped nodes at their base, which become less swollen and closer together towards the barbule tip. Weka barbules are of medium length, very wide all along but abruptly decreasing in width immediately after the prongs, producing a scaling effect (Fig. 6e). The nodal structure and internodal spaces are difficult to determine in western weka barbules, which are wide, indistinct, and heavily pigmented along most of their length, with four small prongs at intervals separating the pigmentation (Fig. 6f). Small symmetrical prongs appear all along the barbules with little or medium pigment.

Pūkeko barbules share more of the typical characteristics of other Gruiformes, and differ considerably from those of weka in microscopic features. Pūkeko barbules have four large quadrilobed nodes, at the base of distal barbules from the base of the barbs; in proximal barbules these nodes appear smaller, indicating a characteristic of asymmetry as seen in this order. These barbules appear thin, with medium to heavy pigmentation except in and just after the nodes, and are also shorter than those seen in weka. Pūkeko barbules at mid-barb have small pronged nodes all along their length and at the tip of the barb; short barbules have long prongs at the base and tips.

Weka feathers from the back, breast, belly and rump were found in 12 of Te Papa's Māori cloaks. The species could not be determined based on microscopic and skin comparisons alone. As with brown kiwi feathers, weka feathers are often turned over on cloaks, with the ventral surface facing outwards. Single or small bunches of weka feathers are dispersed among brown kiwi feathers in two kahu kiwi, and several different body feathers are identified in the main central pattern of a kahu weka (weka-feather cloak).

Pūkeko feathers in Te Papa's cloaks are mainly purple-blue feathers from the breast and belly, but white feathers from the vent under the tail and black feathers from the back are also present. Feather colours from this species range from pastel blue to royal blue, and are used in strips, small bunches and borders.

The distinctive small black and white barred belly feathers from the banded rail (*Gallirallus philippensis*) were confirmed using birdskin comparisons. These feathers adorned two cloaks in the form of strips and small bunches.

Order Columbiformes, family Columbidae – pigeons and doves

The native New Zealand pigeon (*Hemiphaga novaeseelandiae*) is most likely the only species of this order present in Te Papa's cloaks. Microscopic features of feathers from this pigeon are summarised in Table 2.

Body feathers from columbids have a significant amount of down in the breast and, particularly, in the belly. The rachis is also distinctively flattened at the calamus. Barbules from columbids have been described as having three to eight large, expanded and conspicuous nodes at the base, with another three to eight less conspicuous nodes decreasing in size towards the barbule tip, where there may be minute prongs (Chandler 1916: 361). The majority of barbules are long and measure up to 3–4 mm in length despite some variation among genera (Chandler 1916: 361; Day 1966: 214). Dove & Koch (2010) also noted some asymmetry in node sizes in distal and proximal barbules.

New Zealand pigeon feathers have typical columbid barbules, being long with four to six large crocus-shaped (four-lobed) nodes at the base of most barbules (Figs 7a,b). Node size abruptly decreases near the middle of the barbule, until there are minute or no nodes, and there may be three to four pairs of long, transparent prongs at the barbule tip. Internodal spaces are uniformly long, and barbules and nodes have little pigment.

Feathers from the New Zealand pigeon are widespread throughout the cloak collection, having been identified in 45 cloaks. The green neck feathers, and white breast and belly feathers are the most common types found. Maroon and 'teal green' back and upperwing coverts are also present to a lesser degree. The white and green feathers are used either in strips, borders or contrasting patterns. One kahu huruhuru features the green neck feathers, which covers most of the cloak.

Order Psittaciformes – parrots and parakeets

The endemic kākāpō and kākā belong to the family Strigopidae, while native parakeets belong to the family Psittacidae (Gill *et al.* 2010: 249). Feathers of all three kinds of birds from this order were identified in cloaks. Feathers from a North Island kākā (*Nestor meridionalis septentrionalis*) and a red-crowned parakeet (*Cyanoramphus novaezelandiae novaezelandiae*) were analysed microscopically and their key characteristics summarised in Table 2.



Fig. 12 Kahu huruhuru (feather cloak) with native New Zealand pigeon, kākā, tūi and parakeet feathers (Te Papa ME004275).

Chandler (1916: 365) gives key features for these birds as small heart-shaped or globular pigmented nodes along the length of the barbules, and short, lightly pigmented internodal spaces. Also, nodes are large at the base of the barbule and minute at the tip. Dove & Koch (2010: 50) suggest that the diagnostic features for Psittaciformes are the long to very long barbules, widely flared pigmented nodes along barbules, and absence of villi at the base of barbules.

Kākā barbules are long, straight and pointed towards the barb tip, and vary in width. Nodes are present along the whole length of barbules, gradually decreasing in size. Nodes from barbules at the barb base are short and expanded at the tip. At mid-barb, triangular nodes decrease to form globular nodes in the middle of the barbules, continuing to the tip. At the tip of the barb there are minute prong-like nodes,

which become longer towards the tip of the barbules. There is medium to heavy pigmentation in kākā nodes, with little to medium pigmentation in internodal spaces.

Red-crowned parakeet barbules are also long, decreasing in length towards the barb tip. Barbules generally remain the same width along their length (Fig. 7c). In the feather examined, from the middle of the downy area, barbules from the base of the barbs had more symmetrical droplet-shaped nodes in their middle. At the base of the barb and at the base of the barbules, the nodes are widely spaced, expanded and heavily pigmented except in the tips of the lobes (Fig. 7d). Nodes are present all along barbules, with little to medium pigmentation in internodal spaces. At mid-barb, nodes are droplet-shaped, heavily pigmented and some have small transparent prongs. At the tip of the barb, barbules have long, thin prongs that are closely spaced.

Colour variations of kākā feathers in Te Papa's cloaks indicate that both the North Island kākā and South Island kākā (*Nestor meridionalis meridionalis*) subspecies are present in the collection, based on comparisons with museum bird skins. Kākā feathers were identified in 43 of the cloaks. Weavers primarily used the light orange to crimson-red underwing coverts (Fig.2c) and the red-tipped belly feathers. Four of Te Papa's cloaks contain kākā feathers as their main feature. Two cloaks are catalogued as kahu kura or kākahu kura and primarily utilise the orange kākā feathers; where 'kura' may refer to the colour red or reflect high (chiefly) status. The other two cloaks, catalogued as kahu kākā or kākahu kaka, predominately feature the red or rusty-brown feathers, and may specifically be named after the bird.

Kākā feathers were recorded in cloak borders and geometric patterns, while single or small bunches have been used to lift the colour of some cloaks, a technique described by Te Kanawa (1992: 26). In this, brightly coloured feathers are used as a contrast against darker feathers in the background. Also, where single or small bunches of kākā feathers were hidden underneath the feathers of other species, it is possible they were used as possible weaver 'signatures', a concept that is discussed below.

Light green native parakeet feathers appear in strips, bunches, borders and geometric patterns. Single feathers are also used to lift the colour from surrounding feathers. Light green feathers from the breast, belly, crown (head) and back were observed. One cloak includes blue-green upperwing covert feathers, and other cloaks feature the light green head feathers tipped with red from the crown of the bird (i.e. red-crowned parakeet). Parakeet feathers were often woven into cloak patterns alongside white and green New Zealand pigeon feathers, orange kākā feathers and black tūi feathers (Fig.12).

Kākāpō feathers from the belly, breast, back and upperwing were easily identified by comparisons with museum skin images (Fig.2d). Only one cloak in Te Papa's collection, a kahu kiwi, featured kākāpō feathers. In this garment, green, light green and brown mottled feathers were present in the borders, along with feathers of other species; kākāpō feathers were also interspersed throughout brown kiwi feathers in the middle of the cloak, possibly again as a colour lift.

Order Cuculiformes, family Cuculidae – cuckoos

The long-tailed cuckoo (*Eudynamys taitensis*) and the shining bronze-cuckoo (pīpīwharaurua, *Chrysococcyx lucidus*) are

migrants, breeding in New Zealand each spring (Gill *et al.* 2010: 261). Feathers of both species have been identified in Te Papa's cloaks. Microscopic examination was conducted on a long-tailed cuckoo feather, and data summarised in Table 2.

Chandler (1916: 365) described feathers from Cuculiformes as having long, slender barbules, at least 2 mm in length, with globular nodes in the form of rounded droplets. The nodes were large near the barbule base, and smaller towards the tip. He also noted that the internodal spaces were long, slender and heavily pigmented, particularly just before the nodes. Long-tailed cuckoo barbs are short, with medium to long barbules (Fig.7e). The nodes at the barb base are distinct in that the pigmentation is pre-nodal, being located just before the main node on the barbules, and form a bell shape (Fig.7f) (Dove & Koch 2010: 27). These nodes are quadrilobed and gradually decrease in size towards the tip of the barbule, where they have the same width as the barbule. There is heavy pigmentation before the nodes on barbules at the base and middle of the barb. Barbules at the tip of barbs have little to medium pigmentation, with little pigment in the nodes. The nodes are distributed all along the barbule length and are uniform in size.

Long-tailed cuckoo feathers were identified in two of Te Papa's cloaks: white breast feathers with a central brown line; white side belly or flank feathers; and vent feathers with a brown 'V' shape across the feather (Fig.2e). Shining bronze-cuckoo feathers were identified by comparisons with images of museum skin feathers, but not with microscopic analysis. Iridescent light green and white horizontal barred feathers from the breast and belly, and iridescent green back feathers were recorded in the borders of a kahu kiwi.

Order Strigiformes, family Strigidae – owls

The morepork (*Ninox novaeseelandiae novaeseelandiae*) is the only extant native New Zealand species belonging to this family (Gill *et al.* 2010: 264), and it is also the only species from this order identified in Te Papa's cloaks. A feather from this species was used to record microscopic characteristics for the order, which are summarised in Table 2.

Barbules from feathers of Strigiformes generally have three large globular nodes at the base (Chandler 1916: 375). Pigmentation of the nodes is heavy, while the internodal space is slightly transparent. Barbule lengths are 3–4 mm long, and the internodal spaces are large (Day 1966: 215).



Fig. 13 Close-up of mottled morepork feathers in a kahu huruhuru (feather cloak) (Te Papa ME011987).

Morepork barbs are very soft, long and wispy. At the base of the barb, barbules are long and spindly, becoming straighter towards the barb tip. They measure 1–2 mm in length, with shorter barbules in the middle of the barb (Fig. 8a). The barbules at the barb base have five to seven large triangular nodes at their base that gradually decrease in size to very thin, widely spaced pigmented nodes at the tips. At the very tips of the barbules, the nodes often have small transparent prongs. Barbules from the middle and tip of the barb have three to four large triangular nodes at their base (Fig. 8b), becoming uniform in size and more closely spaced towards the tip. Generally, internodal spaces are greater in the middle of the barbules. Pigmentation is heavy in nodes, but light to medium in the internodal spaces.

Two single mottled brown, cream and white morepork belly feathers were identified in a small kahu huruhuru (Fig. 13), with one feather on either side of a vertical pattern of bluish-black tūi feathers and dark blue pūkeko feathers. The two morepork feathers are light against this dark background.

Order Passeriformes – passerines or perching birds

Feathers from at least three species of passerine – two native and one introduced – have been found in Te Papa cloaks: the tūi (*Prosthemadera novaeseelandiae novaeseelandiae*), the extinct hūia (*Heteralocha acutirostris*) and the introduced yellowhammer (*Emberiza citrinella*). Summaries for their microscopic feather characteristics are given in Table 2.

Down and nodes vary greatly among species of this large group of birds. Nodes are generally well pigmented, triangular and roughly the same size along the barbule (Chandler 1916: 383). Barbules have flattened transparent growths with knobbed ends or villi (Fig. 8e) at the proximal end or from the barbule base (Day 1966:213). Internodal spaces are transparent and exceptionally short. Passeriformes appears to be the only order of New Zealand birds with these distinctive characteristics. Passerine barbules are variable in length, ranging from 1.5 mm to 2.5 mm in Day (1966: 213), or from 1 mm to 5 mm in Chandler (1916: 382). The shape of the barbules and length of internodal spaces also vary among family groups.

In tūi, the barbules are of medium length. Villi with distinctive knobbed ends were identified on the base of barbules from the base of the barb. Barbules are slightly wider in the middle, and nodes are present all along the barbules. At the barbule base, nodes are large and quadrilobed, with rudimentary transparent prongs that develop in the top quarter of the barbule. Nodes at mid-barbule are uniform in size and generally heavily pigmented, but with little pigment in the internodal spaces except at the tips of barbules, where nodes are wider, darker and closer together. Internodal spaces are short.

Hūia barbules are very short, 0.4–1 mm long, and wide (Fig. 8c). Nodes are small and slightly triangular in shape, and present all along barbules, spaced closely with a slight decrease in size towards the tip (Fig. 8d). Villi are also present at the base of proximal barbules (Fig. 8e). Barbule widths gradually decrease along their length. Nodes in hūia feathers are heavily pigmented, but pigment in internodal spaces is light to medium. Internodal space is very short. There are some rudimentary transparent prongs on pigmented nodes at the base of some barbules, with transparent pronged nodes at the tips.

Yellowhammer feathers have few villi at the base of barbules. Nodes are trapezoidal at the base of barbules at the barb base, and globular at the middle of barbules, with minute prongs only at the very tip of the barbule. Barbule lengths in the yellowhammer are short, ranging from 0.8 mm to 1.4 mm. There is little to medium pigmentation in the barbules. Basal quadrilobed nodes are heavily pigmented, with rudimentary prongs that are lightly or not pigmented. Internodal spaces are medium to long at the base and mid-barbule, becoming abruptly shorter at the tip.

Iridescent black tūi feathers from the neck, back, breast and upperwing coverts were identified in 35 Te Papa cloaks.



Fig. 14 Close-up of a small bunch of hidden hūia feathers in a kahu kiwi (kiwi-feather cloak) (Te Papa ME003714).

These feathers were incorporated into borders, strips, geometric shapes and small bunches. Each of the two white throat-tuft feathers from a tūī (Fig. 2f), identified from museum skins, adorned each side border of a cloak.

The black belly feathers from a hūia were identified in two kahu kiwi, hidden among kiwi feathers. In one cloak, small bunches of hūia feathers were hidden among those from a brown kiwi across the garment (Fig. 14). The other kahu kiwi featured single hūia, kākā and New Zealand pigeon feathers hidden among the brown kiwi feathers. The last confirmed sighting of a live hūia was in 1907 (Heather & Robertson 1996: 419).

Feathers from a yellowhammer, an introduced Eurasian passerine (Gill *et al.* 2010: 322), were identified in a single kahu huruhuru. Their distinctive canary-yellow breast and belly feathers, with central vertical brown lines, were identified in two small bunches in the middle of a cloak, surrounded by feathers of other species.

Conclusions and future research

Previously, the bird species from which feathers were used in Te Papa's Māori cloaks had not been identified with precision using scientific methods or analysis, but made visually or somewhat anecdotally, with little scrutiny of the methodology or accuracy required. Using a complete and well-curated collection of bird skins, such as those at Te Papa, and an accurate microscopic examination of down proved to be a cost- and time-effective method of identifying cloak feathers. Microscopic analysis has already proven

effective in identifying feather and hair fragments in archaeological material in Alaska (Dove & Peurach 2002), and in identifying Pacific and historical museum collection items in international studies (Dove 1998; Pearlstein 2010). There is potential for successfully replicating the methods used in this study to identify feathers in other significant ethnological collections, including other taonga Māori (treasures) in collections held in museums both in New Zealand and overseas.

DNA analysis has proven useful in identifying the species and sex of kiwi (Shepherd & Lambert 2008; Hartnup *et al.* 2009), but it is not always possible to extract DNA from degraded or contaminated samples, or from fragile Māori textiles in a museum collection. Studies of brown kiwi are particularly relevant to research on the history of Māori cloaks, owing to the prevalence of kiwi feathers throughout the cloak collection. Analysing the DNA of brown kiwi feathers in conjunction with the muka fibres from a cloak could possibly retrieve the geographic origin of the materials used, and therefore iwi (Māori tribe) provenance could possibly be inferred.

Isotopic analyses of feathers have proven to be an effective tool in tracing the geographical origins of birds (Hobson *et al.* 2007). The stable isotope composition of bird feathers determined by diet and ingested water is a unique geographical marker of the bird's origin. Provenance could therefore be determined by comparing isotope landscape maps of New Zealand against feathers of known provenance, and then with feathers from cloaks. However, both this method and DNA analysis require destruction of some of the feather material, and results can also be dependent on the degradation and viability of the samples used. There is also the issue of trade and gifting of cloaks, feathers and birds between iwi and Europeans that can mislead or confuse evidence of origin and ownership of items. It is therefore important that several feather and fibre samples are taken from the cloak, as this increases the likelihood that similar samples have originated from the same location, thereby revealing possible geographic origins. This in itself is new information about the materials used not previously known.

The most frequently identified bird species whose feathers feature in Te Papa's cloaks were once abundant, widespread, and ground-dwelling or low-flying. They were used by Māori for food, and their feathers used for kākahu, and other clothing and weaving, personal adornment or for inclusion on weapons and carvings (Best 1942; Orbell 2003). Particular feather types of certain species were

preferred by weavers, for example the green neck and white breast feathers of the New Zealand pigeon, and the orange underwing and red belly feathers of the kākā. Introduced birds also played an important role in changing Māori weaving in recent history. As native bird numbers declined and their use was restricted by law in the second half of the nineteenth century, the inclusion of feathers from introduced birds into Māori cloak designs not only became essential, but also introduced a whole new range of colours and designs.

The identification of feathers in Māori cloaks in other national and international collections warrants further research as it will undoubtedly lead to additional important findings and, possibly, associations in the location of origins. One of the most interesting discoveries resulting from feather identification of Te Papa's Māori cloaks has been the uncovering of hidden feathers incorporated into some cloaks. At least 30 of the 110 cloaks examined had hidden feathers or a subtle use of feathers, as well as the inclusion of other materials (e.g. wool). Presumably, these were inserted by the maker as an individual mark or memory of an event or person and, in some cases, could indicate the identity of the weaver. They may also provide an indication of the status of the wearer, and the time and environment in which he or she was living. Documentation about the use of all feathers (particularly the location of hidden ones) in other national and overseas cloak collections could test this hypothesis and, through the comparison and matching of these unique feather insertions or 'signatures', potentially provide provenance for some cloaks.

The use of bird feathers to create striking coloured patterns in Māori cloaks dating from the last two centuries is testimony to the enormous skill, ingenuity and creativity of their weavers. This research highlights the relevance of scientific identification and verification of materials held in museum collections. In addition to studying bird skins and the cloaks themselves, a better understanding of the Māori cloaks in Te Papa's collection could also be gained through the documentation of the techniques and materials employed by modern weaving practitioners. Kākahu embody the ever-changing knowledge and resources available to Māori weavers, and the information contained within the materials the weavers used will be a key to the rediscovery of their origins.

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Obituary:

A tribute to Robert Louis Cecil Pilgrim (26 August 1921–7 April 2010), Research Associate, Museum of New Zealand Te Papa Tongarewa

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With great sadness, I received the news of the death of my colleague, close friend and mentor, Professor R.L.C. Pilgrim, affectionately known as Bob. Despite his deteriorating physical health, Bob continued to do research on his beloved fleas until the last minute of his life. He died suddenly at home of a heart attack, after spending the evening working on his monograph of the flea larvae of the world. Although Bob will not see the results of his research in print, his friend and colleague Terry Galloway will complete the manuscript for publication.

I met Bob over 37 years ago, a few weeks after I arrived in New Zealand with my wife and son as political refugees from Chile, where democracy had been crushed and many people killed by the military. Little did I realise then that meeting Bob would mark an important turning point in my life as a person and as a scientist. I feel privileged and honoured to have known Bob and his family over all these years and remember him as a truly exceptional man.

Bob was a holistic scientist, a natural historian of the old school, who had extensive knowledge of biology in its broadest meaning. He was capable of working in any area of biology he chose, and his published papers are testimony to the wide range of topics he investigated in a career spanning seven decades. He was a practical, modest man who was not at all interested in publicity and adulation. His greatest pride was the quality of his work and that of his students.

Students filled a great part of Bob's time and effort during the almost 40 years he was a lecturer at the University of Canterbury. Bob could be called a 'man of all trades': he was

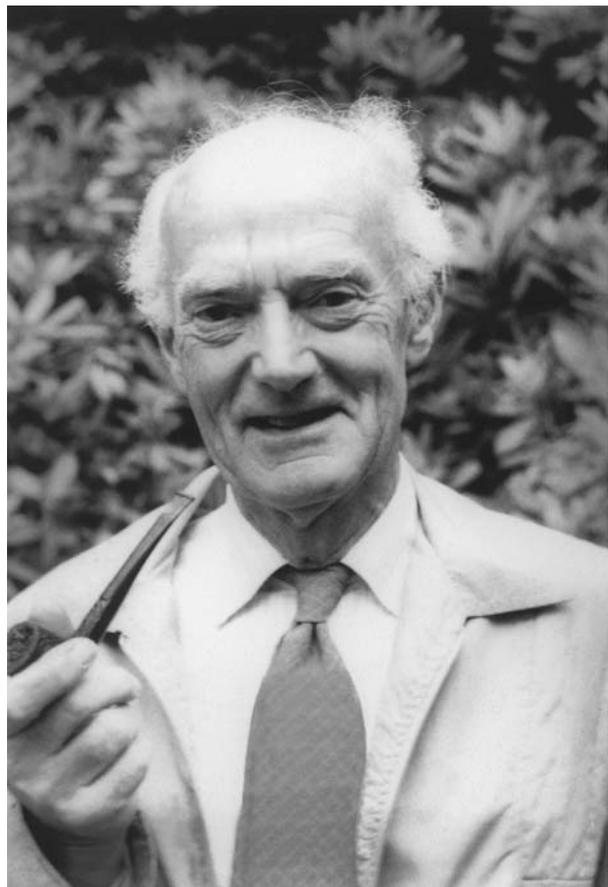


Fig. 1 Professor Pilgrim in July 1988, at the XVIII International Congress of Entomology held in Vancouver, Canada.

a biologist, a researcher, a collector, a handyman, a book-binder, a linguist, a historian, a geographer, a family man, an outdoor man, a gardener and, above all, a great teacher. As university colleagues agreed during a memorial meeting held shortly after Bob's death, he was the best lecturer the Zoology Department had had in its history. Bob's main vocation was teaching, and I was fortunate enough to receive the benefits of his talent for that role on many occasions.

Bob was born and lived all his life in Christchurch, New Zealand. He had two sisters and one brother. His father's business collapsed during the Depression of the 1930s and Bob had to leave Christchurch Boys' High School at the age of 16, having completed only his sixth form. Bob's dream of becoming a medical doctor was shattered, and instead he had to settle for the reality of work in menial jobs to earn a living. Eventually, he obtained a job as a public servant, working first with the Department of Agriculture and later in the Department of Social Security, from the age of 17 until he was 21. He was sent to Wellington for some weeks, but hated the capital city and asked to be relocated to Christchurch.

The Depression years left an indelible mark on Bob – literally. He was proud to show an unusual paperweight made of acrylic with bones stained red embedded in it, which he kept on top of his desk. They were the bones of one of his little toes, both of which had to be surgically removed in adult life after badly fitted shoes had deformed them during the Depression. Bob never discarded anything that could be reused later, including envelopes, paper clips, rubber bands, wrapping paper, string, boxes and so on. Although for different reasons, he was a pioneer of today's practice of recycling used goods.

Bob's lifelong interest in biology began at an early age when, with two schoolmates, he established the Onslow Museum Society, named after its location. The father of one of the boys refurbished a bedroom with shelves for the budding natural historians to display the shells, fossils and other specimens that formed the museum's collection. Since biology was not taught in secondary schools at that time, the boys were desperate to purchase an authoritative manual to assist in the identification and classification of shells. However, to purchase such a book was beyond their financial means. So, they took their plight to the top, and wrote to the Minister of Education, Peter Fraser, a man who appreciated the value of education. The reward for their bold initiative was a parcel containing the precious book, as a personal gift from Fraser. The Onslow Museum Society also received

expert advice and visits from Dr Robert A. Falla, then director of the Canterbury Museum; Professor Edward Percival, Head of Zoology at Canterbury University College; and Professor Robin Allan, Head of Geology at Canterbury.

While working as a public servant, Bob was able to enrol as a part-time student at Canterbury University College in 1939. Although he was allowed time off work to attend lectures, it was given grudgingly, and he struggled to commute between the office and the lecture room within the allocated time. Frequently, he had no time for lunch and, had it not been for Saturday morning lectures and laboratory work, he would not have been able to complete his Bachelor of Science degree, which he achieved in May 1943 (Fig. 2). Bob never forgot the value of part-time studies and had a special regard for those students who had to work while studying. Years later, he had the opportunity of recalling part-time work while studying overseas. He assisted a Welsh relative who had a contract to clean chimneys in Wales, and proudly claimed to have been the only New Zealand professor who had swept the chimneys of Cardiff Castle.

After obtaining his B.Sc. degree, Bob was awarded the Charles Cook, Warwick House, Memorial Scholarship and the Shirtcliffe Graduate Bursary, but the Second World War put an end to his hope of immediate graduate studies. He was called for war service and spent the following year in the army. After training in Trentham, his scientific knowledge led to his recruitment as biochemist and diagnostician in a hospital of the New Zealand Army Medical Corps in New Caledonia. When the hospital was disbanded, Bob entered Burnham Army Camp. Scheduled to sail with reinforcements to Italy in 1944, he was released from the army to perform an essential occupation as research assistant in the unit dealing with artificial insemination of cattle in the Ruakura Animal Research Station, near Hamilton. He found out about his release and new research position only by chance, while giving a book to his commanding officer to return to the library because he had no time to do it himself before sailing to Europe. His battalion suffered heavy losses in the battle of Monte Cassino in Italy, and it is quite likely that Bob's biology studies saved his life.

Bob was a keen tramper and skier, and while skiing at Arthur's Pass in the winter of 1942 he met Joy Davies. They were married in May 1945, two weeks after the war ended in Europe. His work at Ruakura lasted until 1946, when he was appointed as an assistant lecturer in zoology at Canterbury University College and was then able to resume his studies, graduating with a Master of Science in zoology



Fig. 2 Bob Pilgrim with his fiancée, Joy Davies, on the day in May 1943 he received his diploma as a Bachelor of Science, Christchurch, New Zealand.

with equivalent first-class honours. A National Research Scholarship enabled Bob and his wife to travel to England in December 1948, where he undertook research on the physiology of oysters at London's University College, gaining a Ph.D. in 1951. His thesis supervisor was George Philip 'Gip' Wells, son of renowned novelist and science writer H.G. Wells (H.G. had taken classes under biologist T.H. Huxley; and H.G. and G.P. Wells co-authored *The science of life* (1930) with Julian Huxley, grandson of T.H. – connections that Bob would have appreciated). Bob's first series of scientific papers resulted from that research work, which confirmed his initial career as a physiologist (see Appendix 1, below). On his return to Christchurch, not only with a Ph.D. but also with Susan, his and Joy's first daughter, Bob was appointed as lecturer in Canterbury University College. In September 1952, he became a father for the second time when another daughter, Jennifer, was born in Christchurch, and on 1954 he was promoted to senior lecturer at Canterbury.

In 1958, Bob was awarded a postdoctoral fellowship by the National Academy of Sciences to undertake research at the California Institute of Technology in Pasadena, and at the Friday Harbor Laboratories of the University of Washington, where he worked on crustacean neurophysiology. In 1963, Bob was promoted to reader at the University of Canterbury, and awarded a travel grant by the British Council to continue his research at the Marine Biological Association in Plymouth. From England, he travelled to Italy to extend his research at the Stazione Zoologica in Naples. He made major contributions to the field of invertebrate neurophysiology, and this work led to his establishment of the physiology laboratory and course in the Department of Zoology at Canterbury, at a time when physiology was taught only at medical schools. Bob was the driving force behind the establishment of biochemistry and biophysics as teaching disciplines at Canterbury, and was appointed as the faculty's coordinator for the two subjects. This was a major achievement in his career, for which he felt very proud.

After his appointment to the second Chair of Zoology in 1965, Professor Pilgrim, as I respectfully addressed him for many years, saw his teaching and research activities reduced as he assumed more administrative responsibilities. Noted for his efficiency, he was appointed Dean of the Faculty of Science from 1967 until 1969. He also became the secretary of the Lecturers' Association, a lecturers' representative on the Professorial Board, and represented the university on the Papanui High School Board of Governors. As if that was not enough, Bob served as chairman of the Canterbury Branch of the Association of University Teachers, as council member of the Royal Society of New Zealand as well as president of its Canterbury Branch, and as vice-president of the New Zealand Science Teachers' Association. However, his greatest administrative interest within the university related to his lifelong love affair with books: he was a member of the Library Committee for nine years, the last three as chairman.

The time and effort taken by Bob's numerous administrative positions meant that his neurophysiology research had to be abandoned because it required long and sustained hours of laboratory work. Bob turned instead to insect research and became an entomologist. It was Tillyard's (1926) book on Australian and New Zealand insects that, many years earlier, had enticed him into collecting and studying insects and other invertebrates. The challenge of identifying specimens found in the field attracted him greatly, and through it he was able to combine his love for the outdoors with that of biology. Bob enjoyed leading students and

colleagues to his favourite collecting spots in Canterbury: Cass, Banks Peninsula and Kaikoura. Several new invertebrate species were described by colleagues based on material collected by Bob during those field trips, and some of them carry his patronymic for posterity (see Appendix 2, below). A major entomological achievement was Bob's discovery of the aquatic larva and pupa of the only species of scorpion fly living in New Zealand, and he proudly took visiting foreign entomologists to the locations where these unusual larvae could be found. Bob was also interested in coastal invertebrates – he wrote the corresponding chapter for the 1969 book *The natural history of Canterbury* – and decapod crustaceans, in particular hermit crabs, of which he had a considerable collection, now housed at the Museum of New Zealand Te Papa Tongarewa (Te Papa).

However, the subject that delighted Bob most, and which took up the greatest part of his time and effort after he left neurophysiology, was parasitology – partly because he believed parasites made 'clever' adaptations and partly because of their close relation to humans. He collected and researched ectoparasites from birds, mammals and marine fishes for the rest of his life. Bob amassed very large collections of lice and fleas, mainly from New Zealand hosts but also from Australian ones, and later added specimens from many other countries, mostly as the result of exchange with overseas colleagues. He donated his collections of lice and fleas – amounting to several tens of thousands of specimens – to Te Papa, where they are now permanently housed, maintained, and available on loan to bona fide researchers.

Bob's interest in parasitic lice, and my M.Sc. thesis on the same group of insects, were the reason for our first meeting in April 1974. I was somewhat worried about my poor spoken English but, as soon as we made contact, we established a strong connection that became a close friendship as years passed. Bob was Head of the Department of Zoology at the time, and he was able to employ me as his personal research assistant for two years, until I took a position at the National Museum of New Zealand, now Te Papa, in 1976. Those two years working with Bob were enlightening and extremely important for my future career as an entomologist and, in particular, as a specialist on lice. He improved my English pronunciation, and he taught me how to write academic English and how important it was to express scientific concepts clearly, without colloquial expressions. He also taught me the necessary tools for publishing scientific papers, and introduced me to many New Zealand entomologists. After my departure from Canterbury, we

corresponded weekly and visited each other at least once a year to work on lice. The number of joint papers we published is testimony to that fruitful cooperation lasting over 30 years (see Appendix 1, below).

During the 1980s, when the National Museum of New Zealand established the honorary positions of research associates, Professor Pilgrim was among the first group of scientists to receive such a title. His appointment was in recognition of his close and mutually beneficial association with the museum, which continued uninterrupted until his death.

Bob was extremely concerned with the quality of spoken and written scientific language, and his office and home contained many foreign-language dictionaries. He was critical of the language skills of science students, noticing that those skills were diminishing as years passed. Bob blamed schools, and wondered how students could become good scientists if they lacked knowledge of grammar and spelling. He strongly believed that if they could not observe language rules, they would not make proper observations in the field or in the laboratory. Bob was also a strong supporter of introducing foreign languages to science degrees, to help students access publications in other languages and when they travelled to international conferences.

In 1983, after almost 40 years working at the University of Canterbury, Bob decided to retire early to dedicate himself to the full-time study of flea larvae, as he felt that was a much-neglected area within the discipline of entomology. His interest in the immature stages of insects was not new, as his previous work on scorpion fly larvae would attest. He felt that studying flea larvae was important considering the role played by some flea species in the transmission of human pathogens, especially the agent of bubonic plague. When interviewed by Christchurch's *The Press* in June 1983, Bob said that he would continue with his flea research at the university 'for at least another 20 years, maybe 30'. At the time of his death, he had achieved 27 years of steady work and had published more than 15 papers on the subject (see Appendix 1, below).

Bob established correspondence with many flea workers, ornithologists and mammalogists around the world in his relentless search for flea larvae representing as many families and genera as possible. He visited Canada, the USA, China, Russia, England and Slovakia to meet colleagues and to obtain specimens. He taught himself to read papers in Russian and in Chinese, since much of the relevant literature is written in those languages. He developed an innovative

technique to dissect, slide-mount and examine the larvae, and used SEM photography to interpret and confirm the nature of anatomical structures he had seen in slide-mounted specimens. He prepared more than 8000 slides of fleas, most of them with larvae, but some with adults that were needed to identify the larvae by association. As a result, Bob amassed what is almost certainly the largest and most diverse collection of flea larvae in the world.

Professor Pilgrim was an active member of the Entomological Society of New Zealand for 40 years. He attended many annual conferences at which he gave engaging oral presentations, he assisted in the organisation of conferences held at the University of Canterbury, he contributed papers to the *New Zealand Entomologist*, and he held the offices of president (1987–89) and immediate past-president (1989–91) in the society's executive. His professionalism, friendly personality and unique sense of humour will be greatly missed in future annual meetings of the society.

At the time of his death, Bob had been associated with the University of Canterbury for more than 70 years, as a student, lecturer, professor, researcher, administrator, emeritus professor and, above all, as a highly respected member of the university community. He was well known for his high level of professionalism, extreme efficiency, sharp punctuality, warm friendliness, special sense of humour and great honesty. At an informal meeting held in Bob's memory at the University of Canterbury in May 2010, several of his old colleagues and friends agreed that his death marked the end of a special era at the university. I believe that Bob's passing marked the end of an era in biological science everywhere.

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Appendix 2: Animal taxa named after Professor Pilgrim

INSECTA

Phthiraptera (parasitic lice)

- Colpocephalum pilgrimi* Price, 1967
Ardeicola pilgrimi Tandan, 1972
Rallicola pilgrimi Clay, 1972
Pseudomenopon pilgrimi Price, 1974
Degeeriella mookerjeei pilgrimi Tendeiro, 1979
Forficuloecus pilgrimi Guimarães, 1985

Hymenoptera (wasps)

- Spilomicrus pilgrimi* Early, 1978

Siphonaptera (fleas)

- Notiopsylla peregrinus* Smit, 1979

ARACHNIDA

Acari (mites)

- Analges pilgrimi* Mironov & Galloway, 2002

Araneae (spiders)

- Plectophanes pilgrimi* Forster, 1964
Aorangia pilgrimi Forster & Wilton, 1973

Opilionida (harvestmen)

- Nuncia (Micronuncia) roeweri pilgrimi* Forster 1954

CRUSTACEA (crabs, shrimps, etc.)

- Neocyproidea pilgrimi* Hurley, 1955
Scherocumella pilgrimi (Jones, 1963)
Mecaderocondria pilgrimi Ho & Dojiri, 1987
Schistobrachia pilgrimi Kabata, 1988
Trizocheles pilgrimi Forest & McLaughlin, 2000

The podocarp *Afrocarpus falcatus* (Podocarpaceae) newly recorded as a casual alien in New Zealand

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ABSTRACT: The African podocarp *Afrocarpus falcatus* (Thunb.) C.N.Page is newly recorded as reproducing within New Zealand. Numerous seedlings were found directly beneath a mature female tree in Palmerston North. Within New Zealand, *A. falcatus* clearly fits the ‘Cultivation Escape’ subcategory of the Casual Record list, and it is easily distinguished from other podocarps by the yellow-orange colour and large size of its mature seed cones, its relatively thin, flaky bark, and details of the leaves.

KEYWORDS: *Afrocarpus falcatus*, Podocarpaceae, new record, casual, naturalised, exotic.

Introduction

Seventeen species of the conifer family Podocarpaceae (*sensu lato*, subsuming the Phyllocladaceae) are presently recognised as indigenous to New Zealand (Eagle 2006). Although more than 2000 exotic vascular plant species are regarded as reproducing autonomously in New Zealand (Wilton & Breitwieser 2000), only a single exotic Podocarpaceae species has been reported as doing so: *Podocarpus elatus* Endl., brown pine, from Australia (Gardner 2010; New Zealand Plant Conservation Network 2010). Evidence is here reported for the autonomous reproduction within New Zealand of a second exotic podocarp, the African *Afrocarpus falcatus* (Thunb.) C.N.Page, or Outeniqua yellowwood.

Eckenwalder (2009) accepted only two species in *Afrocarpus* (J.Buchholz et N.E.Gray) C.N.Page: *A. mannii* (Hook.f.) C.N.Page and *A. falcatus*. *Afrocarpus mannii* is distinguished by its longer, wider leaves and bigger seeds, and is endemic to São Tomé Island (off Africa’s central west coast). The natural distribution of *A. falcatus sensu lato* is eastern Africa, from northern Ethiopia discontinuously to the Cape region of South Africa. In contrast, Farjon (2010) recognised four species within the broadly circumscribed *A. falcatus* of Eckenwalder (2009), to give five species for the genus. The natural distribution of *A. falcatus sensu* Farjon (2010) is from Malawi and Mozambique to South Africa.



Fig. 1 Adult foliage and seed cones of *Afrocarpus falcatus* (source of WELT SP088055).



Fig. 2 Immature seed cone of *Afrocarpus falcatus* (source of WELT SP088055).

Collection data and identification

On 4 January 2010, numerous seedlings were found directly beneath a mature female of *Afrocarpus falcatus* in Palmerston North, between Massey University's College of Education campus and the Manawatu River. The female parent (Figs 1–3) and seedlings (Fig. 4) are vouchered by specimens in the herbarium of the Museum of New Zealand Te Papa Tongarewa (WELT SP088055 and SP088056, respectively; see Museum of New Zealand Te Papa Tongarewa 2010). The adult was part of a stopbank shelterbelt consisting largely of *Pittosporum eugenoides*, with surrounding grass lawn. At least another three, smaller trees of *A. falcatus* occur nearby (c. 500 m), within the Esplanade Gardens. Two of these are females (*Afrocarpus* being dioecious), while no cones were seen on the third. Seedlings were not observed at this second site.

The fruiting female above the seedlings was identified as *Afrocarpus falcatus sensu stricto* using the key in Farjon (2010). Of particular note amongst the characters used by Farjon (2010), the surface of the seed proper inside the fleshy epimatium is verrucose in the Palmerston North material (not shown).

Successful reproduction of *Afrocarpus falcatus* (*sensu stricto*; C. Ecroyd, pers. comm. November 2010) in New Zealand is also indicated by a specimen held by Scion's herbarium. NZFRI 26519 is a specimen of an adult tree collected on 6 May 2007 by T.R. Pellett from Napier's Hospital Hill. The collection notes record 'There are a number of seedlings under and close to both trees'. However, vouchers of the seedlings themselves were not collected.

Discussion

In the parlance of Heenan *et al.* (2008: 257), *Afrocarpus falcatus* in New Zealand is regarded as a Casual (Alien, or Non-native) Record, rather than a Naturalised Record, because there is no evidence (yet) that its 'populations are self-maintained' by seed or vegetative reproduction, or they occur repeatedly in natural or semi-natural habitats or [outside cultivation] in urban environments' (emphasis added). Furthermore, it clearly fits the Cultivation Escape subcategory of the Casual Record list, in that it is 'regenerating only in the immediate vicinity of the cultivated parent plant' (Heenan *et al.* 2008: 258). *Afrocarpus falcatus* has also been



Fig. 3 Bark of *Afrocarpus falcatus* (source of WELT SP088055).



Fig. 4 Some of the *Afrocarpus falcatus* seedlings (source of WELT SP088056) under the adult in Figs 1–3. Note the fallen seeds.

recorded as naturalised in Australia, near Sydney (Hill 1998).

Afrocarpus falcatus is widely cultivated in New Zealand. The New Zealand Virtual Herbarium (2010; drawing on collections in the herbaria of Auckland Museum, Landcare Research, Massey University and Scion) records presumably cultivated specimens from Northland, Auckland, Coromandel, Bay of Plenty, Taranaki, Central Plateau, Hawke's Bay, Manawatu and Canterbury. *Afrocarpus falcatus* may have a relatively long history of cultivation in New Zealand. For instance, the label on the Scion specimen referred to above (NZFRI 26519) states 'Growing close to graves from 1893–1897 and likely to have been planted around this time'. *Afrocarpus gracilior* (Pilg.) C.N.Page, which was synonymised with *A. falcatus* by Eckenwalder (2009) but retained by Farjon (2010), is also cultivated in New Zealand, but only sparingly so (C. Ecroyd, pers. comm. November 2010); it has a smooth surface to the seed coat inside the epimatium (Farjon 2010).

Within the context of New Zealand's podocarps, *Afrocarpus falcatus* is superficially similar to *Prumnopitys taxifolia* (or even *Podocarpus totara*) in leaf architecture, and to *Prumnopitys ferruginea* in the size of the mature seed cone. However, the yellow-orange colour of the mature seed cone (Fig. 1) readily distinguishes *A. falcatus*, especially when considered in combination with the relatively thin, flaky bark (Fig. 3; rather than being pockmarked or furrowed), the large size of the mature seed cone, and details of the leaves.

Eckenwalder (2009) suggests that the major natural seed disperser of *Afrocarpus falcatus* may be fruit-eating bats. With this vector unavailable in New Zealand, it will be interesting to observe to what extent *A. falcatus* will naturalise.

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Some terrestrial flatworm taxa (Platyhelminthes: Tricladida: Continenticola) of the Subantarctic Islands of New Zealand

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ABSTRACT: Within the context of ongoing taxonomic revisions of terrestrial flatworms from the New Zealand Subantarctic Islands: (1) a new tribe Argaplanini is erected; (2) a new genus *Argaplana* is erected; (3) the species *Argaplana ranuui* is redescribed; and (4) the replacement name *Marionfyfea* is proposed for *Fyfea*, pre-occupied.

KEYWORDS: Land planarians, Continenticola, Geoplanidae, Argaplanini, *Argaplana*, *Marionfyfea*, Subantarctic Islands, New Zealand.

Introduction

Terrestrial flatworm taxa from the Subantarctic and other islands, based on the Museum of New Zealand Te Papa Tongarewa collection of terrestrial flatworms, are presently being studied and revised by the author (Winsor 2006, 2009). This paper concerns the redescription of *Kontikia ranuui* (Fyfe, 1953) and its assignment to a new genus to be accommodated in a new tribe of the Rhynchodermata. A replacement name is also proposed for *Fyfea*, pre-occupied.

Materials and methods

The specimen selected for histology was processed to paraffin wax, longitudinally sagittally (LSS) and transversely sectioned (TS) at 8 µm, and stained using the AZAN method (Winsor 1998). Nomenclature of the stripe pattern follows the scheme of Graff (1899: 25). Determination of the cutaneous and parenchymal muscular indices (CMI, PMI) follows Winsor (1983). The classification follows that of Sluys *et al.* (2009). The specimen is held in the collections of the Museum of New Zealand Te Papa Tongarewa, Wellington (MONZ).

Abbreviations used in figures

an	antrum
cg	cyanophil glands
cm	cutaneous musculature
cod	common ovovitelline duct
cs	creeping sole
dp	dorsal plate, parenchymal musculature
ed	ejaculatory duct
ep	eversible penis
fg	female genital canal
gm	glandular margin
gp	gonopore
in	intestine
l	lateral median stripes
m	median dorsal stripe
mo	mouth
nc	nerve cord
oe	oesophagus
ovd	ovovitelline duct
p	pale dots on ventral ground colour
pg	penial glands
ph	pharynx
php	pharyngeal pouch

psv	proximal seminal vesicle
rh	rhammites
sdv	spermiducal vesicle
sg	shell glands
sv	seminal vesicle
te	testis
vd	vas deferens
vi	vitellaria
vp	ventral plate, parenchymal musculature

Systematics

Family Geoplanidae Stimpson, 1857

Argaplana new genus

DIAGNOSIS: Geoplanid with small body, gently tapered at each end, subcylindrical in cross section. Mouth situated in mid-third of body, gonopore closer to mouth than to posterior end. Eyes present in multiple rows around the anterior tip and dorso-anteriorly, extending the length of the body. Sensorial margin passes antero-ventrally around the anterior tip. Sensory papillae, anterior adhesive cup and sucker absent. Creeping sole ciliated, 50% or more of body width. Cutaneous musculature tripartite, with circular, helical and longitudinal muscles; longitudinal muscles in well-defined bundles; dorsal cutaneous musculature thinner than that ventrally, CMI 3.6%. Parenchymal longitudinal muscles present in a dorsal and a ventral plate, PMI 35%, stronger ventrally than dorsally and intersected by a closely woven meshwork of oblique-transverse and dorso-ventral muscle fibres. Testes ventral, extending from behind ovaries to almost the posterior end. Efferent ducts ventral. Penis eversible type without papilla. Ovaries in anterior body third. Ovovitelline ducts unite then enter female genital canal ventro-posteriorly (postflex ventral approach). Female genital canal enters antrum dorso-posteriorly. Resorptive bursa, adenodactyls and viscid gland absent.

TYPE SPECIES: *Argaplana ranuui* (Fyfe, 1953).

ETYMOLOGY: the name *Argaplana* comprises *Argus* (Latin), the mythical hundred-eyed guardian of Io, alluding to the multiple eyes around the anterior tip of the planarian; and *plana* (Latin = flat, planarian). Gender: feminine.

DISTRIBUTION: Campbell Island, New Zealand.

Systematic discussion

The recently proposed higher classification of planarian flatworms (Sluys *et al.* 2009) places all terrestrial flatworms within the Geoplanidae, which comprises three

subfamilies: the Bipaliinae, the Microplaninae, and the Rhynchodeminae (to which all native terrestrial flatworms of New Zealand and its Subantarctic Islands belong). The Rhynchodeminae presently comprises five Tribes: the Rhynchodemini, Caenoplanini, Pelmatoplanini, Anzoplanini and Eudoxiatopoplanini.

The tribe Eudoxiatopoplanini and genus *Eudoxiatopoplana* were erected to accommodate taxa with multiple eyes concentrated around the anterior end, dorsally and along the sides; without auricular or tentacular organs or a semilunar headplate; without a creeping sole; and with dorsal testes. The eye pattern in which multiple rows of eyes pass around the anterior tip, with lateral clustering, and eyes extending the length of the body present in *Argaplana*, is similar to that in *Eudoxiatopoplana*. However, in *Argaplana* the testes are located ventrally, unlike *Eudoxiatopoplana*, where the testes are located dorsally. Also, *Argaplana* has a creeping sole, absent in *Eudoxiatopoplana*. *Argaplana* is therefore excluded from the Eudoxiatopoplanini and placed in a new tribe, the Argaplanini.

Argaplanini new tribe

TYPE GENUS: *Argaplana* Winsor, new genus.

DIAGNOSIS: Geoplanidae with eyes of pigment cup-type in multiple rows around the anterior tip, continuing to the posterior end and dorsally. With ventral testes and ventral efferent ducts. With tripartite cutaneous musculature, with cutaneous longitudinal muscles in well-defined bundles, with parenchymal longitudinal muscles present in strong dorsal and ventral plates. Ring zone absent. With a ciliated creeping sole extending over 50% of the body width.

A comparison of key taxonomic characters and states present in *Argaplana* (Argaplanini) and *Eudoxiatopoplana* (Eudoxiatopoplanini) is provided in Table 1.

Argaplana ranuui (Fyfe, 1953) new combination (Figs 1–5)

Geoplana ranuui Fyfe, 1953: 10, text fig. 3, plate II, fig. 2.

Kontikia ranuui (Fyfe) Ogren and Kawakatsu 1991: 83; Ogren *et al.* 1997: 80, 90.

MATERIAL EXAMINED: MONZ 1389. Campbell Island, New Zealand, 52° 30'S 169° 05'E. Collected at 10 m above sea-level under logs by C.M. Clark on 10 August 1962. Sectioned at 8 µm, a series of 44 slides stained with the AZAN method: anterior LSS, and pre-pharyngeal TS and posterior LSS together, sectioned from the left side.

Table 1 A comparison between some key taxonomic characters and states present in the multi-eyed taxa *Argoplana* (tribe Argaplanini) and *Eudoxiatopoplana* (tribe Eudoxiatopoplanini).

Character	<i>Eudoxiatopoplana</i>	<i>Argaplana</i>
Rows of eyes around anterior tip	Multiple	Multiple
Testes	Dorsal	Ventral
Type of creeping sole	Non-ciliated	Ciliated
Cutaneous longitudinal musculature	Weak in bundles	Weak in bundles
Cutaneous muscular index	4.5–6.5%	3.6%
Parenchymal longitudinal musculature	Very strong; present in a ring zone	Very strong, present in a dorsal and a ventral plate; not in a ring zone
Parenchymal muscular index	38.5%	35%
Pharynx	Cylindrical	Cylindrical
Length of pharynx as % of body length	13.3	11.0
Pharyngeal musculature – inner	Mixed circular and longitudinal muscles	Mixed circular and longitudinal muscles
Pharyngeal musculature – outer	Longitudinal muscles, then mixed circular and longitudinal muscles	Circular muscles, then mixed circular and longitudinal muscles
Oesophagus	?Absent	Present
Pharyngeal pouch length as % of body length	8.1	7.7
Mouth position as % of body length	33.8 (anterior body third)	63.2 (mid- to mid-third of body)
Gonopore position as % of body length	49.0 (about mid-body)	76.1 (posterior third of body)
Mouth–gonopore distance as % of body length	15.2	15.5
Copulatory organs – penis type	introverted	eversible without distinct papilla
Copulatory organs – resorptive bursa	present	absent
Copulatory organs – adenodactyls	present	absent

DESCRIPTION:**External features**

A small, cylindroid rhynchodemid, slightly tapered anteriorly to a blunt anterior end (Fig. 1a), the tip of which is rounded. The body broadens, reaching maximum width in the mid-body, after which it tapers gently to a rounded posterior with pronounced caudal tip (Fig. 1b). Body sub-cylindrical in cross section. Mouth ventrally situated in the

second third of the body, with the gonopore in the last body quarter. Creeping sole ciliated, distinct. Dorsal and ventral ground colour cream-white, with the creeping sole a paler colour than the rest of the body. There was no evidence of other markings. With multiple eyes (Fig. 2a–c), crowded around the anterior tip margin, scattered dorsally in a loose median patch and continuing posteriorly in a zigzag pattern to the posterior tip; slightly crowded antero-

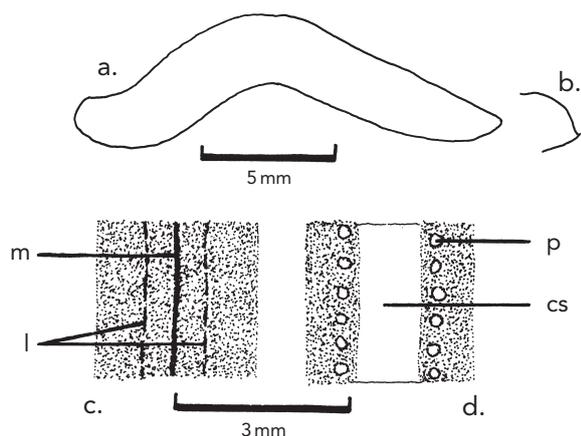


Fig. 1 *Argaplana ranuii* MONZ 1389: (a) whole specimen, latero-dorsal aspect, and (b) caudal tip; (c) dorsal markings and (d) ventral markings redrawn from the original card index belonging to Marion Fyfe and now in the author's possession.

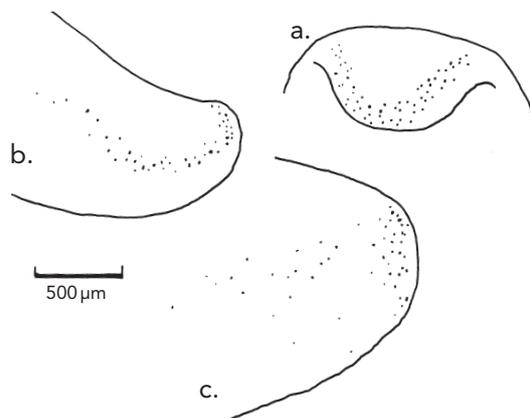


Fig. 2 *Argaplana ranuii* MONZ 1389, anterior tip showing distribution of eyes: (a) frontal aspect; (b) antero-lateral aspect; (c) dorsal aspect.

laterally on either side, then continuing in a staggered submarginal row to the posterior. Dimensions of the single specimen are provided in Table 2.

Internal anatomy

Head: Adhesive suckers with associated musculature absent. Gut extends to within approximately 0.5 mm of tip, overlies ganglion. Eyes pigment cup 23–31 µm diameter; the number of retinal clubs could not be determined. Sensorial zone extends around antero-ventral margin. Ciliated pits some 50 µm apart, simple invaginations, 12.6 µm diameter, 36 µm deep, lined by ciliated anucleate epithelium.

Pre-pharyngeal region: A schematic representation of the transverse pre-pharyngeal region is provided in Fig. 3. Dorsal

Table 2 *Argaplana ranuii* (Fyfe, 1953), dimensions of specimen MONZ 1389. Positions of body apertures are measured from the anterior tip. Dimensions of the specimen given in Fyfe (1953) are provided in parentheses.

Specimen MONZ 1389	
Length (mm)	15.5 (15)
Width (mm)	2.5
Mouth (mm)	9.4 (7.5)
Mouth position as % of body length	63.2 (50.0)
Gonopore (mm)	11.8 (10)
Gonopore position as % of body length	76.1 (66.7)
Distance from mouth to gonopore (mm)	2.4 (2.5)
Mouth–gonopore distance as % of body length	15.5 (16.7)
Width of creeping sole (mm)	1.3
Width of creeping sole as % of body width	52
Body height (mm)	1.3
Pharynx length (mm)	1.7 (protruded)
Length of pharynx as % of body length	11
Pharyngeal pouch length (mm)	1.2
Length of pharyngeal pouch as % of body length	7.7

epithelium 28 µm thick, slightly thicker than the ventral epithelium, which is 27 µm thick, nucleate. Creeping sole comprises a ciliated nucleate columnar epithelium. Broad leaf-like (foliaceous) rhammites 18–27 µm long and 3.6 µm wide, derived from rhabditogen cells underlying cutaneous musculature, extend dorso-laterally to outer margins of creeping sole, abundant laterally. Epitheliosomes secreted from creeping sole. Finely granular erythrophil secretions from parenchymal glands present dorso-laterally over body, abundant laterally to form a marginal adhesive zone. Amorphous xanthophil secretions from parenchymal glands discharged from the ventral surface. Cutaneous cyanophil secretions and pigment absent.

Body 2.5 mm wide. Creeping sole 1.3 mm wide, 52% of body width. Body height 1.3 mm. Body width to height ratio 1.9:1. Cutaneous musculature weak, tripartite, with

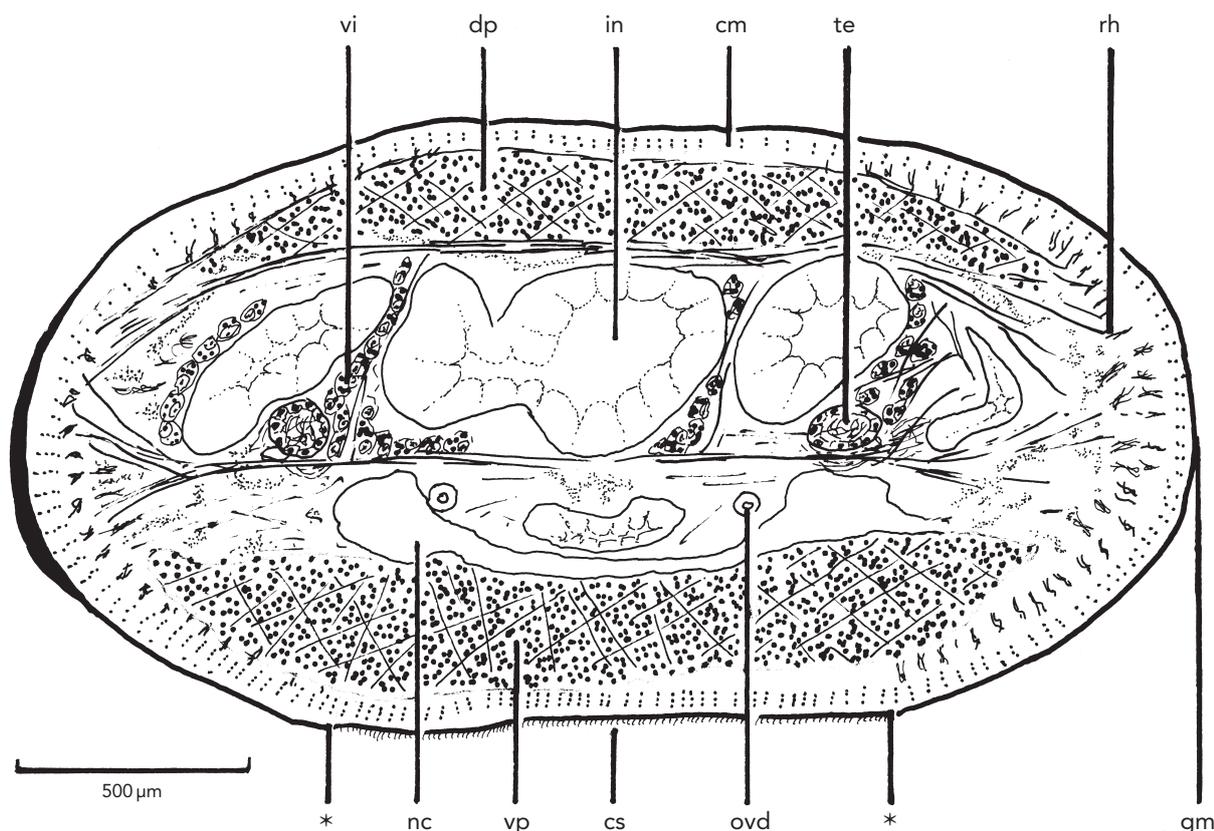


Fig. 3 *Argaplana ranuii* MONZ 1389: pre-pharyngeal region, transverse section. The asterisk (*) indicates the ventral extent of the rhammites. Note that the section is slightly oblique, resulting in an apparent thicker epithelium on the left-hand side of the body.

circular and helical muscles, and with cutaneous longitudinal muscles in distinct bundles, not in-sunk. Dorsal cutaneous musculature thinner ($28\ \mu\text{m}$ thick) than ventral musculature ($33.6\ \mu\text{m}$ thick). CMI 3.6%.

Parenchymal longitudinal muscles in bundles of varying size present in two massive plates tapering laterally to sparse bundles of longitudinal muscles, PMI 35%, stronger ventrally ($284\ \mu\text{m}$ thick) than dorsally ($177\ \mu\text{m}$), intersected by a closely decussate meshwork of oblique-transverse and dorso-ventral muscle fibres in diamond-pattern corseting. Strong suprainestinal transverse muscles, infrainestinal transverse muscles and dorso-ventral muscles present. Nephridial elements present between the ventral plate and cutaneous nerve net.

Alimentary tract: Gut with lateral intestinal branches mostly bifurcate, largely empty. Pharynx (Fig. 4) cylindrical, contracted, ruptured through the dorsal pouch wall, $1.7\ \text{mm}$ long, 11% of body length, with dorsal insertion posterior to ventral insertion. Inner pharyngeal musculature with subepithelial mixed longitudinal-circular muscles; outer

pharyngeal musculature comprises subepithelial circular, then mixed circular-longitudinal muscles. Oesophagus present. Pharyngeal pouch $1.2\ \text{mm}$ long, 7.7% body length. Mouth opens mid-pouch; the pharynx is contracted and the mouth may open more posteriorly towards the end of the pharyngeal pouch. Diverticulum absent.

Reproductive organs: Copulatory organs simple (Fig. 5), situated immediately behind the pharyngeal pouch, with eversible penis. Gonopore $200\ \mu\text{m}$ diameter. Resorptive bursa and adenodactyls absent. Testes mature, ellipsoidal in shape up to $40\text{--}70\ \mu\text{m}$ diameter, follicular, mostly uniserial, ventral, lying just below the gut (Fig. 3) between the intestinal diverticula, extending posteriorly from just behind the ovaries to within $2\ \text{mm}$ of the hind end. Sperm ductules emerge from the lateral lower pole of the testes, pass ventrally around the lateral margin of the nerve cords, and join the vas deferens, which lie approximately in line with the testes immediately below the nerve cords. The vasa deferentia anterior to the pharynx are thin-walled. Just behind the pharyngeal pouch, the efferent ducts form

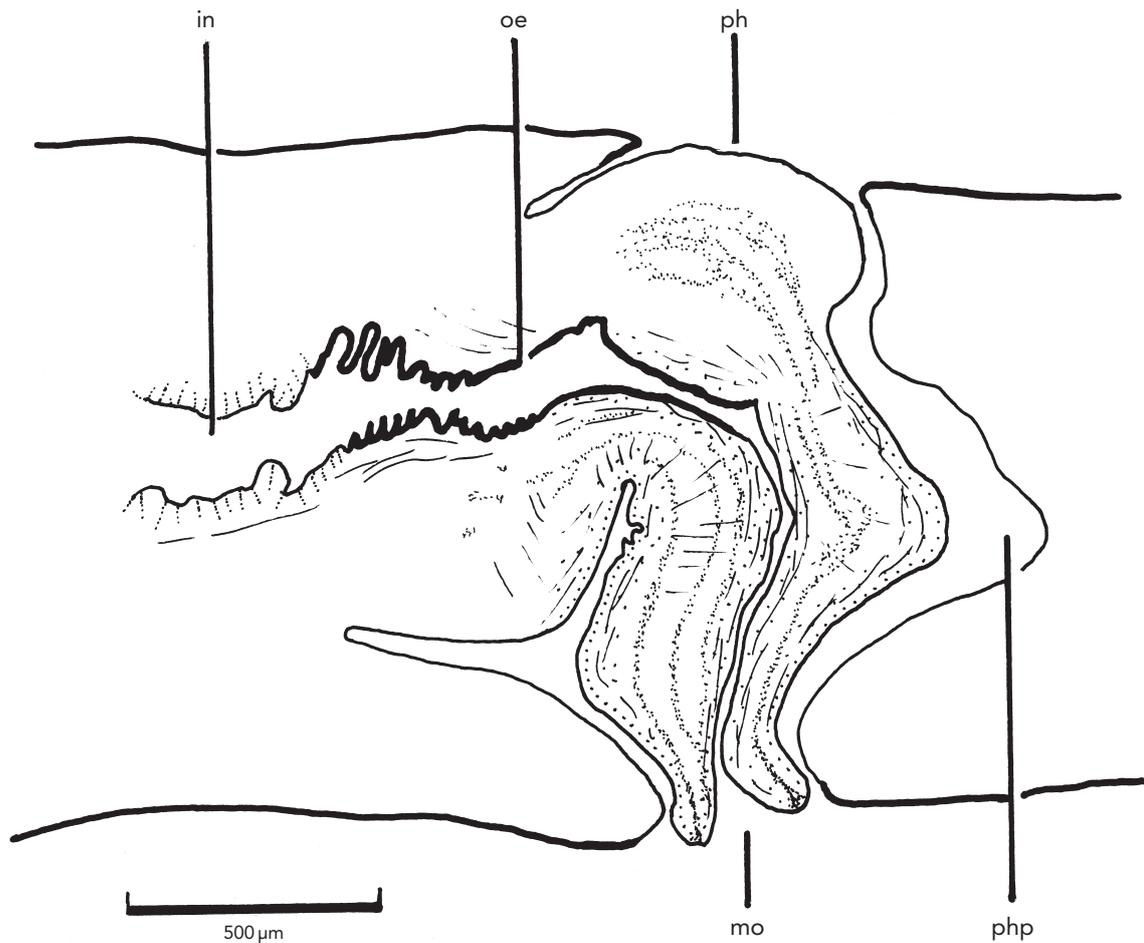


Fig. 4 *Argaplana ranuii* MONZ 1389: pharynx, longitudinal sagittal section.

capacious spermiducal vesicles that rise slightly to open separately into the seminal vesicle.

Seminal vesicle musculature comprises inner circulo-oblique muscles that merge ectally with the longitudinal muscles of the penis bulb. Glands supplying the seminal vesicle are located in the parenchyma outside the penis bulb. The seminal vesicle comprises two parts: a proximal section, spheroid in shape, some 70 μm diameter, with fimbriate vacuolate nucleate non-ciliated columnar cyanophil epithelium, through which necks of glands situated external to the penis bulb discharge fine-grained erythrophil and amorphous cyanophil secretions into the lumen; and a distal section, 57 μm long with a columnar epithelium that merges into that of the ejaculatory duct.

Ejaculatory duct short, 114 μm long, lined by rugose nucleate non-ciliated cuboidal epithelium that grades into the tall, glandular antral epithelium, underlain by strong circulo-oblique muscles. Fine erythrophil and xanthophil

secretions derived from glands external to the penis bulb pass through penial musculature into lumen of ejaculatory duct. Penis bulb with fairly loose, mixed musculature enclosing the spermiducal vesicles, with strong circular and longitudinal muscles where the ejaculatory duct opens into the antrum. Penis eversible type without a papilla.

Ovaries situated approximately one-third of the distance between the brain and the root of the pharynx; ellipsoid, with left ovary slightly larger (140 μm dorso-ventral axis \times 170 μm antero-posterior axis) than the right (106 μm \times 84 μm), both with 200 μm diameter laterally, embedded in lateral nerve cords. Ovitelline ducts arise from mid-posterior walls of ovaries. Proximal end of each duct slightly expanded, without sphincter muscle at point of contact with ovary. Resorptive cells absent.

Ovitelline ducts lined by nucleate ciliated low-columnar epithelium, and with inner longitudinal and ectal circular musculature, filled with sperm, pass ventrally and

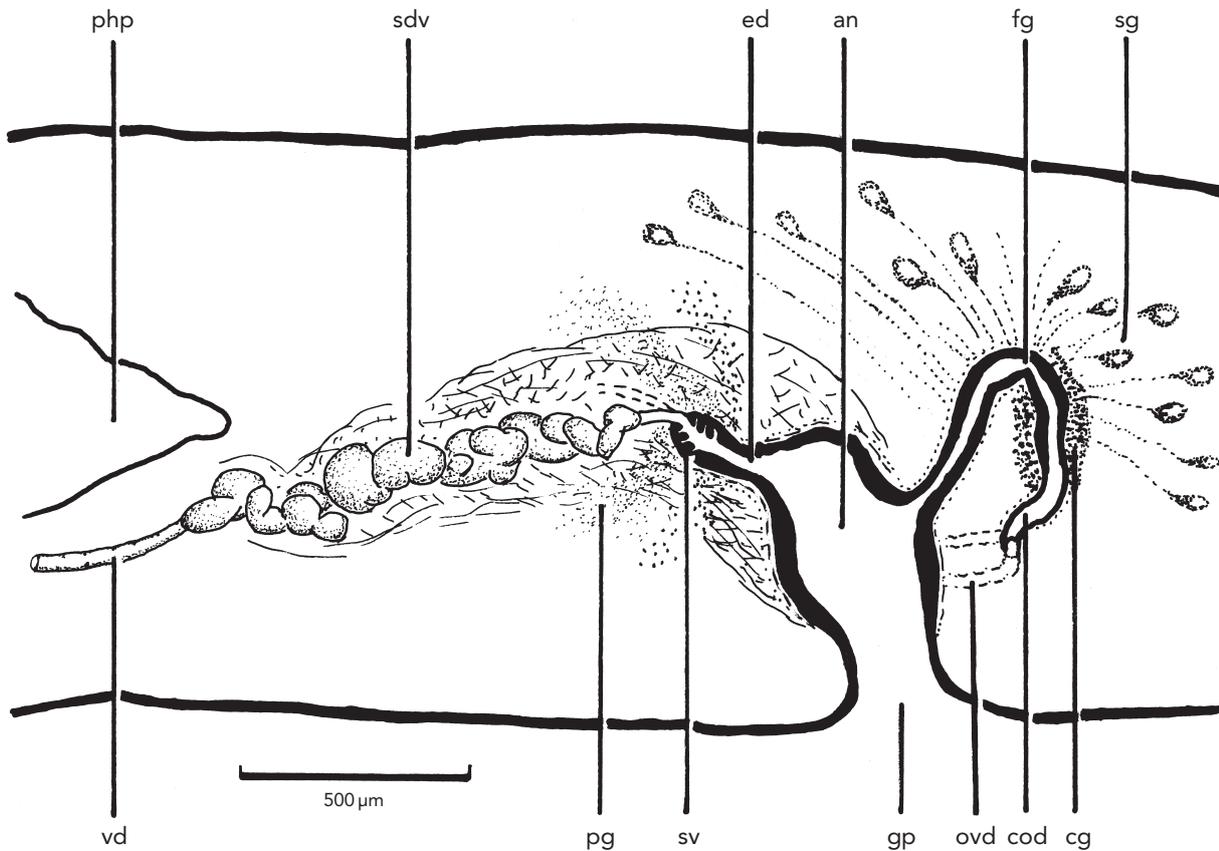


Fig. 5 *Argaplana ranuii* MONZ 1389: copulatory organs, composite longitudinal sagittal section.

continue posteriorly along nerve cords, and just behind the copulatory organ bulb bend medially, then unite to form a short, common ovovitelline duct. Common oviduct 200 μm long, with epithelium and musculature same as ovovitelline duct, communicates directly with the female genital canal (proflax ventral approach). Genitointestinal duct absent. Female genital canal curves slightly and rises vertically, bends anteriorly to enter the mid-dorsal rear wall of female antrum. Genital canal lined by columnar epithelium with cyanophil cytoplasm, receives coarse xanthophil ('shell gland' secretion), and fine granular cyanophil granules secreted into lumen as strands; both secretions derived from glands in surrounding parenchyma; with inner longitudinal and outer circular musculature. A thick lamellar xanthophil length of secretion (putative cocoon wall) was present in the distal genital canal. Antrum lined by pseudostratified epithelium comprising strand cells, the tips of which are heavily charged with coarse xanthophil granules together with cyanophil gland cells. The cyanophil gland cells appear to be secreted in a holocrine manner into the

antral lumen. The antral lumen contains a mixture of xanthophil and cyanophil secretions. Antrum with subepithelial longitudinal muscularis is surrounded by circular muscles merging into a loosely interwoven, mixed muscularis.

Vitellaria well developed, situated between gut diverticula, empty into the ovovitelline ducts via short, narrow vitelline funnels.

PATHOLOGY: Gregarines present in intestinal mucosa.

ETYMOLOGY: Fyfe (1953) did not specify the origin or gender of the specific epithet. During the Second World War, one of the relief ships that supplied the coastwatchers on the Subantarctic Islands was the *Ranui* (Fraser 1986), after which Ranui Cove in Port Ross, Auckland Island, is named. Fyfe based her description on some eight specimens (RAF4) collected by J.H. Sorensen on Campbell Island. Contrary to Ogren & Kawakatsu (1991: 83) and Ogren *et al.* (1997: 80), the species has not been found on the Auckland Islands. As there are no landmarks named 'Ranui' on Campbell Island, in all likelihood Fyfe named the species

as *ranuii* after the relief ship or Ranui Cove. Ranui is also a community in urban Waitakere City, West Auckland, New Zealand. The ending of the specific epithet *ranuii* suggests that the name is masculine and therefore is in apposition to the feminine generic name.

Systematic discussion

With respect to the eyes in *Argaplana ranuii*, Fyfe (1953) stated that ‘The numerous eyes are arranged in a ring round the anterior end, which is turned up, and the eyes continue in a zig-zag along the sides’; the eye pattern was not illustrated (although six taxa were considered by Fyfe (1953), only plate IV, figure 1 illustrates an eye pattern of the hooded end of *Coleocephalus fuscus*). In the absence of a specific comment, it must be assumed that Fyfe did not consider the eye pattern present in *A. ranuii* to be noteworthy.

At present, only two austral flatworm genera are known to have multiple rows of eyes that contour around the anterior tip – *Argaplana* and *Eudoxiatopoplana* – the key taxonomic characters and states of which are compared in Table 1. The two genera are chiefly differentiated on the basis of the positions of the testes (dorsal in *Eudoxiatopoplana* and ventral in *Argaplana*), penis type and creeping sole (present in *Argaplana* and absent in *Eudoxiatopoplana*). The pointed caudal tip noted in the specimen of *Argaplana ranuii* is similar to that present in an as yet undescribed eyeless Australian terrestrial flatworm and may be a fixation artefact. The specimen examined and described in this paper (MONZ 1389) exhibited no markings, possibly resulting from the process of preservation. Only the ventral markings showing the ‘row of pale dots on the brown bands’ of *A. ranuii* have previously been illustrated (Fyfe 1953: text fig. 3). However, the dorsal and ventral markings of the species are illustrated in colour in the original card index belonging to Marion Fyfe, now in the author’s possession. In the material examined and described by Fyfe (1953), the species had a dark brown dorsal ground colour with a single median dark brown dorsal stripe. In an immature specimen 12 mm long, Fyfe (1953: 11) noted that the dorsum had a red-brown ground colour with two narrow black stripes dividing it into three more or less equal zones. The markings of the dorsal surface illustrated by Fyfe in her card index and redrawn here (Fig. 1c) appear to be a composite of these two forms.

Fyfe (1953) compared *Geoplana ranuii* to *Geoplana quadrangulata* (Dendy, 1890; 1891; now *Reomkago quadrangulata*) with respect to similarities in the external features of the two species, in particular the size, antero-ventral halo

markings (circles in Fig. 1d), and lack of clear demarcation between dorsal and ventral surfaces. *Reomkago* is characterised by a single row of eyes around the anterior tip without antero-lateral crowding (multiple rows of eyes in *Argaplana*); creeping sole <50% body width (>50% in *Argaplana*); and strong dorso-ventral musculature (absent in *Argaplana ranuii*) that is responsible for the quadrangulate cross-sectional shape of *R. quadrangulata*. A distinct penis papilla is present in *Reomkago quadrangulata* and absent in *Argaplana ranuii*, which has an eversible penis lacking a papilla.

Fyfe (1953) also noted that the cylindrical pharynx in *Argaplana ranuii* was also present in *Reomkago quadrangulata* and another species, *Artioposthia ventropunctata* (Dendy, 1892). A cylindrical pharynx is present in numerous land planarian taxa. Of greater significance than the type of pharynx is the pharyngeal musculature. In this case, *Argaplana ranuii*, *Artioposthia ventropunctata* and *R. quadrangulata* all have a Dendrocoelid-type derived pharyngeal musculature with mixed inner musculature, but differ in that *Argaplana ranuii* has an outer circular-mixed musculature whereas *R. quadrangulata* and *Artioposthia ventropunctata* have an outer pharyngeal musculature of longitudinal-circular-longitudinal muscles (Winsor 2003).

Curiously and without explanation, Ogren & Kawakatsu (1991) transferred Fyfe’s *Geoplana ranuii* to the genus *Kontikia*, although data on the musculature of *G. ranuii* was unavailable and Fyfe’s figure showed that the species clearly lacked a penis papilla characteristic of *Kontikia*. The description of the seminal vesicle and ejaculatory duct provided by Fyfe (1953) generally accords with that of the specimen examined here. The only difference noted is the relative lengths of the seminal vesicle (127 µm) and ejaculatory duct (114 µm); in Fyfe’s figure (plate II, fig. 2), the distal seminal vesicle appears longer than in the specimen considered here. Fyfe’s description of the distal epithelium with long gland cells of the seminal vesicle accords more with that of the distal ejaculatory duct.

Comments

Both *Argaplana* and *Eudoxiatopoplana* exhibit unusual combinations of taxonomic features that underline the constraints of morphologically based taxonomy of terrestrial flatworms and reinforce the need to reassess the characters and states that define terricolan genera and higher ranks. The relative importance of some characters, including the dorso-ventral extent of the testes, and the presence or absence of

a creeping sole and adenodactyls, needs to be reassessed. Are terrestrial planarians with multiple eyes around the anterior tip, with dorso-ventral testes, with or without a creeping sole, and with or without adenodactyls in their copulatory apparatus awaiting discovery?

Replacement name for *Fyfea* Tribe Anzoplanini

Marionfyfea nomen novum

Fyfea Winsor 2006: 88. Junior homonym of *Fyfea* Finlay & Marwick, 1937.

Artioposthia (in part); Fyfe, 1953: 9; Ogren & Kawakatsu 1991: 37.

TYPE SPECIES: *Artioposthia carnleyi* Fyfe, 1953.

The terrestrial flatworm genus *Fyfea* was erected to accommodate those Anzoplanini with a post-oral ovary, inverted penis and adenodactyl (Winsor 2006). Subsequently, I found that the name had previously been used for a Palaeocene gastropod honouring a Mr H.E. Fyfe, who discovered an important Wangaloan fossil assemblage at Boulder Hill, near Dunedin (Finlay & Marwick 1937). The name *Marionfyfea* is now proposed to replace *Fyfea* Winsor, 2006, preoccupied. The new name is after Marion Fyfe, the author of the type species. Gender feminine.

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Annotated checklist of New Zealand Decapoda (Arthropoda: Crustacea)

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ABSTRACT: A checklist of the Recent Decapoda (shrimps, prawns, lobsters, crayfish and crabs) of the New Zealand region is given. It includes 488 named species in 90 families, with 153 (31%) of the species considered endemic. References to New Zealand records and other significant references are given for all species previously recorded from New Zealand. The location of New Zealand material is given for a number of species first recorded in the *New Zealand Inventory of Biodiversity* but with no further data. Information on geographical distribution, habitat range and, in some cases, depth range and colour are given for each species.

KEYWORDS: Decapoda, New Zealand, checklist, annotated checklist, shrimp, prawn, lobster, crab.

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Introduction

This annotated checklist provides a list of the Recent Decapoda of the New Zealand region. It grew from unpublished lists of New Zealand decapods written by John Yaldwyn and circulated among specialists between 1973 and 1988. It has been regularly augmented until the present, and includes revisions, name changes, and new species and records for the region, published up to November 2010.

A list of New Zealand decapod species is also included in the second volume of the *New Zealand inventory of biodiversity* (see Webber *et al.* 2010). While this checklist includes most of the species listed in the *Inventory of biodiversity*, a few have been omitted because they have been found only beyond the confines of what we define as the New Zealand region (see Fig. 1). Conversely, and because taxonomic work on southwest Pacific decapods is currently highly active, this checklist includes some additional species described since the *Inventory of biodiversity* was completed.

The New Zealand region is confined within the coordinates 25°S and 57°S, and 157°E and 167°W (Fig. 1), but for our purposes it excludes areas in the northwest of this frame. As perceived here, the New Zealand region includes only the southern portions of the Lord Howe Rise and West Norfolk Ridge, excluding Lord Howe and Norfolk islands and the shallow waters surrounding them. Both areas have species in common with New Zealand but also have shallow, warm-water species not recorded in the New Zealand region. Therefore, the New Zealand region as defined in this paper encompasses features outside New Zealand's economic zone (NZ EEZ), including the Louisville Ridge to the northeast, ridges extending to the north, northwest and southwest, and trenches and abyssal plains that extend away from New Zealand, such as Macquarie Ridge and Macquarie Island, which are in Australian waters. The map in Fig. 1 differentiates only between waters shallower and deeper than 2000 m, to indicate clearly the extent of submarine features of the New Zealand 'continent'.

This checklist includes 488 species in 90 families. Among the named species, 153 (31%) are presently considered to be endemic. Five exotic species are recorded as having been introduced for commercial purposes, and a small number of accidentally introduced species that have become established are also listed. Exotic species that have been found, usually in harbours, but that have not established themselves, are excluded from the list.

Methods

Classification

An earlier manuscript of this paper followed the higher classification to decapod family level of Martin & Davis (2001), but fundamental changes have been made since then. Ng *et al.* (2008) updated the classification of the Brachyura, but the primary source of generic and higher classification used here is De Grave *et al.* (2009). However, even this has since been modified in two papers that have expanded the classification of the squat lobsters (Ahyong *et al.* 2010; Schnabel & Ahyong 2010). Further changes can be expected but, in the meantime, the classification of De Grave *et al.* (2009) and subsequent changes are adopted here, uncritically.

Species included

Considering that many New Zealand decapods also occur in Australian waters, the presence of a species in both countries is noted in each species account in this checklist. Australian records are taken primarily from the *Zoological catalogue of Australia* (Davie 2002a,b) and *Marine decapod Crustacea of southern Australia* (Poore 2004). The latter account is of particular relevance because the temperate waters of southern Australia and New Zealand share many decapod species. Poore's work is an essential reference to these taxa, providing general accounts of families and descriptions of species, including illustrations of the diagnostic characters of each species. Some species are illustrated whole, often for the first time, with excellent drawings, and there are many colour photos.

A number of papers on New Zealand brachyuran species from deep water and, especially, on crabs of the Kermadec Islands have been published in the last five years (e.g. Takeda & Webber 2006; Ahyong 2008; McLay 2009). These papers have added considerably to the number of families, genera and species recorded from New Zealand. The Kermadec Ridge, now more readily included in New Zealand faunal lists than it was prior to the declaration of the '200-mile limit', has been a rich source of new taxa for the region. Further new records can be expected from there and inadequately sampled areas elsewhere, particularly in northern waters.

In 2009, following completion of her Ph.D. on the New Zealand squat lobsters (2009a), Kareen Schnabel published the first comprehensive account of the family Chirostylidae in New Zealand, taking the number of known species from seven to 15 (Schnabel 2009b). She is currently preparing further publications on the Galatheoidea. A very recent

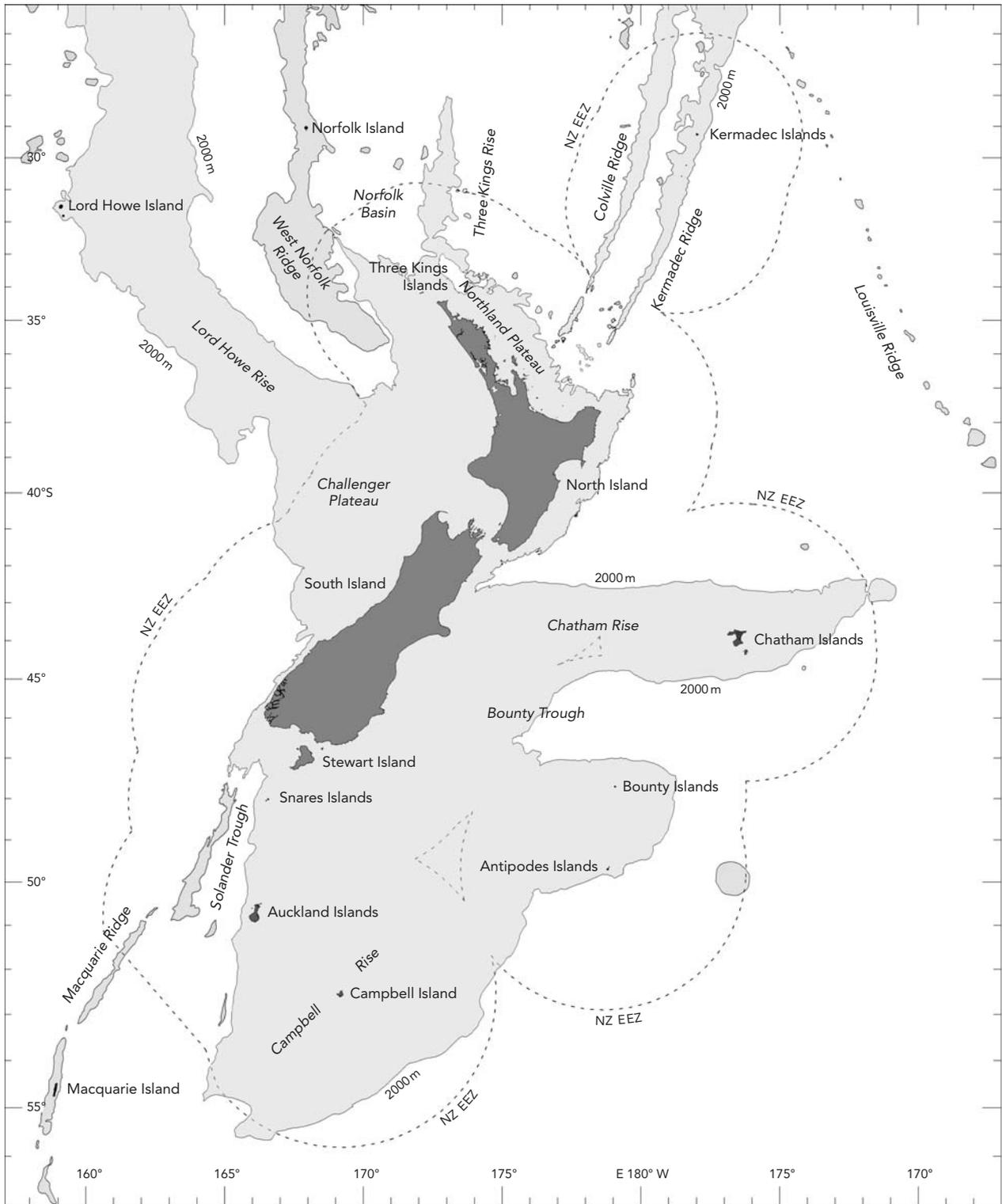


Fig. 1 The New Zealand region, indicating geographic features named in the text.

excellent monograph by Shane Ahyong on the lithodid crabs of Australasia and the Ross Sea (Ahyong 2010b) has completely redefined the New Zealand representatives of this family. Four of the seven species previously listed for New Zealand have remained, while the other three have been subsumed among nine new species from the region. Most recently, in October and November of 2010, both of these authors published papers on squat lobster classification (Ahyong *et al.* 2010; Schnabel & Ahyong 2010), as discussed above.

Presentation

We give references to New Zealand records (*NZ reference(s)*) for species previously recorded from the region. In addition, to give readers an opportunity to locate illustrations, taxonomy and other biological information, we include references to the same species occurring outside New Zealand (*Other significant reference(s)*). References to figures are drawings unless indicated otherwise, and references to 'photo' indicate black and white photographs unless indicated otherwise.

The list of extant decapod species published by Webber *et al.* in the *New Zealand inventory of biodiversity* (Gordon 2010) includes new records and, as a consequence, no new records are indicated here. Since the species lists in both publications are virtually identical, reference to the *Inventory of biodiversity* is not made under each species account in this checklist. However, a small number of the new records listed in the *Inventory of biodiversity* are not accompanied by any other data; therefore, under those records in this checklist, we include the location of preserved specimens under the heading '*NZ material*', and make reference to the *Inventory of biodiversity*.

Data on geographical distribution, approximate or precise depth ranges and colour are also provided, where available. No references to descriptions or illustrations of larval (zoëa) or post-larval (megalopa) stages of decapods are included. Even so, New Zealand decapod larvae are comparatively well documented (see Webber *et al.* 2010 for lists of names, and references).

Throughout the text, in places where they fit taxonomically, a small number of notes on related subjects are inserted (e.g. a paragraph on lobster introductions appears after the listing of New Zealand Nephropidae). A number of illustrations, most by the authors, representing major taxonomic groups are inserted throughout the text, and are placed at the beginning of each of those groups.

Abbreviations

EEZ	Exclusive Economic Zone
JCY	John C. Yaldwyn
MNZ	Museum of New Zealand Te Papa Tongarewa, Wellington
NIWA	National Institute of Water and Atmospheric Research, Wellington
NZ	New Zealand

Checklist of New Zealand Decapoda

Phylum ARTHROPODA

Subphylum CRUSTACEA Brünnich, 1772

Class MALACOSTRACA Latreille, 1802

Subclass EUMALACOSTRACA

Grobben, 1892

Superorder EUCARIDA Calman, 1904

Order DECAPODA Latreille, 1802

Suborder DENDROBRANCHIATA

Bate, 1888

Superfamily PENAEOIDEA Rafinesque, 1815

Family **ARISTEIDAE** Wood-Mason
& Alcock, 1891

Aristaeomorpha foliacea (Risso, 1827)

NZ references: Richardson & Yaldwyn (1958: 25) fig. 3 (female rostrum); Webber *et al.* (1990b: 8) fig. (whole animal and female rostrum); Webber (2002a: 75) fig. 1 (colour photo).

Other significant references: Crosnier (1978: 540) fig. 23a–b (female rostra), fig. 23c (male rostrum), figs 23d–f, 24; Pérez-Farfante & Kensley (1997: 36) fig. 5 (whole female), fig. 6; Dall (2001) fig. 2 (cephalothorax); Davie (2002a: 118) fig. page 117 (whole animal); Poore (2004: 25) fig. 3a (whole animal).

Distribution: northern NZ shelf edge and slope; sub-cosmopolitan, including Western, southern and eastern Australia. Fished commercially in Mediterranean and North Atlantic.

Colour: uniform pink or red with numerous dark red lensless photophores on ventral surface of body; specific photophore pattern shown in Crosnier (1978) fig. 23e–f.

Aristaeopsis edwardsiana (Johnson, 1867) (Fig. 2)

NZ references: Webber *et al.* (1990b: 6) fig. (whole animal as *Plesiopenaeus edwardsianus*); Webber (2002c: 70) fig. 1 (colour photo).

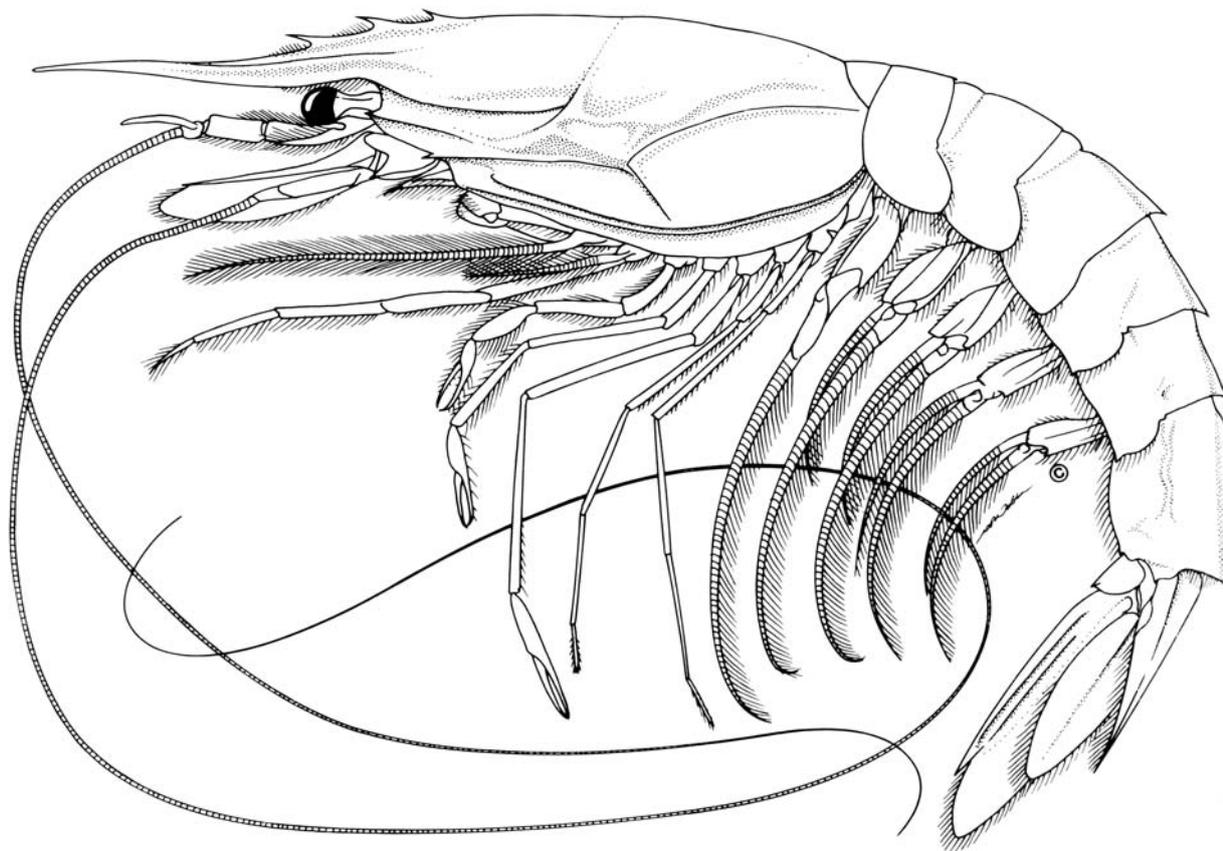


Fig. 2 Superfamily PENAEOIDEA: *Aristaeopsis edwardsiana* (Johnson, 1867) (drawn by W.R. Webber; from Webber *et al.* (1990b); reproduced with permission from New Zealand Ministry of Fisheries, Wellington).

Other significant references: Crosnier (1978: 88) figs 31a–c, 32a–c, 33a, as *Plesiopenaeus*; Pérez-Farfante & Kensley (1997: 39) fig. 7 (whole animal), fig. 8; Dall (2001: 413) fig. 3 (cephalothorax); Davie (2002a: 119); Poore (2004: 25) fig. 3b (carapace).

Distribution: northern and western NZ; deep water, benthic; Atlantic and Indo-West Pacific.

Colour and size: uniform bright red; largest NZ natant decapod.

***Aristeus semidentatus* Bate, 1881**

NZ reference: Bate (1888: 305) pl. 49, fig. 1 (whole animal with female rostrum), as *Hemipenaeus semidentatus*.

Other significant references: Crosnier (1978: 68); Kensley *et al.* (1987: 280).

Distribution: NZ, off Kermadec Islands; deep water; Indo-Pacific.

Colour: body pale rose or orange; pigmented lensless photophores on legs.

***Aristeus* sp.**

NZ material: specimens in MNZ.

NZ references: Webber *et al.* (1990b: 6); Webber (2002b: 71).

Distribution: northern and southern NZ, one or more unidentified large *Aristeus* spp., probably distinct from *A. semidentatus*.

***Austropenaeus* cf. *nitidus* (Barnard, 1947)**

NZ material: specimens in MNZ from West Norfolk Ridge.

NZ reference: Webber *et al.* (2010: 224).

Other significant references to Austropenaeus nitidus: Pérez-Farfante & Kensley (1997: 41) fig. 11 (whole animal), fig. 12; Dall (2001: 417) fig. 5 (cephalothorax, antennule); Davie (2002a: 120); Poore (2004: 27) fig. 3d (carapace).

Distribution of Austropenaeus nitidus: South Atlantic, southern Indian Ocean, and Western, southern and eastern Australia.

Family BENTHESICYMIDAE
Wood-Mason & Alcock, 1891

***Benthesicymus cereus* Burkenroad, 1936**

NZ references: Bate (1888: 332), as *B. brasiliensis*, but identified specimens not the same as Bate's figured material; Burkenroad (1936: 30) numerous figs; Richardson & Yaldwyn (1958: 25) fig. 4 (carapace).

Distribution: off east coast North Island; Atlantic; abyssal-benthic.

***Benthesicymus investigatoris* Alcock & Anderson, 1899**

NZ references: Bate (1888: 236), as *B. altus*, but identified specimens not the same as Bate's figured material; Crosnier (1985: 857). *Challenger* specimens from Kermadec stations 170, 171 reidentified as *B. investigatoris* in text on *B. altus*.

Other significant references: Crosnier (1978: 21) figs 7c–d, 8c–d, 9–10; Dall (2001: 427) fig. 12 (cephalothorax); Davie (2002a: 125); Poore (2004: 30) fig. 4a (carapace).

Distribution: off Kermadec Islands; deep water; Indo-Pacific.

***Gennadas capensis* Calman, 1925**

NZ material: specimens in MNZ.

NZ reference: Webber *et al.* (2010: 224).

Other significant references: Kensley *et al.* (1987: 277); Poore (2004: 30) fig. 4c (petasma, thelycum).

Distribution: northern NZ; South Atlantic and southern Indo-Pacific; bathypelagic.

***Gennadas gilchristi* Calman, 1925**

NZ reference: Richardson & Yaldwyn (1958: 25) fig. 5.

Other significant references: Kensley (1971a: 280) fig. 6; Kensley *et al.* (1987: 39); Dall (2001: 431) fig. 16A–C (carapace anterior, petasma, thelycum); Davie (2002a: 126); Poore (2004: 30) fig. 4d (petasma, thelycum).

Distribution: NZ; South Atlantic and southern Indo-Pacific; bathypelagic.

Colour: overall bright red with blue patches on abdomen, and numerous deep blue lensless photophores on body and appendages.

***Gennadas incertus* (Balss, 1927)**

NZ material: specimens in MNZ.

NZ reference: Webber *et al.* (2010: 224).

Other significant references: Kensley *et al.* (1987: 278); Dall (2001: 432) fig. 17A–C (carapace anterior, petasma, thelycum); Davie (2002a: 126); Poore (2004: 30) fig. 4h (petasma, thelycum).

Distribution: northern NZ; South Atlantic and southern Indo-Pacific; meso- and bathypelagic.

***Gennadas kempfi* Stebbing, 1914**

NZ reference: Richardson & Yaldwyn (1958: 25).

Other significant references: Kensley (1971a: 285) fig. 8a–e (petasma, thelycum, other diagnostic characters); Kensley *et al.* (1987: 278); Dall (2001: 432) fig. 18A–C (carapace anterior, petasma, thelycum); Davie (2002a: 126); Poore (2004: 30) fig. 4f (petasma, thelycum).

Distribution: central NZ; South Atlantic and southern Indo-Pacific; bathypelagic.

Colour: overall bright red with no blue on abdomen, but with deep blue lens-less photophores on appendages.

***Gennadas tinayrei* Bouvier, 1906**

NZ material: specimens in MNZ.

NZ reference: Webber *et al.* (2010: 224).

Other significant references: Kensley *et al.* (1987: 279); Dall (2001: 435) fig. 21A–C (carapace anterior, petasma, thelycum); Davie (2002a: 127); Poore (2004: 31) fig. 4i (petasma and thelycum).

Distribution: northern NZ; South Atlantic and southern Indo-Pacific; mesopelagic.

Family PENAEIDAE Rafinesque, 1815

***Funchalia villosa* (Bouvier, 1905)**

NZ material: specimens in MNZ.

NZ reference: Webber *et al.* (2010: 224).

Other significant references: Crosnier (1985: 869) fig. 13 (cephalothorax, petasma, appendix masculina), fig. 14b–c (female thoracic sternite); Kensley *et al.* (1987: 281); Davie (2002a: 134); Poore (2004: 35) fig. 5b (carapace).

Distribution: NZ; Australia, Atlantic and southern Indian Ocean; pelagic and mesopelagic.

***Funchalia woodwardi* Johnson, 1867**

NZ references: Robertson *et al.* (1978: 299); Webber *et al.* (1990b: 140) figs (whole animal; distribution map for *F. villosa* and *F. woodwardi*).

Other significant references: Kensley *et al.* (1987: 282); Pérez-Farfante & Kensley (1997: 85) fig. 43 (whole animal), fig. 45 (petasma, thelycum); Davie (2002a: 134); Poore (2004: 35) fig. 5c (carapace).

Distribution: northern and southern NZ; Indo-West Pacific and Atlantic; pelagic and mesopelagic.

Colour: transparent with areas of pink, orange and yellow.

Notes: there was a short-term attempt to farm a 'saltwater king prawn' from Hong Kong, understood to have been the penaeid *Fenneropenaeus chinensis* (Osbeck, 1765), at South Kaipara Heads in the early 1990s. The attempt failed and the stock was destroyed.

Family **SICYONIIDAE** Ortmann, 1898***Sicyonia inflexa*** (Kubo, 1949)

NZ reference: Dall (2005: 415).

Other significant reference: Kubo (1949: 458) figs 8O, 48D, 77C–I, 79G (diagnostic characters), fig. 159 (female, lateral view), fig. 160 (rostral variation).

Distribution: Cape Reinga, West Norfolk and Norfolk ridges, Lord Howe Rise; Indian Ocean, western Pacific, southwest Pacific from Chesterfield Islands to Tonga.

Sicyonia truncata (Kubo, 1949)

NZ material: specimens at NIWA.

NZ reference: Webber *et al.* (2010: 224).

Other significant reference: Dall (2005: 415) (occurrence in northern Tasman Sea); Kubo (1949: 456) figs 8M, 48F, 77A–G, 79J (diagnostic characters), fig. 158 (female, lateral view).

Distribution: northeastern NZ and eastern North Island; Norfolk Island, western Indian Ocean, Indonesia, northwest Australia, northern Pacific, and southwest Pacific from Fiji to Chesterfield Reef.

Family **SOLENOCERIDAE**
Wood-Mason & Alcock, 1891***Haliporoides sibogae*** (de Man, 1907)

NZ references: Richardson & Yaldwyn (1958: 24) fig. 2 (carapace), as *Hymenopenaeus*; Webber *et al.* (1990b: 10) fig. (whole animal); (Webber 2002b: 76) fig. 2 (colour photo, whole animal).

Other significant references: Crosnier (1978: 108) fig. 36a (carapace), as *Hymenopenaeus* when discussing differences between *H. sibogae sensu stricto* and a new subspecies *H. s. madagascariensis*; Kensley *et al.* (1987: 269) figs 3A–E, 4A–F, 5A–F (diagnostic characters), as subspecies *H. s. australiensis*; Dall (1999: 562) fig. 6B (cephalothorax); Davie (2002a: 166); Poore (2004: 44) fig. 7e (carapace).

Distribution: NZ south to Chatham Rise; Indo-West Pacific. Fished commercially in Japan and Australia.

Colour: reddish pink with colourless to yellow-orange patches on abdomen.

Status: subspecific status of NZ material not yet established.

Hymenopenaeus halli Bruce, 1966

NZ material: specimen in MNZ from northwestern Bay of Plenty.

NZ reference: Webber *et al.* (2010)

Other significant references: Bruce (1966: 216) fig. 1 (whole animal), fig. 2 (diagnostic characters); Kensley *et al.*

(1987); Dall (1999: 566) fig. 8B (cephalothorax); Davie (2002a: 167); Poore (2004: 44) fig. 7f (cephalothorax).

Distribution: North Island; Indo-West Pacific, including eastern Australia.

Hymenopenaeus obliquirostris (Bate, 1881)

NZ references: Bate (1888: 286) pl. XLI, fig. 2 (whole animal as *Haliporus*); Crosnier (1989: 48) fig. 4a (female thoracic sternite); Crosnier & Dall (2004: 3) fig. 3a (female cephalothorax), fig. 3b (female rostrum), fig. 4a–g (thelycum, female sternites), fig. 5a–e (petasma, petasma distal lobes), fig. 9a (eye).

Distribution: off Kermadec Islands; Indo-West Pacific; deep water.

Solenocera comata Stebbing, 1915

NZ references: Richardson & Yaldwyn (1958: 24) fig. 1 (cephalothorax), as *S. novaezealandiae*; Webber *et al.* (1990b: 12) fig. (whole animal), as *S. novaezealandiae*.

Other significant references: Crosnier (1978: 138) fig. 48b (cephalothorax), figs 49–59 (various characters, compared to other *Solenocera* spp.); Crosnier (1989: 52) (*S. novaezealandiae* synonymised with *S. comata*); Dall (1999: 577) fig. 16 (cephalothorax); Davie (2002a: 169).

Distribution: northern NZ, shelf and slope; Indo-West Pacific.

Superfamily **SERGESTOIDEA** Dana, 1852Family **LUCIFERIDAE** De Haan, 1849***Lucifer typus*** H. Milne Edwards, 1837

NZ references: Bate (1888: pl. 83) fig. 1 (whole animal); Borradaile (1916: 82), as *Leucifer batei*; Richardson & Yaldwyn (1958: 23) fig. 10 (cephalothorax).

Other significant references: Kensley (1971b: 223) fig. 2a–d (cephalothorax, other diagnostic characters); Pérez-Farfante & Kensley (1997: 185) figs 126–127 (whole animal, petasma); Davie (2002a: 129) fig. page 128 (whole animal after Bate 1888); Poore (2004: 45) fig. 7j (male abdominal somite 6).

Distribution: northern NZ; Atlantic, Indo-West Pacific, eastern Pacific; pelagic.

Family **SERGESTIDAE** Dana, 1852***Sergestes arcticus*** Krøyer, 1855

NZ references: Yaldwyn (1957a: 9) figs 1–5 (diagnostic characters); Webber *et al.* (1990b: 18) fig. (whole animal).

Other significant references: Hansen (1922: 62) pl. 1, figs 1–2 (colour figs, whole animal), pl. 3, fig. 3; Kensley (1971b:

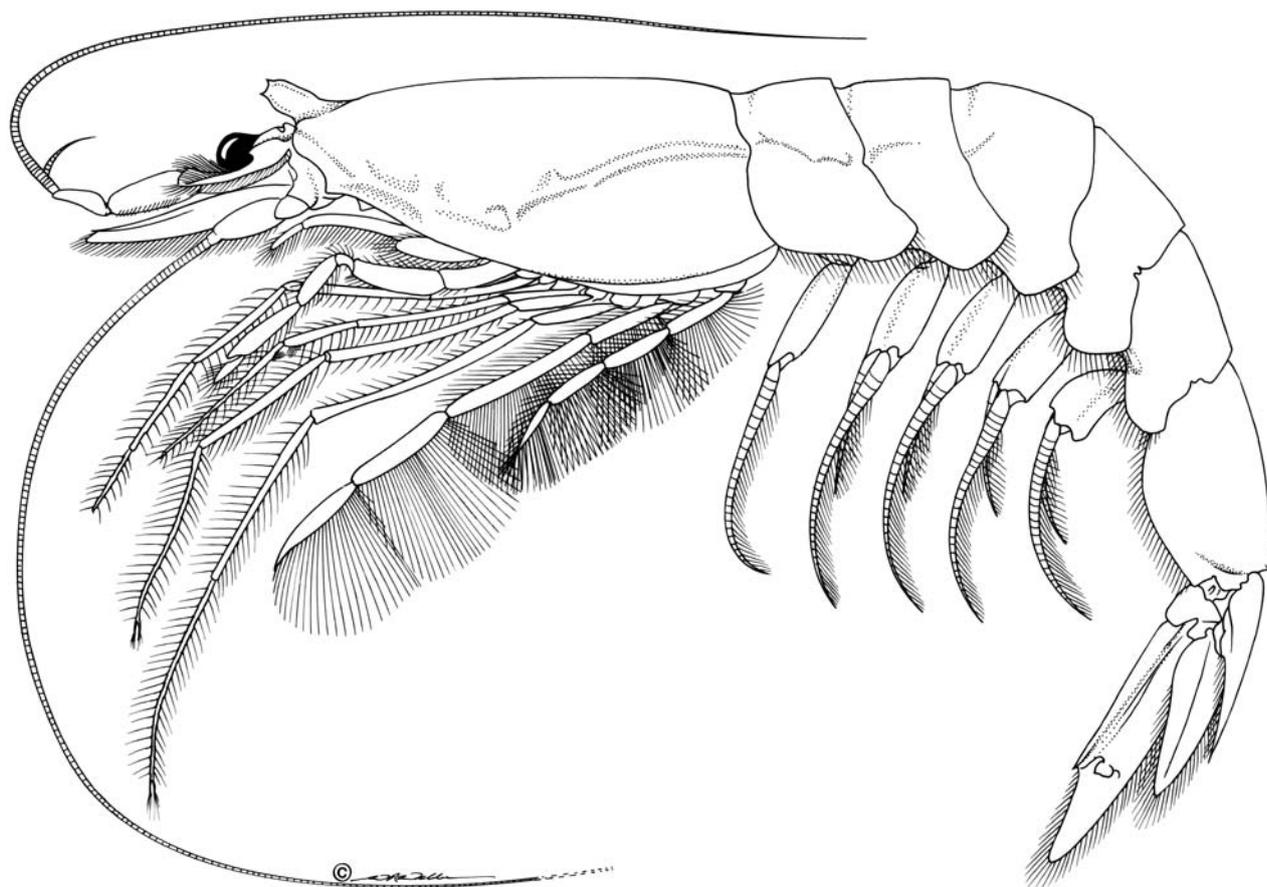


Fig. 3 Superfamily SERGESTOIDEA: *Sergia potens* (Burkenroad, 1940) (drawn by W.R. Webber; from Webber *et al.* (1990b); reproduced with permission from New Zealand Ministry of Fisheries, Wellington).

232) fig. 7a–f (diagnostic characters); Davie (2002a: 155); Poore (2004: 48).

Distribution: northern and southern NZ; Atlantic and southern Indo-West Pacific; bathypelagic.

Colour: transparent with scattered red chromatophores and bright red organs of Pesta (internal light-producing bodies within the cephalothorax).

***Sergestes disjunctus* Burkenroad, 1940**

NZ reference: Burkenroad (1940: 38).

Other significant references: Kensley (1971b: 236) fig. 11a–d (diagnostic characters); Wasmer (1993: 57) figs 7–8; Davie (2002a: 156); Poore (2004: 48).

Distribution: northern NZ; South Atlantic and southern Indo-West Pacific; bathypelagic.

***Sergestes index* Burkenroad, 1940**

NZ reference: Burkenroad (1940: 41).

Other significant reference: Pérez-Farfante & Kensley (1997: 197).

Distribution: northern NZ; northwest Pacific; bathypelagic.

***Sergestes cf. seminudus* Hansen, 1919**

NZ references: Yaldwyn (1957a: 14) fig. 10 (carapace); Richardson & Yaldwyn (1958: 26) fig. 7 (carapace); Robertson *et al.* (1978: 299), as *S. seminudus*.

Other significant references to Sergestes seminudus: Hansen (1919: 18) pls 1a–b, 2a–f (diagnostic characters); Sakai & Nakano (1985: 18) figs 1a–e, 2a–e, 3a–f, 4a–f, 5a–d (whole animal, numerous diagnostic characters including petasmas and female sterna); Davie (2002a: 157) fig. page 128 (whole animal after Sakai & Nagano 1985); Poore (2004: 48).

Distribution of Sergestes seminudus: Indo-West Pacific; bathypelagic.

Colour of NZ specimen: red chromatophores scattered over body and appendages, posterior half of dorsal surface of carapace with purplish-blue cuticular pigment, pigmented internal organs of Pesta present.

***Sergia japonica* (Bate, 1881)**

NZ reference: Yaldwyn (1957a: 22) figs 6–9 (carapace, front, petasma), as *Sergestes* (*Sergia*) *japonicus*.

Other significant references: Sakai & Nakano (1983: 98) figs 2a–e, 3a–c, 4a–f, 5a–f (diagnostic characters), as *Sergestes* (*Sergia*) *japonicus*; Vereshchaka (2000: 91) figs 8, 9A–C, 10A–C (diagnostic characters), fig. 11 (map, distribution), pl. 4A (SEM, petasma); Davie (2002a: 157); Poore (2004: 51) fig. 9f (end of uropodal exopod).

Distribution: NZ; Indo-West Pacific; bathypelagic.

Colour: entire body and appendages bright red; no pigmented lensless photophores present.

***Sergia tenuiremis* (Krøyer, 1855)**

NZ references: Bate (1888: 388) pl. 70, figs 3–4 (whole animal and diagnostic characters), as *Sergestes kroyeri*; Robertson *et al.* (1978: 299), as *Sergestes kroyeri*.

Other significant references: Hansen (1903: 58) pl. 11, fig. 5a–b, as *Sergestes kroyeri*; Vereshchaka (2000: 84) figs 3A–C, 4A,C (diagnostic characters), fig. 5 (map, distribution).

Distribution: off Kermadec Islands and eastern central NZ; bathypelagic.

Note: *Sergestes kroyeri* Bate, 1881, regarded by Vereshchaka (1994, 2000) as a synonym of *Sergia tenuiremis*, is from North Atlantic and north-West Pacific.

***Sergia potens* (Burkenroad, 1940) (Fig. 3)**

NZ references: Yaldwyn (1957a: 15) figs 11–18 (carapace, other diagnostic characters), as *Sergestes* (*Sergia*) *potens*; Webber *et al.* (1990b: 16) fig. (whole animal); Webber (2002c: 71) fig. 2 (colour photo, whole animal).

Other significant references: Kensley (1971b: 253) fig. 19a–f (carapace and other diagnostic characters); Wasmer (1993: 61); Davie (2002a: 158); Poore (2004: 51) fig. 9e–f (front of carapace, uropod tip).

Distribution: northern and southern NZ; South Atlantic and southern Indo-West Pacific; bathypelagic.

Colour: entire body and appendages bright red, with numerous intense purple lensless photophores on ventral surface of body and on appendages; unique specific photophore pattern shown in Yaldwyn (1957a) figs 12–14, 18.

Suborder PLEOCYEMATA Burkenroad, 1963

Infraorder STENOPODIDEA Bate, 1888

Family SPONGICOLIDAE Schram, 1986

***Spongicoloides novaehelandiae* Baba, 1979**

NZ references: Baba (1979: 311) figs 1a–j, 2a–e (diagnostic characters); Poore (2004: 146) fig. 38b–c (carapace).

Distribution: Chatham Rise, 990–1110m; Tasmanian seamounts.

Colour: body almost colourless, cornea yellow.

***Spongiocaris yaldwyni* Bruce & Baba, 1973**

NZ reference: Bruce & Baba (1973: 163) figs 7, 8a–g, 9a–g, 10a–b (whole animal, diagnostic characters).

Distribution: only published record is the holotype taken from inside a hexactinellid sponge (i.e. venus flower basket) in the Bay of Plenty, 585–620 m (hence ‘venus shrimp’ as common name for spongiolid shrimps, *vide* Poore 2004). Additional specimens in MNZ collections from off Raoul Island in the Kermadecs (1190–1225 m), Reinga Ridge northwest of the Three Kings Islands (469–526 m) and Hawke Bay (840–935 m).

Family STENOPODIDAE Claus, 1872

***Stenopus hispidus* (Olivier, 1811)**

NZ references: Yaldwyn (1968: 279); Doak (1971) pl. 39D (colour photo, with blue egg mass); Yaldwyn (1974: 1044) fig. 1 (colour photo, whole animal).

Other significant references: Gillett & Yaldwyn (1969: 70) pl. 33 (colour photo, whole animal); Healy & Yaldwyn (1970: 52) pl. 24 (colour photo, whole animal); Holthuis (1993: 311) fig. page 316 (whole animal, from Bate 1888); Jones & Morgan (1994: 76) (colour photos, whole animal); Davie (2002a: 177) fig. page 175 (whole animal after Bate 1888); Poore (2004: 149) fig. 38 (rostrum), pl. 11b (colour photo, live specimen in habitat).

Distribution: east coast of Northland, NZ, rocky crevices at diving depths; tropical Indo-Pacific and tropical western Atlantic, shallow water rocky shores and coral reefs.

Colour and biology: *Stenopus hispidus* is the widely distributed and much illustrated ‘banded coral shrimp’ of books and publications on shallow-water tropical marine life. Body white with prominent broad red bands on carapace, abdomen and enlarged chelipeds; white antennae (six branches to each animal) long and obvious; eggs blue. *Stenopus hispidus* is the best known of the fish-cleaning shrimps (*vide* Yaldwyn 1968), attracting fish to their crevice with waving white antennae; the fish remain still while the shrimp picks with its two pairs of small chelae (it does not use the large banded chelipeds for cleaning) at parasites, injured tissue and fungal growths on their bodies and fins. *Stenopus* advertises its services with its antennae but does not appear to venture far from its crevice to clean. It reaches out to the fish that in some

localities appear to congregate around known *Stenopus* cleaning sites, assuming a 'head-down' pose to signal their need to be cleaned.

Infraorder CARIDEA Dana, 1852

Superfamily PASIPHAEOIDEA Dana, 1852

Family PASIPHAEIDAE Dana, 1852

***Alainopasiphaea australis* (Hanamura, 1989)**

NZ reference: Ah Yong (2010a: 355) fig. 4G–H (anterior of carapace).

Other significant references: Hanamura (1989: 59) fig. 5a (holotype ovigerous female body), fig. 5b (paratype male anterior part), figs 6a–h, 7a–h (diagnostic characters), as *Pasiphaea*; Hayashi (2004: 369) fig. 26a (female front of cephalothorax), fig. 26b (abdominal somites 5–6), fig. 26c,d (male P1), fig. 26e (P2), fig. 26f (gills); Poore (2004: 61) fig. 12f (epipod P1), fig. 12g (epipod P2), fig. 12h (chela P2), as *Pasiphaea australis*.

Distribution: Chatham Rise and Challenger Plateau, 552–797 m, probably elsewhere in NZ; southern Australia.

***Eupasiphae gilesii* (Wood-Mason, 1892)**

NZ material: specimens in MNZ from NZ waters.

NZ reference: Webber *et al.* (2010: 225)

Other significant references: Kensley (1977: 32) fig. 10B (cephalothorax with appendages of right side); Kensley *et al.* (1987: 293); Crosnier (1988: 786) figs 1, 5a; Hanamura & Evans (1994: 52) fig. 1 (mature male); Davie (2002a: 354); Poore (2004: 59) fig. 12c (carapace).

Distribution: NZ; tropical and subtropical waters of Atlantic and Indo-West Pacific, and eastern Pacific off Baja California; bathypelagic.

Colour: uniform red.

***Parapasiphae compta* Smith, 1884**

NZ reference: Yaldwyn *in* Imber (1973: 652), as ?*Dantecia* sp.

Other significant reference: Crosnier (1988: 799) figs 1–3.

Distribution: northern NZ, from grey-faced petrel vomit; previously known only from deep water in North Atlantic.

***Parapasiphae sulcatifrons* Smith, 1884**

NZ reference: Yaldwyn *in* Imber (1973: 652), as *Parapasiphae* sp.

Other significant references: Crosnier & Forest (1973: 142) fig. 41 (carapace); Kensley *et al.* (1987: 293); Holthuis (1993: 27) fig. 8 (whole animal); Davie (2002a: 357) fig. page 353 (whole animal); Poore (2004: 61) fig. 12e (carapace).

Distribution: NZ; North and South Atlantic, Indo-Pacific and eastern Pacific; usually deep-water pelagic but also from grey-faced petrel vomit.

Colour: uniform red.

***Pasiphaea barnardi* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 29) fig. 12 (carapace), as *P. aff. pacifica*; Yaldwyn (1971: 86); Webber (2002c: 71) fig. 3 (colour photo, whole animal).

Other significant references: Kensley (1977: 34) figs 11, 12A–L, 13, 14A–B (whole animal, diagnostic characters), as *P. meiringnaudei*; Kensley *et al.* (1987) front pl. A (colour photo, whole animal), as *P. berentsae*, figs 7A–H, 8A–L, 9A–H (diagnostic characters), as *P. berentsae*; Davie (2002a); Poore (2004) fig. 12i (pereopod 2).

Distribution: southern NZ; southern Indo-West Pacific and South Atlantic; bathypelagic.

Colour: usually uniform red, but abdomen sometimes partly red and partly translucent.

***Pasiphaea burukovskyi* Wasmer, 1993**

NZ reference: Wasmer (1993: 79) figs 22–24.

Distribution: known only from type locality at edge of Challenger Plateau, west of Cape Farewell; bathypelagic.

***Pasiphaea grandicula* Burukovsky, 1976**

NZ material: specimens in MNZ from southern slope of Chatham Rise, southeast of Banks Peninsula, and Challenger Plateau.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Burukovsky (1976: 17) fig. 1; Burukovsky & Romensky (1987: 51) figs 2.3, 3.4; Clarke & Holmes (1987: 23).

Distribution: NZ; Southern Ocean, both Atlantic and Pacific sectors; bathypelagic.

***Pasiphaea notosivado* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 29) fig. 11 (carapace), as *P. aff. sivado*; Yaldwyn (1971: 29).

Distribution: NZ; bathypelagic.

Colour: transparent, with irregularly scattered red chromatophores.

***Pasiphaea tarda* Krøyer, 1845**

NZ material: specimens in MNZ from NZ waters.

NZ references: Webber *et al.* (1990b: 20) fig. (whole animal as *P. barnardi*, but not *P. barnardi* Yaldwyn); Webber *et al.* (2010: 225).

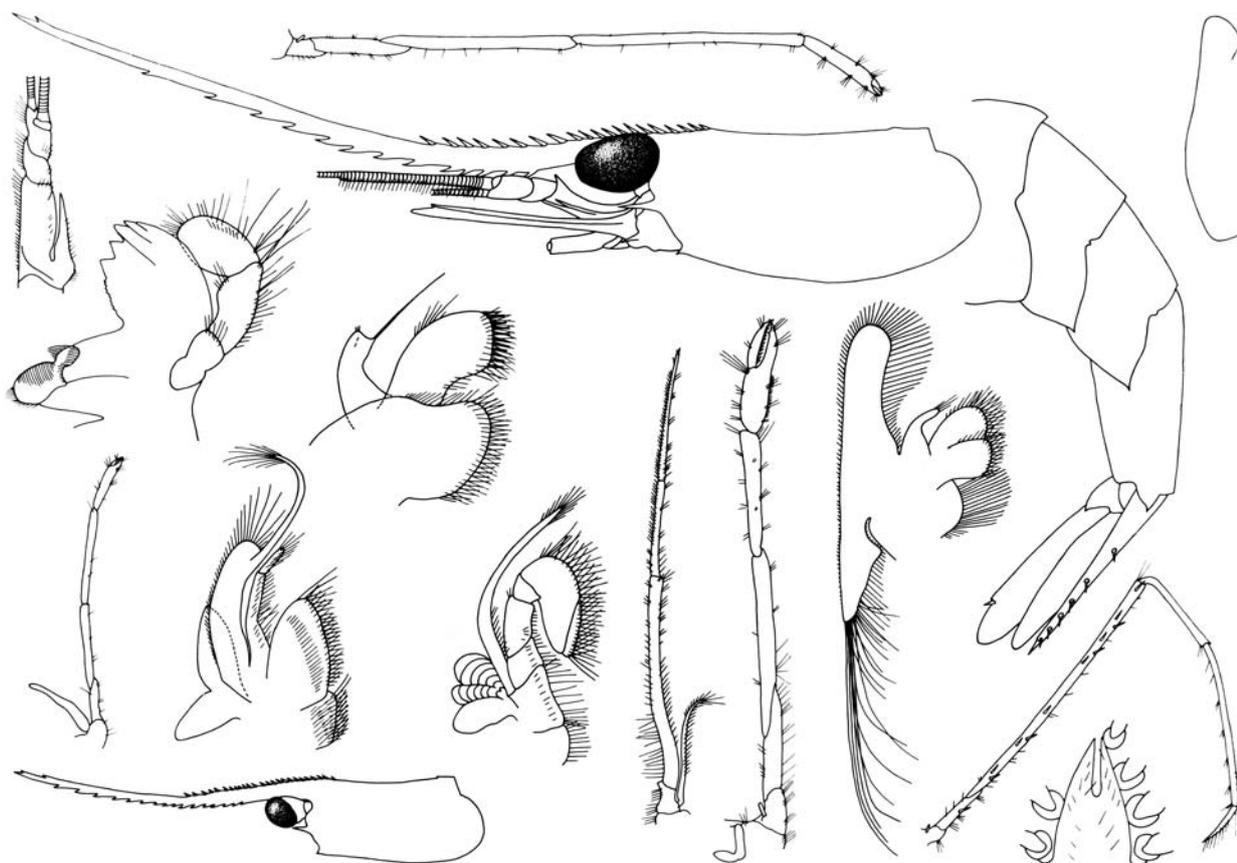


Fig. 4 Infraorder CARIDEA: *Lipkius holthuisi* Yaldwyn, 1960 (drawn by J.C. Yaldwyn; from Yaldwyn (1960); reproduced with permission from National Institute of Water and Atmospheric Research Ltd, Hamilton).

Other significant references: Sivertsen & Holthuis (1956: 23) fig. 17a–f (various rostra); Crosnier & Forest (1973: 133) fig. 37a–g (carapace and diagnostic characters), as *P.* cf. *tarda*; Squires (1990) fig. 61 (whole animal) fig. 62, pl. 1b (colour photo, whole animal); Davie (2002a: 359); Poore (2004: 62).

Distribution: NZ; North and South Atlantic, North Pacific and southern Indo-West Pacific; bathypelagic.

Colour: uniform red.

***Psathyrocaris infirma* Alcock & Anderson, 1894**

NZ material: specimens in MNZ from NZ waters.

NZ reference: Webber *et al.* (2010: 225)

Other significant references: Holthuis (1951: 14) fig. 2; Crosnier & Forest (1973: 141) fig. 40e; Holthuis (1993: 29) fig. 10 (whole animal).

Distribution: NZ; North and South Atlantic, and Indo-West Pacific; bathypelagic.

Colour: uniform red.

Superfamily OPLOPHOROIDEA Dana, 1852

Family OPLOPHORIDAE Dana, 1852

***Acanthephyra brevirostris* Smith, 1885**

NZ material: *Galathea* bottom station 661, Kermadec Trench, 5230–5340 m, specimen in University Zoological Museum, Copenhagen, identified by JCY in 1974.

NZ reference: Webber *et al.* (2010: 225).

Other significant reference: Crosnier & Forest (1973: 41) fig. 8c–d.

Distribution: NZ; southern Indo-West Pacific, eastern Pacific, and North and South Atlantic; bathypelagic or near benthic.

***Acanthephyra eximia* Smith, 1884**

NZ references: Bate (1888: 753) pl. 126, fig. 7 (whole animal), as *A. brachytelsonis*; Richardson & Yaldwyn (1958: 30).

Other significant references: Chace (1940: 147) fig. 24 (whole animal); Crosnier & Forest (1973: 34) fig. 7c–d; Chace

(1986: 18) figs 2, 4–6, 9 (appendages compared to other spp.); Davie (2002a: 281).

Distribution: northern and central NZ; Indo-Pacific, and North and South Atlantic; bathypelagic.

Colour: uniform red.

***Acanthephyra pelagica* (Risso, 1816)**

NZ references: Bate (1888: 739) pl. 125, fig. 1 (whole animal as *A. sica*); Richardson & Yaldwyn (1958: 30) fig. 15 (carapace); Webber *et al.* (1990b: 26) fig. (whole animal); Webber (2002b) fig. 4 (colour photo, whole animal).

Other significant references: Chace (1986: 8) figs 3–5, 7, 9 (appendages compared to other spp.); Wasmer (1986) figs 7–8; Kensley *et al.* (1987: 284).

Distribution: northern and southern NZ; Indo-Pacific, and North and South Atlantic; bathypelagic.

Colour: uniform red.

***Acanthephyra quadrispinosa* Kemp, 1939**

NZ references: Richardson & Yaldwyn (1958: 30); Webber *et al.* (1990b: 26) fig. (telson compared to *A. pelagica*, map, distribution).

Other significant references: Chace (1986: 26) figs 3–5, 7, 10 (appendages compared to other spp.), fig. 14 (whole animal); Wasmer (1986) figs 5, 6; Kensley *et al.* (1987: 284); Poore (2004: 64) figs 13a, 14l (whole animal, telson).

Distribution: northern and central NZ; South Atlantic, and Indo-Pacific including Western, southern and eastern Australia; bathypelagic.

Colour: uniform red.

***Acanthephyra smithi* Kemp, 1939**

NZ material: specimen in MNZ from within EEZ north of Kermadec Islands; additional specimens from beyond EEZ between Kermadecs and Tonga.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Hayashi & Miyake (1969: 62) fig. 2 (whole animal); Chace (1986: 31) figs 3–5, 7, 10 (appendages compared to other spp.); Hanamura (1987) fig. 9a–b; Kensley *et al.* (1987: 285); Davie (2002a: 282); Poore (2004: 66).

Distribution: off Kermadec Islands; Indo-West Pacific including Western and eastern Australia; bathypelagic.

***Ephyrina fueirai* Crosnier & Forest, 1973**

NZ material: specimens in MNZ from northern NZ waters.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Crosnier & Forest (1973: 73) figs 20b, 21g–h, 22c–d, 23; Chace (1986: 35) fig. 15i–m.

Distribution: NZ; Indo-West Pacific and North Atlantic; bathypelagic.

Colour: uniform red.

***Heterogenys microphthalma* (Smith, 1885)**

NZ material: *Galathea* bottom station 661, Kermadec Trench, 5230–5340 m, specimens in University Zoological Museum, Copenhagen, identified by JCY in 1974.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Crosnier & Forest (1973: 42) fig. 9, as *Acanthephyra microphthalma*; Chace (1986: 38) fig. 20; Holthuis (1993: 35) fig. 13 (animal without legs or pleopods).

Distribution: NZ; Indo-Pacific, eastern Pacific and North Atlantic; bathypelagic or near benthic.

***Hymenodora glacialis* (Buchholz, 1874)**

NZ material: *Galathea* bottom station 661, Kermadec Trench, 5230–5340 m, specimen in University Zoological Museum, Copenhagen, identified by JCY in 1974.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Crosnier & Forest (1973: 84) fig. 25b; Chace (1986: 42); Wasmer (1986: 48) figs 10a, 11; Holthuis (1993: 35) fig. 14 (whole animal).

Distribution: NZ; Indo-Pacific including Pacific sector of Southern Ocean, Western and eastern Australia, eastern Pacific, North and South Atlantic; bathypelagic or near benthic.

***Janicella spinicauda* (A. Milne-Edwards, 1883)**

NZ material: specimens in MNZ from within EEZ north-west of Kermadec Islands.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Chace (1986: 44) figs 23, 24; Hanamura (1987: 26) figs 10, 11; Kensley *et al.* (1987: 285); Holthuis (1993: 36) fig. 15 (whole animal); Davie (2002a: 284) fig. page 278 (whole animal, from Boone 1927).

Distribution: off Kermadec Islands; Indo-West Pacific including Western and eastern Australia, and tropical Atlantic; bathypelagic.

***Kemphyra corallina* (A. Milne-Edwards, 1883)**

NZ material: specimens in NIWA collection from bottom station, 1571–1619 m, within EEZ southwest of Kermadec Islands; in MNZ from West Norfolk Ridge, 1700 m.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Kensley (1968: 314) fig. 15 (whole animal), fig. 17, as *Acanthephyra*; Chace (1986: 44) fig. 25; Holthuis (1993: 37) fig. 16 (whole animal).

Distribution: off Kermadec Islands; North and South Atlantic, and Indo-West Pacific; bathypelagic or near benthic.

***Meningodora mollis* Smith, 1882**

NZ material: specimen in MNZ from within EEZ northeast of Kermadec Islands.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Crosnier & Forest (1973: 44) fig. 10c; Chace (1986: 50) fig. 26; Kensley *et al.* (1987: 285); Holthuis (1993: 37) fig. 17 (whole animal); Davie (2002a: 284).

Distribution: off Kermadec Islands; North and South Atlantic, Indo-West Pacific including eastern Australia, and eastern Pacific; bathypelagic.

***Meningodora vesca* (Smith, 1886)**

NZ material: specimens in MNZ from off east coast of North Island.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Crosnier & Forest (1973: 46) fig. 10d; Chace (1986: 50) fig. 27; Kensley *et al.* (1987: 286); Davie (2002a: 284); Poore (2004: 67) fig. 14e (carapace).

Distribution: NZ; North and South Atlantic, and Indo-West Pacific; bathypelagic.

Colour of a NZ specimen: bluish green.

***Notostomus auriculatus* Barnard, 1950**

NZ references: Richardson & Yaldwyn (1958: 31) fig. 16 (carapace), as *N. cf. westergreni*; Webber *et al.* (1990b: 24) figs (whole animal, map, distribution).

Other significant references: Macpherson (1984: 51) figs 6B, 7B, 8C–D; Wasmer (1993: 71) figs 14, 17; Davie (2002a: 285); Poore (2004: 67) fig. 13b (whole animal).

Distribution: NZ; South Atlantic and southern Indo-West Pacific; bathypelagic.

Colour: uniform red.

***Notostomus japonicus* Bate, 1888**

NZ material: specimens in MNZ from NZ waters.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Yaldwyn (1963: 149) fig. (photo, whole animal), as *Notostomus* sp.; Stevens & Chace (1965: 278) figs 2–4; Crosnier (1987: 708) fig. 5a.

Distribution: NZ; North and South Pacific, and eastern Pacific; bathypelagic.

Colour: uniform red.

***Oplophorus novaeseelandiae* de Man, 1931**

NZ references: de Man (1931: 369) fig. 1 (whole animal), fig. 20, as *Hoplophorus*; Richardson & Yaldwyn (1958: 30) fig. 14 (carapace); Webber *et al.* (1990b: 22) fig. (whole animal, map, distribution).

Other significant references: Crosnier & Forest (1973: 26) fig. 5 (whole animal); Wasmer (1986: 37) figs 3a–c, 4; Kensley *et al.* (1987: 289); Davie (2002a: 286); Poore (2004: 68) fig. 13c (cephalothorax, abdomen without appendages), fig. 14j (scaphocerite).

Distribution: NZ; South Atlantic, southern Indo-Pacific including Western, southern and eastern Australia, and southeastern Pacific; bathypelagic.

Colour: carapace and anterior part of abdomen mainly red, posterior part of abdomen mainly translucent, eggs red; distinctive pattern of lens-bearing, dark blue-pigmented photophores on body and appendages. This species is capable of discharging short-lived clouds of luminous matter from glands near the mouth.

***Oplophorus spinosus* (Brullé, 1839)**

NZ references: Robertson *et al.* (1978: 299), as *O. grimaldii*; Webber *et al.* (1990b: 22) fig. (front, distinguishing features, map, distribution with that of *O. novaeseelandiae*).

Other significant references: Kensley *et al.* (1987: 289); Squires (1990: 90) fig. 43 (whole animal), fig. 44; Holthuis (1993: 39) fig. 19 (whole animal); Davie (2002a: 287); Poore (2004: 68) fig. 14k (scaphocerite).

Distribution: NZ; North and South Atlantic, Indo-Pacific including eastern Australia, and eastern Pacific; bathypelagic.

***Systellaspis debilis* (A. Milne-Edwards, 1881)**

NZ references: Richardson & Yaldwyn (1958: 31) fig. 17 (carapace); Webber *et al.* (1990b: 28) figs (whole animal, map, distribution).

Other significant references: Chace (1986: 65) figs 34g–i, 35e–f; Crosnier (1987: 715) figs 9, 10; Kensley *et al.* (1987: 290); Holthuis (1993: 39) fig. 20 (whole animal); Davie (2002a: 287); Poore (2004: 68) fig. 14h,n (carapace, telson).

Distribution: NZ; North Atlantic, and Indo-Pacific including Western, southern and eastern Australia; bathypelagic.

Colour: partly red, partly translucent; distinctive pattern of dark blue-pigmented photophores on body and appendages.

***Systellaspis pellucida* (Filhol, 1885)**

NZ reference: Webber *et al.* (1990b: 28) (map, distribution with that of *S. debilis*).

Other significant references: Crosnier & Forest (1973: 92) figs 26c, 27c; Chace (1986: 67) figs 34m–o, 35g–h; Crosnier (1987: 720) figs 12–15; Davie (2002a: 287).

Distribution: NZ; North Atlantic, and Indo-West Pacific including Western Australia; bathypelagic or near benthic.

Superfamily ATYOIDEA De Haan, 1849

Family ATYIDAE De Haan, 1849

Paratya curvirostris (Heller, 1862)

NZ references: Thomson (1903) pl. 29B; Kemp (1917) fig. 4; Bouvier (1925) figs 87–91; Richardson & Yaldwyn (1958: 30) fig. 13 (carapace).

Distribution: endemic, fresh waters from Northland to Stewart Island/Rakiura and Chatham Islands. Habitat in lowland streams and estuaries where salinity is less than 20%; upper altitudinal range decreases towards southern limit (*vide* Carpenter 1977: 41). NZ's only freshwater shrimp; estuarine distribution does not overlap with palaemonid shrimp *Palaemon affinis*.

Colour and biology: transparent with dense speckling of small dark (mainly blue and red) chromatophores. The species is a protandrous hermaphrodite (*vide* Carpenter 1978: 343) with females larger and darker than smaller, much lighter coloured males.

Other names used: *Leander fluviatilis* Thomson, 1879; *Xiphocaridina curvirostris* (Heller, 1862); *Caridina*; *Xiphocaris*.

Superfamily BRESILIOIDEA Calman, 1896

Family ALVINOCARIDIDAE

Christoffersen, 1986

Alvinocaris alexander Ahyong, 2009

NZ reference: Ahyong (2009b: 777) figs 1A–F, 2A–H, 3A–E (including whole ovigerous female holotype and diagnostic characters of holotype and male paratype).

Distribution: endemic, Rumble V Seamount and Brothers Caldera, southern Kermadec volcanic arc, on hydrothermally active areas.

Colour and structure: pinkish white, blind, with a thin and flexible exoskeleton.

Alvinocaris longirostris Kikuchi & Ohta, 1995

NZ references: Webber & Yaldwyn in Wright *et al.* (1998: 342), as *A. cf. lusca*; Webber & Bruce (2002: 6) fig. (whole animal as *Alvinocaris* sp. B); Webber (2004: 5) figs 5, 6a–f (whole female, diagnostic characters); Ahyong (2009b: 776).

Other significant references: Kikuchi & Ohta (1995: 772) fig. 1a (whole animal), figs 1b–c, 2–7; Hashimoto (1997: 190) unnumbered upper left fig. (whole animal).

Distribution: Brothers Caldera, southern Kermadec volcanic arc, on hydrothermally active areas; Okinawa Trough, Japan.

Colour and structure: pinkish white, blind, with a thin and flexible exoskeleton.

Alvinocaris niwa Webber, 2004

NZ references: Webber & Bruce (2002: 6) fig. (whole animal), as *Alvinocaris* sp. A; Batson (2003: 77) fig. (whole animal, after Webber & Bruce 2002), as *Alvinocaris* sp. A; Webber (2004: 5) fig. 1a–c (holotype male, paratype female), figs 2a–g, 3a–h, 4a–h (diagnostic characters); Ahyong (2009b: 776).

Distribution: endemic, Brothers Caldera and Rumble V Seamount, southern Kermadec volcanic arc, on hydrothermally active areas.

Colour and structure: pinkish white, blind, with a thin and flexible exoskeleton.

Nautilocaris saintlaurentae Komai & Segonzac, 2004

NZ reference: Ahyong (2009b: 785) fig. 4A–B (carapaces, two females).

Other significant reference: Komai & Segonzac (2004: 1181) fig. 2 (whole female holotype), fig. 3A–F (female holotype, diagnostic characters).

Distribution: southern Kermadec Ridge to North Fiji and Lau basins.

Family DISCIADIDAE Rathbun, 1902

Discias cf. exul Kemp, 1920

NZ material: specimens in MNZ from northern NZ waters.

NZ reference: Webber *et al.* (2010: 225).

Other significant references to Discias exul: Bruce (1976: 119) fig. 1 (whole animal), figs 2–5; Kemp (1920) figs 1–3, pl. 8 (whole animal).

Distribution of Discias exul: Indo-West Pacific (western Indian Ocean, Indonesia, tropical Western and eastern Australia); shallow water, free-swimming or commensal.

Superfamily NEMATOCARCINOIDEA

Smith, 1884

Family NEMATOCARCINIDAE

Smith, 1884

Lipkius holthuisi Yaldwyn, 1960 (Fig. 4)

NZ references: Yaldwyn (1960: 16) fig. 1; Takeda (1990: 353) fig. 281 (colour photo, whole animal); Webber *et al.* (1990b: 36) fig. (whole animal, map, distribution); Webber (2002b: 77) fig. 5 (colour photo, whole animal); Batson (2003: 132) fig. (colour photo, whole animal).

Other significant references: Kensley *et al.* (1987: 304); Holthuis (1993: 79) fig. 69 (whole animal after Webber *et al.* 1990b); Davie (2002a: 272) fig. page 271 (whole animal after Webber *et al.* 1990); Poore (2004: 73) fig. 17a (whole animal).

Distribution: NZ; eastern Australia; near benthic on continental slope.

Colour: anterior part of body red, abdomen partly red and partly transparent.

***Nematocarcinus cf. exilis* (Bate, 1888)**

NZ material: *Galathea* expedition bottom station 661, Kermadec Trench, 5230–5340 m, specimen in University Zoological Museum, Copenhagen, identified by JCY in 1974.

NZ reference: Webber *et al.* (2010: 225).

Other significant reference to Nematocarcinus exilis: Crosnier & Forest (1973: 116) figs 2d–e, 33d–f.

Distribution of Nematocarcinus exilis: Kermadec Trench; North Atlantic; deep water, benthic.

***Nematocarcinus gracilis* Bate, 1888**

NZ references: Bate (1888: 815) pl. 132, fig. 8; Richardson & Yaldwyn (1958: 31).

Other significant references: Crosnier (1976: 229) fig. 2; Chace (1986: 71) fig. 38; Kensley *et al.* (1987: 291); Davie (2002a: 273); Poore (2004: 75) fig. 17b (front, rostrum).

Distribution: off Kermadec Islands; Indo-Pacific including Western and eastern Australia; deep water.

***Nematocarcinus hiatus* Bate, 1888**

NZ references: Bate (1888: 821) pl. 132, fig. 12; Richardson & Yaldwyn (1958: 31) fig. 18 (carapace).

Distribution: described from a single damaged specimen taken off East Cape at 1280 m with *N. serratus* Bate.

Status: possibly a synonym of the more widely distributed Indo-Pacific *N. longirostris* Bate.

***Nematocarcinus longirostris* Bate, 1888**

NZ material: *Galathea* expedition bottom station 661, Kermadec Trench, 5230–5340 m, specimen in University Zoological Museum, Copenhagen, identified by JCY in 1974.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Bate (1888: 806) pl. 132, fig. 2; Tiefenbacher (1990: 230) (*N. proximatus* synonymised with *N. longirostris*).

Distribution: NZ; Indo-Pacific and eastern Pacific; deep-water benthic or near benthic.

***Nematocarcinus novaezealandicus* Burukovsky, 2006**

NZ reference: Burukovsky (2006: 441) fig. 1a–d (front and other diagnostic characters).

Distribution: endemic, Challenger Plateau and Chatham Rise, 870–1170 m.

***Nematocarcinus serratus* Bate, 1888**

NZ references: Bate (1888: 819) pl. 132, fig. 11; Richardson & Yaldwyn (1958: 31) fig. 19 (rostrum).

Distribution: described from a single specimen taken from off East Cape at 1280 m with *N. hiatus* Bate, 1888.

***Nematocarcinus undulatipes* Bate, 1888**

NZ references: Bate (1888: 801) pl. 130 (whole animal); Richardson & Yaldwyn (1958: 31).

Other significant references: Chace (1986: 76) figs 41, 42; Kensley *et al.* (1987: 291); Burukovsky (2002); Davie (2002a: 275); Poore (2004: 75) fig. 17e (front, rostrum).

Distribution: off Kermadec Islands; Indo-West Pacific; deep water.

***Nematocarcinus webberi* Burukovsky, 2006**

NZ reference: Burukovsky (2006: 444) fig. 2a–d (rostrum, other diagnostic characters).

Distribution: endemic, one specimen from Mernoo Bank.

***Nematocarcinus yaldwyni* Burukovsky, 2006**

NZ reference: Burukovsky (2006: 441) fig. 3a–e (carapace, other diagnostic characters).

Distribution: endemic, east of the North Island.

Family RHYNCHOCINETIDAE

Ortmann, 1890

***Rhynchocinetes balssi* Gordon, 1936**

NZ references: Gordon (1936: 85) fig. 7a–b; Richardson & Yaldwyn (1958: 29).

Other significant references: Bruce (1985: 124) fig. 1; Davie (2002a: 373).

Distribution: northern NZ; Lord Howe and Norfolk islands in Indo-West Pacific, and Juan Fernandez Islands in eastern Pacific; shelf.

Other names used: *Rhynchocinetes typus* H. Milne Edwards, 1837; *Rhynchocinetes rugulosus* Rathbun, 1906.

***Rhynchocinetes ikatere* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 29) fig. 25 (carapace), as *Rhynchocinetes* n. sp.; Yaldwyn (1971: 87).

Distribution: endemic, northern NZ; shelf.

Colour: body and appendages light red with distinctive pattern of bilaterally symmetrical white bands.

Superfamily STYLODACTYLOIDEA

Bate, 1888

Family STYLODACTYLIDAE

Bate, 1888

***Stylodactyloides crosnieri* Cleva, 1990**

NZ reference: Yaldwyn *in* Cleva (1994: 63) based on specimens in NIWA and MNZ collections from NZ and Kermadec Islands waters.

Other significant references: Cleva (1990: 129) fig. 17a–e (diagnostic characters), fig. 18d–e (colour photos, whole animal); Holthuis (1993: 88) fig. 77 (after Cleva 1990); Davie (2002a: 377).

Distribution: NZ; New Caledonia, Great Barrier Reef; shelf and slope, benthic.

***Stylodactylus discissipes* Bate, 1888**

NZ references: Bate (1888: 851) pl. 138, fig. 1 (whole animal), pl. 138, fig. 2, as *S. orientalis*; Richardson & Yaldwyn (1958: 28); Crosnier & Forest (1973: 131) fig. 36g–h; Chace (1983: 11).

Distribution: endemic, known only from three specimens taken off Kermadec Islands in 1100 m.

Superfamily CAMPYLONOTOIDEA

Sollaud, 1913

Family CAMPYLONOTIDAE

Sollaud, 1913

***Campylonotus rathbunae* Schmitt, 1926**

NZ references: Yaldwyn (1960: 20) figs 2–4 (male rostrum); Webber *et al.* (1990: 40) fig. (whole female); Webber (2002b: 76) fig. 3 (colour photo, whole animal).

Other significant references: Schmitt (1926: 373) pl. 67 (whole female); Holthuis (1955: 26) fig. 20a (after Schmitt 1926); Kensley *et al.* (1987: 304); Davie (2002a: 236) fig. page 235 (female, after Schmitt 1926); Poore (2004: 80) fig. 20 (whole animal).

Distribution: NZ; eastern and southern Australia; benthic, continental slope.

Colour and biology: translucent with irregular pinkish-red blotches, characteristically with rostral tip red and red 'saddle' dorso-laterally on 3rd abdominal segment. The species is a protandrous hermaphrodite, with the rostrum in males almost a straight continuation from dorsal midline of carapace, while in females the rostrum is strongly curved dorsally with dorsal margin more or less evenly concave.

Superfamily PALAEMONOIDEA

Rafinesque, 1815

Family PALAEMONIDAE Rafinesque, 1815

Subfamily PALAEMONINAE

Rafinesque, 1815

***Palaemon affinis* H. Milne Edwards, 1837**

NZ references: Holthuis (1950: 76) fig. 16 (not synonymous with eastern Australian *P. serenus* (Heller, 1862)); Holthuis (1952: 204); Yaldwyn (1954a: 171) figs 1–2; Yaldwyn (1957b: 883) figs 1–5 (rostral variation); Yaldwyn (1974: 1043) fig. 3 (colour photo, whole animal); Powell (1987: 32) fig. 172 (whole animal).

Distribution: endemic, abundant, intertidal and saline estuary species throughout NZ mainland, Stewart Island/Rakiura and Chatham Islands (but not at Kermadec Islands or Subantarctic Islands; replaced in the latter by hippolytid *Nauticaris marionis*), recorded to depths of c. 4 m.

Colour: transparent with narrow, longitudinal, wavy green and red stripes along carapace and abdomen, prominent diagnostic orange and black spot laterally at base of tail fan.

Other names used: *Leander affinis* (H. Milne Edwards, 1837); *Leander quoianus* Kemp, 1929.

Notes: the wide-ranging tropical and subtropical pelagic palaemonid *Leander tenuicornis* (Say, 1818), often associated with drifting seaweed, has been recorded from NZ by Miers (1876: 86) (as *L. natator*) from specimens in the Natural History Museum, London. No additional specimens have been recorded from NZ since.

The large Indo-Pacific freshwater palaemonid *Macrobrachium lar* (Fabricius, 1798), commonly used for food throughout its range, was recorded from Auckland, NZ, by Heller (1865: 119) (as *Palaemon ornatus*). This is clearly an error as members of this genus do not occur naturally in NZ fresh waters. The equally large *M. rosenbergii* (de Man, 1879), from Southeast Asia, the Malay Archipelago and northern Australia, has been introduced into NZ for prawn farming under controlled conditions in geothermally heated water at Wairakei on the Waikato River, just north of Taupo. The species is considered as unable to survive or breed in unheated NZ fresh waters.

Subfamily PONTONIINAE Kingsley, 1879

***Hamiger novaezealandiae* (Borradaile, 1916)**

NZ references: Borradaile (1916: 87) fig. 4 (whole animal), as *Periclimenes (Hamiger) novaezealandiae*; Bruce (1986:

912) figs 1–4 (whole animal); Holthuis (1993) fig. 130 (whole animal, after Bruce 1986).

Distribution: endemic, originally collected by *Terra Nova* expedition, 128 m off North Cape, additional material now known from waters north of NZ

Other name used: *Periclimenaeus novaezealandiae* Borradaile, 1916.

***Periclimenes fenneri* Bruce, 2005**

NZ reference: Bruce (2005: 5) figs 2A–M, 3A–F, 4A–J (female holotype, diagnostic characters in detail,) fig. 8C (photo, female holotype).

Distribution: West Norfolk Ridge, due west of Cape Maria van Diemen.

***Periclimenes tangeroa* Bruce, 2005**

NZ reference: Bruce (2005: 12) figs 5A–I, 6A–I, 7A–C (female holotype, diagnostic characters in detail), fig. 8D (photo, female holotype).

Distribution: Reinga Ridge, northwest of Three Kings Islands.

***Periclimenes yaldwyni* Holthuis, 1959**

NZ references: Richardson & Yaldwyn (1958: 34) fig. 22, (cephalothorax and abdomen), as *P. (Harpilius) batei*; Holthuis (1959: 197), as *P. (Harpilius) yaldwyni*.

Other significant reference: Bruce & Cropp (1984: 189) fig. 1 (whole animal).

Distribution: abundant shallow-water, sandy-bottom species around NZ mainland, Stewart Island/Rakiura and Chatham Islands coasts (but not Kermadec Islands or Subantarctic Islands); Tasmania; *c.* 3–130 m.

Colour: transparent, lightly scattered with green and red chromatophores, eggs greenish.

Other names used: *Palaemon audouini* Heller, 1862; *Brachycarpus audouini* (Heller, 1862).

Superfamily ALPHEOIDEA Rafinesque, 1815

Family ALPHEIDAE Rafinesque, 1815

***Alpheopsis garricki* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 36), as *Alpheopsis* sp.; Yaldwyn (1971: 87); Chace (1988: 40).

Distribution: endemic; shelf to *c.* 200 m.

Colour: body transparent with prominent transverse red bands (two bands on carapace, one on each abdominal segment).

Status: possibly synonymous with the eastern Australian *Alpheopsis trispinosus* (Stimpson, 1861); see Banner & Banner (1973: 337, fig. 14).

***Alpheus hailstonei* Coutière, 1905**

NZ material: specimens from *c.* 80–120 m off Kermadec Islands in MNZ identified by Y. Miya in 1988.

NZ reference: Webber *et al.* (2010: 224)

Other significant references: Banner & Banner (1982: 38) fig. 6, as member of *Alpheus* ‘*Macrocheles*’ group; Chace (1988: 30); Davie (2002a: 190); Poore (2004: 104) figs 26n–o, 29j (diagnostic characters of carapace front and chela).

Distribution: off Kermadec Islands; Indo-Pacific; shelf and slope depths.

***Alpheus novaezealandiae* Miers, 1876**

NZ references: Yaldwyn (1957c: 806) figs 1–7; Richardson & Yaldwyn (1958: 37) fig. 34; Powell (1987: 32) fig. 173 (whole animal); Davie (2002a: 195); Poore (2004: 105) figs 26t–u, 29o (diagnostic characters of carapace front and chela).

Other significant reference: Banner & Banner (1982: 145) fig. 42, as member of *Alpheus* ‘*Diadema*’ group.

Distribution: intertidal mud and sand flats, often under stones, and in shallow water to 25 m, in northern NZ from Bay of Islands south to Manukau Harbour; very few records from NZ waters, has been taken with *Alpheus richardsoni* in Manukau intertidal zone; around all coasts of Australia and at Lord Howe Island, in intertidal zone and shallow water.

Colour of NZ specimens: carapace yellowish green, abdomen pinkish brown with a distinct dark, longitudinal mid-dorsal line, dark transverse bands across posterior margin of each segment, and symmetrical white patches dorsally and laterally on each segment. Hands pinkish brown and green.

***Alpheus richardsoni* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 37) fig. 35 (carapace, chela), as *Alpheus* sp. ‘*Edwardsii*’ group; Yaldwyn (1971: 88), as *A. richardsoni*; Miller & Batt (1973) fig. 114 (colour photo, whole animal), as *A. richardsoni* on inappropriate broken shell background; Yaldwyn (1974: 1044) cover (colour photo, whole animal as *A. richardsoni* on inappropriate shell background); Powell (1987) fig. 173, as *A. novaezealandiae* but not *A. novaezealandiae* Miers, 1876; Davie (2002a: 198); Poore (2004: 106) figs 27c–d, 28l, 29s–t (diagnostic characters, including whole animal), pl. 9b (colour photo, whole animal).

Other significant reference: Banner & Banner (1982: 235) fig. 74, as member of *Alpheus* ‘*Edwardsii*’ group.

Distribution: endemic, northern NZ south to about Manukau Harbour on west coast and Tauranga Harbour on east coast; in mangrove swamps and intertidal and shallow-water mudflats, and subtidally to depths of about 12 m.

Colour and biology: light green in general colour with alternate bands of light and dark green across abdominal segments, both large and small chelae dorsally green but ventrally pale; eggs olive green and ovigerous females with prominent blue band along edge of abdominal pleura. The deep-burrowing *Alpheus richardsoni* is the classic 'snapping' shrimp, producing the snapping noise that is so characteristic of northern NZ swamps, especially on a falling tide.

***Alpheus socialis* Heller, 1865**

NZ references: Thomson (1903: 436) pl. 27B; Richardson & Yaldwyn (1958: 36) fig. 33; Davie (2002a: 199); Poore (2004: 106) figs 27e–f, 29u–w (diagnostic characters of carapace front, some appendages).

Other significant reference: Banner & Banner (1982: 68) fig. 16, as member of *Alpheus* 'Sulcatus' group.

Distribution: throughout NZ from Northland to Stewart Island/Rakiura, Chatham Islands and Kermadec Islands; southeastern Australia and Lord Howe Island; ranging from rocky intertidal zone to coarse bottoms, to at least 46 m.

Colour: carapace and abdomen orange-red to pink, both large and small chelae dorsally orange-red to purple with characteristic, irregularly scattered spots and markings of white, ventrally both chelae pale orange-yellow, eggs greenish. An unusual variant colour pattern seen in both NZ and Australian specimens has both the large and small chelae yellowish white with an irregular, broad, dark W-shaped mark across the dorsal surface of one or both.

Note: *Alpheus halesii* Kirk, 1887 was described from the 'East Coast of Wellington Province' (*Transactions of the New Zealand Institute* 19: 194, pl. 6D). The type material cannot be found and the species is specifically unidentifiable. It is possible that the species was based on a specimen of *Alpheus glaber* (Olivi, 1792) from European waters, supplied to Kirk in error.

***Athanas indicus* Coutière, 1903**

NZ material: specimens taken commensal with intertidal and shallow-water echinoids at Kermadec Islands in MNZ identified by Y. Miya in 1988.

NZ reference: Webber *et al.* (2010: 224).

Other significant reference: Banner & Banner (1973: 327) fig. 11.

Distribution: Kermadec Islands; Indo-Pacific; commensal with intertidal and shallow-water echinoids and crinoids.

***Betaeopsis aequimanus* (Dana, 1852)**

NZ references: Dana (1855) pl. 35, fig. 11a (whole animal), as *Betaeus*, fig. 11b; Thomson (1903: 438), pl. 28A, as *Betaeus*; Richardson & Yaldwyn (1958: 37) fig. 36 (carapace), as *Betaeus*; Yaldwyn (1971: 88); Holthuis (1993) fig. 193 (after Thomson 1903); Anker & Jeng (2002: 570) fig. 1A (whole animal), figs 2–5.

Other significant reference: Chace (1988: 69).

Distribution: endemic, throughout NZ from Northland to Stewart Island/Rakiura and Chatham Islands, not known from Kermadec or Subantarctic Islands; under stones, intertidal and damp supratidal zones.

Colour: most specimens are dark greenish with a light-coloured band along the dorsal midline of the carapace and abdomen; a few are light orange-yellow with no dorsal band; eggs are bright yellow.

Family HIPPOLYTIDAE Dana, 1852

***Alope spinifrons* (H. Milne Edwards, 1837)**

NZ references: Thomson (1903: 440) pl. 28B, as *A. palpalis* and *Merhippolyte spinifrons*; Holthuis (1947: 34); Richardson & Yaldwyn (1958: 36) fig. 30 (carapace); Morton & Miller (1968) pl. 22, fig. 1 (colour sketch, whole animal); Miller & Batt (1973) fig. 88 (colour photo, whole animal).

Distribution: endemic, NZ rocky shores from Northland to Stewart Island/Rakiura and Chatham Islands, not known from Kermadec Islands (but see following comment) or Subantarctic Islands; intertidal zone and shallow water (even out of water on shaded intertidal rock faces).

Kermadec record: the record of *Alope palpalis* from the Kermadec Islands given in Chilton (1911: 547) probably refers to the wide-ranging Indo-West Pacific and Australian *A. orientalis* (de Man, 1890) but this needs confirmation.

Colour and biology: *Alope spinifrons* is negatively phototrophic. Specimens taken from a dark habitat are transparent with irregular, wavy, longitudinal green bands, with some tingeing of red, dorsally and laterally on carapace and abdomen, appendages green. Specimens kept in the light for a short period have wavy, longitudinal red bands dorsally and laterally on carapace and abdomen, with the

green colour mostly suppressed. Mature males develop elongate 3rd maxillipeds, reaching in some cases up to or more than the combined carapace and abdomen length of the individual.

***Bathyhippolyte yaldwyni* Hayashi & Miyake, 1970**

NZ references: Hayashi & Miyake (1970: 42) fig. 1 (whole animal), fig. 16; Holthuis (1993: 222) fig. 216 (whole animal, after Hayashi & Miyake 1970).

Distribution: endemic, known only from three deep-water bottom stations, off the east coast of the South Island, 220–1110 m.

Colour: body yellowish brown; eyes reduced, non-pigmented, orange in life.

***Hippolyte bifidirostris* (Miers, 1876)**

NZ references: Miers (1876) pl. 2, fig. 1, as *Virbius bifidirostris*; Richardson & Yaldwyn (1958: 35) fig. 26; Gunson (1993: 49) fig. (black and white sketch of whole animal colour pattern); Davie (2002a: 255).

Distribution: endemic, from Northland to Stewart Island/Rakiura and Chatham Islands, not known from Kermadec Islands or Subantarctic Islands; immediate subtidal zone and shallow water, usually associated with algae. Not found together with *Hippolyte multicolorata*.

Colour: overall olive brown or green with scattering of small, bright blue spots. Some specimens carry little tufts of pigmented plumose setae on carapace and abdomen; specimens of *Hippolyte* spp. with such setal tufts are referred to as ‘fascigerous’.

***Hippolyte multicolorata* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 35) fig. 27 (carapace), as *Hippolyte* n. sp.; Yaldwyn (1971: 90); Yaldwyn (1974: 1041) fig. (colour photo, whole animal).

Distribution: endemic, from Northland south to Otago and Chatham Islands, not known from Kermadec Islands nor Subantarctic Islands; immediate subtidal zone and shallow water, usually associated with algae.

Colour: specimens from one locality can range from uniform olive brown to light green and even dark red-brown, in each case with or without transparent lateral windows on carapace and abdomen (see Yaldwyn 1974 – colour photo), with or without a lateral brown band along body, and with or without a narrow longitudinal band of white dorsally along rostrum and midline of carapace and abdomen. Rarely, some specimens are transparent with a few longitudinal wavy red lines. Fascigerous specimens are usually light or dark red brown with the setal tufts red.

Specimens change colour readily in captivity depending on lighting and the colours of algae present.

***Lebbeus cristatus* Ah Yong, 2010**

NZ reference: Ah Yong (2010a: 341) fig. 1A–G (female holotype, whole animal and diagnostic characters), fig. 2A–I (female holotype, diagnostic characters), fig. 3A (female holotype, colour photo, whole animal).

Distribution: endemic, Challenger Plateau.

***Lebbeus wera* Ah Yong, 2009**

NZ references: Ah Yong (2009b: 786) fig. 5 (female holotype, whole animal), fig. 6A–E (female holotype, diagnostic characters), fig. 6F–K (male paratype, diagnostic characters), fig. 7A–J (female holotype, diagnostic characters), fig. 7K–L (male paratype, diagnostic characters); Ah Yong (2010a) fig. 3B (female holotype, colour photo, whole animal).

Distribution: endemic, Brothers Caldera, southern Kermadec Ridge.

***Leontocaris alexander* Poore, 2009**

NZ reference: Ah Yong (2010a: 346).

Other significant reference: Poore (2009: 958) fig. 2a–h (female holotype, diagnostic characters), fig. 2i–k (ovigerous female, diagnostic characters), fig. 3a–h (female holotype, details of major cheliped), fig. 4a–i (female holotype, diagnostic characters).

Distribution: western Chatham Rise; southeastern Tasmania seamounts.

***Leontocaris amplexipes* Bruce, 1990**

NZ reference: Ah Yong (2010a: 346) fig. 4A–B (male carapace), fig. 5A–E (female whole animal, major chela), fig. 6A–L (female, diagnostic characters).

Other significant reference: Bruce (1990: 121) fig. 1 (holotype, whole animal), fig. 2A–I (holotype, diagnostic features), fig. 3A–F (holotype, mouthparts), fig. 4A–M (holotype, P1 and P2), fig. 5A–H (holotype, diagnostic characters).

Distribution: Chatham Rise; southeastern Tasmania.

***Leontocaris yarramundi* Taylor & Poore, 1998**

NZ reference: Ah Yong (2010a: 353) fig. 4D (male, carapace).

Other significant reference: Taylor & Poore (1998: 121) fig. 1 (holotype, whole animal), fig. 2A–I (holotype, diagnostic features), fig. 3A–F (holotype, mouthparts), fig. 4A–M (holotype, P1 and P2), fig. 5A–H (holotype, diagnostic characters).

Distribution: Chatham Rise; southeastern Tasmanian seamounts.

***Lysmata morelandi* (Yaldwyn, 1971)**

NZ references: Yaldwyn (1971: 90), as *Hippolysmata morelandi*; Chace (1997: 73); Hanamura (2008: 94) fig. 4 (Australian female, lateral view), fig. 5 (diagnostic characters).

Distribution: northern NZ; southeastern Australia; shallow water.

Colour and biology: bright red with three longitudinal lateral white bands on each side of abdomen, two of the bands extending onto branchial region of carapace. Acts as a fish-cleaning shrimp (*vide* Doak 1972: 16).

***Lysmata trisetacea* (Heller, 1861)**

NZ references: Kemp (1914: 110) pl. VI, figs 1–4 (cephalothorax, diagnostic characters), as *L. chiltoni*; Holthuis (1947: 65).

Other significant reference: Chace (1997: 77).

Distribution: Kermadec Islands; Indo-Pacific (Red Sea to Hawai'i) and eastern Pacific (Clipperton Island); littoral.

***Lysmata vittata* (Stimpson, 1860)**

NZ reference: Ahyong (2010a: 354) fig. 4e (carapace).

Distribution: northern New Zealand; east Africa to Philippines, Japan and Australia; intertidal zone to shelf.

***Merhippolyte chacei* Kensley, Tranter & Griffin, 1987**

NZ material: several specimens in MNZ from northern NZ waters, 500–700 m.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Kensley *et al.* (1987: 309) figs 18–19; Davie (2002a: 261); Poore (2004: 123) fig. 32f (rostrum).

Distribution: northern NZ; described from two specimens taken off New South Wales, 500–680 m.

***Nauticaris marionis* Bate, 1888**

NZ references: Thomson (1903: 445) pl. 29A (whole animal), as *N. stewarti*; Richardson & Yaldwyn (1958: 35) fig. 28 (carapace); Holthuis (1947: 6, 31); Holthuis (1993: 245) fig. 241 (whole animal, after Thomson 1903); Davie (2002a: 261); Poore (2004: 124) fig. 32a (whole animal), pl. 9h (colour photo, whole animal).

Other significant reference: Bate (1888: 603) pl. 108, fig. 1 (whole animal) but NOT fig. 2 (= *N. magellanica*).

Distribution: southern NZ (south of subtropical convergence) from Cook Strait to Stewart Island/Rakiura, c. 50–550 m, and then a common intertidal and shallow-water species in NZ Subantarctic Islands (where it replaces *Palaemon affinis* of the NZ mainland); southern Indian

Ocean (Marion and Prince Edward islands) and off Tasmania.

Colour: Cook Strait specimen transparent with irregular rows of red chromatophores on body, these rows diagonal on carapace and transverse on abdomen, eyes dark blue, eggs blue-green.

Other names used: *Hippolyte stewarti* Thomson, 1888; *Merhippolyte australis* Hodgson, 1902.

***Tozeuma novaezealandiae* Borradaile, 1916**

NZ references: Borradaile (1916: 86) fig. 3 (whole animal); Richardson & Yaldwyn (1958: 35) fig. 29 (carapace); Chace (1997: 94).

Distribution: endemic, off northern tip of Northland south to Auckland Islands; shelf and upper continental slope.

Colour: body and appendages mostly red, with red chromatophores mostly concentrated in wavy, longitudinal bands laterally on carapace and abdomen, ventral edges of abdominal terga with intense band of red, and prominent band of red along dorsal midline of rostrum, carapace and abdomen.

Other name used: *Angasia novaezealandiae* (Borradaile, 1916).

Family OGYRIDIDAE Holthuis, 1955***Ogyrides delli* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 36) fig. 31 (carapace), as *Ogyrides* n. sp.; Yaldwyn (1971: 89); Banner & Banner (1982: 289) figs 88–89; Poore (2004: 127) fig. 33a (whole animal).

Other significant reference: Davie (2002a: 277).

Distribution: NZ, from Northland to Cook Strait and Chatham Islands, c. 5–50 m; eastern Australia (Moreton Bay to Sydney) southern Australia, burrows in sandy bottoms.

Colour: transparent with prominent transverse red bands across posterior margins of each abdominal segment.

Superfamily PROCESSOIDEA Ortmann, 1896**Family PROCESSIDAE Ortmann, 1896*****Processa moana* Yaldwyn, 1971**

NZ references: Richardson & Yaldwyn (1958: 34) fig. 32 (carapace), as *Processa?* n. sp.; Yaldwyn (1971: 91).

Other significant reference: Noël (1985: 298).

Distribution: endemic, northern NZ; shelf, few collections available.

Colour: transparent, with scattered red chromatophores, concentrations of red on rostrum, tail fan and some appendages.

Superfamily PANDALOIDEA Haworth, 1852

Family PANDALIDAE Haworth, 1825

***Chlorotocus novaezealandiae* (Borradaile, 1916)**

NZ references: Borradaile (1916: 84) fig. 2 (whole animal, as *Thalassocaris novaezealandiae*); Richardson & Yaldwyn (1958: 38) fig. 40 (carapace); Crosnier & Forest (1973: 186); Webber *et al.* (1990b: 30) fig. (whole animal); Davie (2002a: 345); Poore (2004: 132) fig. 35a (carapace).

Other significant reference: Kensley *et al.* (1987: 312).

Distribution: northern and central NZ, from Northland to about 44°S on both coasts of the South Island; eastern Australia (off New South Wales); shelf and upper continental slope.

Colour: transparent with red-pink to orange-yellow markings, thoracic appendages red, viscera within body scarlet.

***Heterocarpus laevigatus* Bate, 1888**

NZ material: specimen at MNZ from West Norfolk Ridge.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Bate (1888: 636) pl. 112, fig. 3 (whole animal); Crosnier & Forest (1973: 195) fig. 61c (lateral view carapace); Chace (1985: 33) fig. 13i; Davie (2002a: 346).

Distribution: northern New Zealand; Indo-West Pacific from South Africa and the Arabian Sea to Indonesia, Philippines, western Pacific Islands and Hawai'i, and eastern Atlantic, including Madeira, Cape Verde Islands and off Western Sahara. *Heterocarpus laevigatus* has been taken in several trapping surveys for deep-water commercial shrimps in the western Pacific e.g. off New Guinea, Vanuatu, Fiji, Western Samoa, Tonga, Guam. King (1981: 33) summarises the commercial potential of *Heterocarpus* trapping in the western Pacific where the 'red-tipped shrimp' (*H. laevigatus*) is one of the largest *Heterocarpus* species known and is common in depths of more than 500 m.

***Notopandalus magnoculus* (Bate, 1888)**

NZ references: Richardson & Yaldwyn (1958: 37) fig. 37 (carapace), as *Pandalus magnoculus*; Yaldwyn (1960: 29) text fig. 5, figs 1–16; Webber *et al.* (1990b: 34) fig. (whole animal); Holthuis (1993) fig. 269 (whole animal, after Webber *et al.* 1990b).

Distribution: endemic, from Northland to Campbell Plateau and Chatham Rise; semi-pelagic and benthic, shelf and slope.

Colour: transparent with irregular scattering of red chromatophores over carapace and abdomen, viscera within body scarlet, eggs blue-green.

***Plesionika costelloi* (Yaldwyn, 1971)**

NZ references: Richardson & Yaldwyn (1958) fig. 39 (carapace), as *Parapandalus* sp.; Yaldwyn (1971: 91), as *Parapandalus costelloi*; Chace (1985: 46).

Other significant reference: Burukovsky (1991: 39) figs 1–3, as *Parapandalus costelloi*.

Distribution: northern NZ; southwest Indian Ocean; shelf.

Colour: transparent with red rostrum, appendages and viscera, eggs blue.

Status: contrary to the statement by Yaldwyn (1971) that *Plesionika costelloi* does not have epipods on the pereopods, the types do have small epipods on the 1st to 4th pereopods and should have been described as a species of *Plesionika sensu stricto* rather than *Parapandalus*. It may be a synonym of *Plesionika edwardsii* (Brandt, 1851) known from off eastern Australia (Kensley *et al.* 1987).

***Plesionika martia* (A. Milne-Edwards, 1883)**

NZ references: Richardson & Yaldwyn (1958: 37) fig. 38 (carapace); Webber *et al.* (1990b: 32) fig. (whole animal).

Other significant references: Crosnier & Forest (1973: 212) figs 63d, 64e, 66; Chace (1985: 84) fig. 38 (whole animal), fig. 39 (differences between new Philippine subspecies *Plesionika martia orientalis* and closely similar *P. semilaevis* Bate, 1888); Kensley *et al.* (1987: 316); Holthuis (1993) fig. 276 (whole animal); Davie (2002a: 349); Poore (2004: 134) fig. 34c (whole animal).

Distribution: northern NZ; widely distributed in Atlantic and Indo-West Pacific; shelf edge and slope.

Colour: translucent with scattered red chromatophores concentrated on anterior part of rostrum, on dorsal surface of carapace and abdomen, along posterior edges of abdominal segments, and on mouthparts and tail fan.

Status: subspecific status of NZ material not yet established.

***Plesionika spinipes* Bate, 1888**

NZ references: Chilton (1911: 547); Richardson & Yaldwyn (1958: 38), as *Parapandalus spinipes*.

Other significant references: Bate (1888: 646) pl. 113, fig. 2 (whole animal), fig. 2k, m; Kensley *et al.* (1987: 319); Davie (2002a: 351); Poore (2004: 134) fig. 35f (carapace).

Distribution: Kermadec Islands, one specimen washed up on beach; Indo-West Pacific including eastern Australia.

Superfamily CRANGONOIDEA

Haworth, 1825

Family CRANGONIDAE Haworth, 1825

***Aegaeon lacazei* (Gourret, 1887)**

NZ reference: Richardson & Yaldwyn (1958: 40) fig. 44 (carapace), as *Pontocaris lacazei*.

Other significant references: Crosnier & Forest (1973: 250) fig. 81, as *Pontocaris lacazei*; Kensley *et al.* (1987: 327), as *Pontocaris lacazei*; Holthuis (1993) fig. 282 (whole animal); Chan (1996: 278) fig. 3; Davie (2002a: 238); Poore (2004: 137) fig. 36e (carapace).

Distribution: northern NZ; eastern North and South Atlantic, and Indo-Pacific including eastern Australia; shelf and slope.

Colour: Chan (1996) records the body as varying from yellow to brown with a broad, transverse pale band across carapace, eyes dark brown, tail fan pale with a broad distal red-brown band. Some NZ specimens after preservation had a scattering of reddish-brown chromatophores and brown (i.e. not black) eyes.

Other names used: *Aegeon* [*sic*] *cataphractus* (Olivi, 1792); *Pontocaris lacazei* (Gourret, 1887).

***Metacrangon knoxi* (Yaldwyn, 1960)**

NZ references: Richardson & Yaldwyn (1958: 40) fig. 43 (carapace), as *Sclerocrangon* n. sp. from Chatham Rise; Yaldwyn (1960: 35) text fig. 7, figs 1–17, as *Sclerocrangon knoxi*; Komai (1997: 670) figs 1E, 8 (partial redescription from type material as member of the *Metacrangon jacqueti* species group).

Distribution: endemic, only known from Chatham Rise at c. 400–530 m.

Colour: body white, speckled irregularly with red on abdomen and with carapace a darker red, eyes dark brown.

***Metacrangon richardsoni* (Yaldwyn, 1960)**

NZ references: Richardson & Yaldwyn (1958: 40) fig. 42, as *Sclerocrangon* n. sp. from Cook Strait; Yaldwyn (1960: 39) text fig. 8, figs 1–7, as *Sclerocrangon richardsoni*; Komai (1995: 902), as member of the informal *Metacrangon minuta* species group.

Distribution: endemic, known only from holotype trawled in Cook Strait at c. 1000 m.

Colour: carapace dark pink, abdomen and tail fan pale pink, eyes black.

***Parapontophilus* aff. *abyssi* Smith, 1884**

NZ references: Bate (1888: 488), as *Pontophilus gracilis* but

NZ specimens not regarded as conspecific with South Atlantic holotype of *P. gracilis* Bate by later authors; Richardson & Yaldwyn (1958: 41) (under replacement name *Pontophilus challengerii* Ortmann, 1893) fig. 48 (after Bate 1888, but now known not to represent NZ material); Crosnier & Forest (1973: 248) (give differences between Bate's NZ specimens and holotype of *P. gracilis* Bate = *P. challengerii* Ortmann); Chace (1984: 51) (Bate's NZ specimens regarded as taxonomically similar to, but different from, *P. gracilis abyssii* Smith).

Other significant reference to *Parapontophilus abyssii*: Komai (2008b: 274) fig. 3A–I (females, Atlantic Ocean, diagnostic characters), figs 34–35 (geographic distribution); Komai (2008b) regards the *Challenger* and Hawke Bay specimens as similar and likely to represent a new species.

Distribution of *Parapontophilus abyssii*: *Challenger* station 168 off east coast of the North Island at c. 2010 m, and possibly off Hawke Bay.

***Parapontophilus junceus* Bate, 1888**

NZ references: Richardson & Yaldwyn (1958: 41) fig. 46 (carapace), as *Pontophilus indicus*; Komai (2008b: 279) fig. 5A–J (females, diagnostic characters), fig. 6A–B (anterior carapace, eyes), fig. 20C (photo, eyes), fig. 35 (geographic distribution).

Other significant references: Chace (1984: 52) figs 20–22 (*P. occidentalis* var. *indica* de Man is a synonym of *P. junceus*). Bate's (1888) illustration of the holotype of *P. junceus* is 'fanciful' (Chace 1984).

Distribution: Bay of Plenty at 542–730 m; Indo-West Pacific including Western Australia; deep water, benthic.

Colour: a Bay of Plenty specimen had a pink body and chelipeds with some scattered red-brown chromatophores, eyes almost colourless but with some internal red-brown pigmentation.

***Philocheras acutirostratus* (Yaldwyn, 1960)**

NZ references: Richardson & Yaldwyn (1958: 41) fig. 47 (carapace), as *Pontophilus* n. sp. with rostrum acute; Yaldwyn (1960: 41) text fig. 9, figs 1–13, as *Pontophilus acutirostratus*; Zarenkov & Bykhovskiy (1968: 165) fig. 9; Komai (2008a: 394).

Distribution: endemic, NZ shelf and slope to at least 730 m.

Colour: carapace and abdomen irregularly blotched with reddish-brown chromatophores and with some white patches laterally, prominent transverse dark band across posterior part of 4th abdominal segment and anterior part of 5th segment.

***Philocheras australis* (Thomson, 1879)**

NZ references: Kemp (1911: 6) pl. 2, figs 1–5, as *Pontophilus australis*; Ralph & Yaldwyn (1956: 64) fig. 6 (general appearance of whole animal), as *Pontophilus australis*; Richardson & Yaldwyn (1958: 40) fig. 45 (carapace), as *Pontophilus australis*; Komai (2008a: 394).

Distribution: endemic, ranging from Northland to Stewart Island/Rakiura and Chatham Islands, not known from Kermadec Islands or Subantarctic Islands; the commonest NZ shallow-water sand shrimp in harbours, inlets and bays, between the intertidal zone and *c.* 20 m.

Colour: three main colour patterns are known for this species. The commonest is body pale, closely speckled with dark sand-grain-coloured flecks, giving the shrimp a general sandy colour. A much less common pattern is the general sandy colour as described above with a pair of prominent black patches dorso-laterally on 4th abdominal segment. A rare pattern is lateral surfaces of carapace and 1st to 3rd abdominal segments, and entire 4th to 6th abdominal segments black, with dorsal surfaces of carapace and 1st to 3rd abdominal segments opaque pinkish white.

Other names used: *Crangon australis* Thomson, 1879; *Pontophilus australis* (Thomson, 1879).

***Philocheras chiltoni* (Kemp, 1911)**

NZ references: Kemp (1911: 5) pl. 2, figs 6–10, as *Pontophilus chiltoni*; Richardson & Yaldwyn (1958: 40) (carapace), as *Pontophilus chiltoni*; Komai (2008a: 395).

Distribution: endemic, ranging from Northland to Dusky Sound, not known from Kermadec Islands or Subantarctic Islands; not as common as, but sometimes found with, *Philocheras australis* in harbours, inlets and bays, between the intertidal zone and *c.* 20 m.

Colour: two colour patterns have been observed. The commonest is overall blotching with brownish black, while the less common pattern is very similar to the rare pattern described above for *Philocheras australis* – lateral surfaces of carapace, abdomen and entire 4th to 6th abdominal segments black, with dorsal surfaces of carapace and 1st to 3rd abdominal segments opaque pinkish white.

***Philocheras hamiltoni* (Yaldwyn, 1971)**

NZ references: Richardson & Yaldwyn (1958: 40) fig. (carapace), as *Pontophilus* n. sp. with rostrum truncated distally; Yaldwyn (1971: 92), as *Pontophilus hamiltoni*; Komai (2008a: 395).

Distribution: endemic, not common, ranging from Cook

Strait to Stewart Island/Rakiura, not known from Chatham Islands or Subantarctic Islands; between intertidal zone and *c.* 100 m.

Colour: only colour notes available are from a Cook Strait shelf specimen with the lateral dark and dorsal light colour pattern described above for *Philocheras australis* and *P. chiltoni*.

***Philocheras pilosoides* (Stephensen, 1927)**

NZ references: Stephensen (1927: 298) fig. 1, as *Pontophilus pilosoides*; Richardson & Yaldwyn (1958: 41) fig. (carapace), as *Pontophilus pilosoides*; Komai (2008a: 395).

Distribution: endemic, ranging from Northland to Subantarctic Islands, not known from Kermadec Islands or Chatham Islands; shelf, *c.* 15–190 m.

Colour: one specimen from Mernoo Bank, Chatham Rise, was mottled with ‘fawn and red brown’ on collection.

***Philocheras quadrispinosus* (Yaldwyn, 1971)**

NZ references: Richardson & Yaldwyn (1958: 41) fig. 50 (carapace), as *Pontophilus* n. sp. with four mid-dorsal spines; Yaldwyn (1971: 93), as *Pontophilus quadrispinosus*; Komai (2008a: 395).

Distribution: endemic, known only from one 1932 *Discovery II* expedition station off Cape Reinga, Northland, at *c.* 58 m.

***Philocheras yaldwyni* (Zarenkov, 1968)**

NZ references: Richardson & Yaldwyn (1958: 41) fig. 49 (carapace), as *Pontophilus* n. sp. with three evenly spaced mid-dorsal spines; Zarenkov & Bykhovsky (1968: 165) fig. 10, as *Pontophilus yaldwyni*; Komai (2008a: 396).

Distribution: endemic, ranging from Northland to southern Fiordland; shelf and upper slope, *c.* 50–335 m.

Colour: some preserved specimens showed patches of reddish-brown chromatophores, while one Cook Strait specimen had the lateral dark and dorsal light colour pattern described above for *Philocheras australis* and *P. chiltoni*.

***Prionocrangon curvicaulis* Yaldwyn, 1960**

NZ references: Richardson & Yaldwyn (1958: 39) fig. 41, as *Prionocrangon* n. sp.; Yaldwyn (1960: 46) text fig. 10, figs 1–17.

Other significant reference: Chace (1984: 57) fig. 24.

Distribution: Chatham Rise, *c.* 400–600 m; one specimen recorded from Philippines at 700 m by Chace (1984).

Colour: entire body pure white, no chromatophores or pigments present in live specimens, eggs bright yellow.

Family **GLYPHOCRANGONIDAE**

Smith, 1884

***Glyphocrangon caeca* Wood-Mason & Alcock, 1891**

NZ material: a specimen in NIWA from Mercury Knoll, Bay of Plenty.

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Wood-Mason & Alcock (1894) pl. 7, fig. 1 (whole animal, dorsal), pl. 7, fig. 1a (whole animal, lateral); de Man (1920: 241) pl. 20, fig. 61 (whole animal, dorsal); Chace (1984: 6) (key to *Glyphocrangon* species) fig. 10.

Distribution: Bay of Plenty; Indian Ocean and Ceram Sea, Indonesia.

Colour: the eyes of the NZ specimen are unpigmented.

***Glyphocrangon lowryi* Kensley, Tranter & Griffin, 1987**

NZ reference: Takeda (1990: 355) fig. 283 (photo, whole animal).

Other significant references: Kensley *et al.* (1987: 322) figs 23, 25D; Komai (2004: 576) figs 99–100 (whole animal); Davie (2002a: 247).

Distribution: northern NZ; eastern Australia; continental slopes and seamounts.

Colour: preserved NZ specimens are cream or white, with the following parts pink (presumably red in life) – anterior half of rostrum, anterior carapace spines, forward-projecting spines on 1st abdominal segment, posterior transverse edge of each abdominal segment, mouthparts and legs. The eyes are dark brown.

***Glyphocrangon regalis* Bate, 1888**

NZ references: Bate (1888: 517) pl. 93, figs 3–4 (both whole animals); Richardson & Yaldwyn (1958: 38).

Other significant references: Chace (1984: 7) (key to *Glyphocrangon* spp.) fig. 20; Komai (2004: 542) figs 77–78 (whole animal).

Distribution: a fragment of a male was taken from 1097 m off the Kermadec Islands by the *Challenger* expedition; Indonesia, Philippines, east coast South Africa; deep water.

***Glyphocrangon sculpta* (Smith, 1882)**

NZ material: several specimens in NIWA from an epibenthic sledge station on the northern edge of Bellona Trough on the western side of the Challenger Plateau at a little over 4000 m. The station is outside the NZ EEZ but clearly within the NZ marine biogeographic region. This is the first record of this deep-water species outside the North and South Atlantic. The extensive increase in the world distribution of *Glyphocrangon sculpta* is confirmed by the

presence of three marginal teeth on the 5th abdominal pleuron, a condition unique to this species.

Significant references: Smith (1882: 49) pl. 5, fig. 3 (whole animal, lateral view) pl. 6, fig. 3 (whole animal, dorsal view), pl. 6, fig. 3a–d, as *Rhachocaris sculpta*; Barnard (1950: 719) fig. 134a–d; Holthuis (1971: 279) fig. 2 (whole animal, dorsal and lateral) fig. 3; Chace (1984: 6) (key to *Glyphocrangon* species).

Distribution: northwestern NZ; Iceland to West Indies in western Atlantic, and to southern tip of South Africa in eastern Atlantic; deep water (1645–4000 m+).

Colour: North Atlantic specimens have rostrum, anterior part of carapace, mouthparts and first three legs red, and some of the carapace and abdominal tubercles as well as the antennules and antennae orange-red. The eyes of New Zealand specimens are pale brown.

Infraorder **ASTACIDEA** Latreille, 1802Superfamily **NEPHROPOIDEA** Dana, 1852Family **NEPHROPIDAE** Dana, 1852***Metanephrops challengerii* (Balss, 1914) (Fig. 5)**

NZ references: Bate (1888: 191) pl. 25, fig. 2 (whole animal, NZ specimens mistakenly identified as females of *Nephrops thomsoni* from the Philippines); Yaldwyn (1954b: 722) fig. 1 (whole animal), as *Nephrops challengerii*, fig. 2 (colour pattern); Takeda (1990: 354) fig. 282 (colour photo, whole animal); Holthuis (1991: 72) figs 125a, 140 (whole animal); Webber (2002a: 48) fig. 1 (colour photo, whole animal); Batson (2003: 133) fig. (colour photo, blue egg mass).

Distribution: the endemic NZ scampi from around and south of the mainland and around the Chatham Islands; burrows in mud and sandy mud, 140–640 m on shelf and slope. It supports a commercial fishery.

Colour: upper surfaces of carapace, abdomen and chelipeds reddish brown; lateral surfaces of carapace and chelipeds white; anterior half of rostrum, postero-lateral corner of branchial region, abdominal terga and tail fan pinkish red; carpus of chelipeds conspicuously bright red, with similarly conspicuous transverse bands of bright red across posterior margin of carapace and posterior margin of abdominal segments; eggs blue.

***Nephropsis submi* Bate, 1888**

NZ material: specimens in MNZ from deep water at the edge of the Challenger Plateau and off the west coast of the South Island.

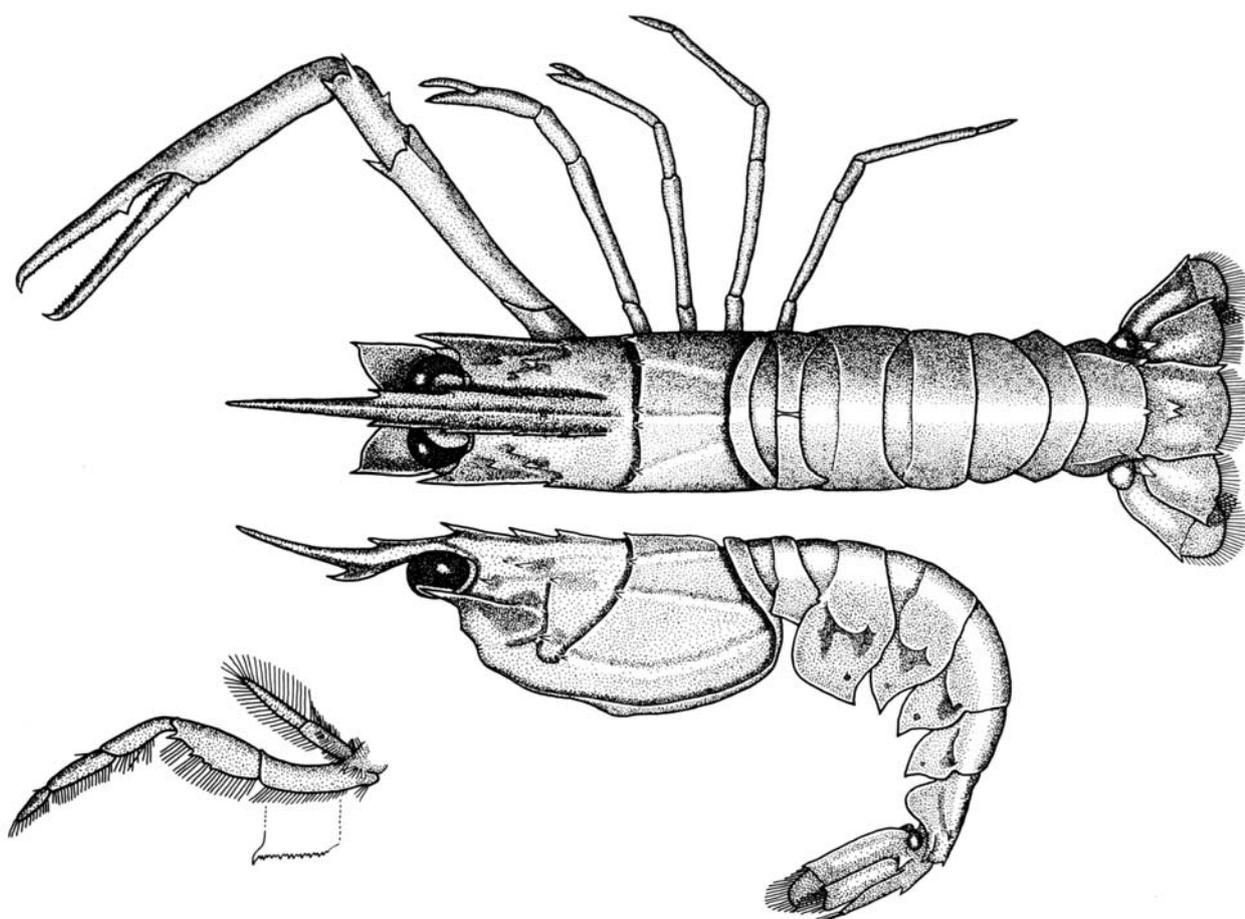


Fig. 5 Infraorder ASTACIDEA: *Metanephrops challengeri* (Bals, 1914) (drawn by J.C. Yaldwyn; from Yaldwyn (1954b); reproduced with permission from the Royal Society of New Zealand).

NZ references: Webber (2002a: 49); Webber *et al.* (2010: 225).

Other significant references: Macpherson (1990: 306) figs 5b, 7d–f, 8c–d, 16b; Holthuis (1991: 46) fig. 82; Griffin & Stoddart (1995: 234); Davie (2002a: 392); Poore (2004: 166) fig. 43e (carapace anterior).

Distribution: NZ; Indo-West Pacific, Western Australia and Lord Howe Rise; c. 700–2000 m+.

Colour of NZ specimens: pinkish red, eyes reduced and cornea without pigment.

Note: between 1906 and 1918, a well-organised attempt was made to introduce the European lobster, *Homarus gammarus* (Linnaeus, 1758) into NZ coastal waters. Live lobsters were imported from the UK and kept in holding ponds at the Portobello Marine Fish-Hatchery and Biological Station in Otago Harbour. It was estimated that in that period more than 750,000 larvae were hatched out and liberated, many 'in the stage at which they seek the bottom and presumably

try to find shelter' (Thomson & Anderton 1921). Mature adults of both sexes were also liberated, but no traces of free-living European lobsters at any stage of growth have been found in Otago Harbour or in NZ waters during or since this attempted introduction. Some young lobsters were hatched and reared in captivity at Portobello for up to four years and four months. A detailed account of this project is given in Thomson & Anderton (1921), with the name of the lobster given as *Homarus vulgaris* H. Milne Edwards, 1837. The only specimen from this failed venture still in existence can found on display at Otago Museum.

Superfamily PARASTACOIDEA Huxley, 1879

Family PARASTACIDAE Huxley, 1879

Paranephrops planifrons White, 1842

NZ references: Archey (1915: 298) fig. 1 (whole animal), figs 2, 3, 5, pl. 4, fig. 1 (photo, whole animal); Hopkins (1970: 284) fig. 5 (photo, whole animal); Riek (1972)

fig. 10 (whole animal); Hopkins (1974) fig. 383 (colour photo, whole animal), fig. 385 (colour photos), fig. 388 (colour photo, juvenile); Powell (1987: 34) fig. 182 (whole animal); Webber (2002a: 51) fig. 6 (colour photo, live animal).

Distribution: endemic, the northern NZ freshwater crayfish, or koura, found in lakes, ponds, running water and swamps throughout the North Island and in Marlborough, Nelson and right down the west coast of the South Island. Subalpine records (to at least 1300 masl) from Tongariro National Park in the central North Island and Paparoa Ranges in Westland (*vide* Fordham *et al.* 1979: 443; Michaelis 1980: 213). Burrows in suitable habitats, otherwise lives under stones.

Colour: body and appendages usually dark greenish brown with some blue highlights; eggs brown, turning red.

***Paranephrops zealandicus* (White, 1847)**

NZ references: Archey (1915: 303) fig. 6 (whole animal), figs 7–9, pl. 4, fig. 2 (photo, whole animal), as *P. setosus*; Archey (1915: 306) fig. 10 (whole animal), fig. 11, pl. 4, fig. 3 (photo, whole animal), as *P. zealandicus*; Hopkins (1970: 286) fig. 6 (photo, whole animal), fig. 7; Hopkins (1974: 387) fig. 2 (photo, whole animal).

Distribution: endemic, the southern NZ freshwater crayfish, or hairy-handed koura, found in similar habitats to *P. planifrons* down the east coast of the South Island from the Waipara River in north Canterbury to Otago, Southland and Stewart Island/Rakiura, not known from the mountain streams of the Kaikoura Range or on the eastern slopes of the Southern Alps. Some small-scale commercial pond farming occurs in central Otago.

Colour: similar to *Paranephrops planifrons*.

Other names used: *Astacus zealandicus* White, 1847; *Paranephrops setosus* Hutton, 1873.

Note: there was a short-lived attempt to pond farm a Western Australian freshwater crayfish known as the marron, *Cherax tenuimanus* (Smith, 1912), near Warkworth, north of Auckland, in the late 1980s to early 1990s. Concern about the possible escape of marron into waterways led to the total destruction of the farmed stock in 1993. For a general account of the project see Lilly (1992), and for a discussion of legal questions regarding the introduction and farming of marron see Hughes (1988).

Infraorder AXIIDEA de Saint Laurent, 1979
Family AXIIDAE Huxley, 1879

***Calocarides vigila* Sakai, 1992**

NZ references: Sakai (1992: 176) fig. 17 (whole animal), fig. 18; Kensley (1996: 54) fig. 1 (distribution map of *Calocarides* spp.).

Distribution: endemic, described from a series of specimens taken in Hawke Bay, Cook Strait and Milford Sound, 74–146 m.

***Calocarides cf. werribee* (Poore & Griffin, 1979)**

NZ material: an ovigerous female in MNZ from Omaha Bay, Northland east coast, 41 m.

NZ reference: Webber *et al.* (2010: 225).

Significant references to Calocarides werribee: Poore & Griffin (1979: 232) figs 5, 6, as *Axiopsis (Axiopsis) werribee*; Sakai (1994: 201), as *Calocarides werribee*; Kensley (1996: 54), as *Axiopsis werribee*; Davie (2002a: 452).

Distribution of Calocarides werribee: southeastern Australia (Victoria, Tasmania), 10–25 m.

***Dorphanaxius kermadecensis* (Chilton, 1911)**

NZ references: Chilton (1911: 550) figs 1–2, as *Iconaxiopsis kermadecensis*; de Man (1925: 4), as *Axius (Eiconaxius) kermadecensis*; Davie (2002a: 452).

Distribution: Kermadec Islands; eastern and southeastern Australia; rock pools.

***Eucalastacus torbeni* Sakai, 1992**

NZ reference: Sakai (1992: 170) fig. 11 (whole animal), figs 12–13.

Distribution: endemic, described from two specimens, one taken off Raglan, west coast of North Island, and one from Milford Sound, Fiordland, 290–340 m.

***Spongioaxius novaezealandiae* Borradaile, 1916**

NZ references: Borradaile (1916: 91) fig. 5 (whole animal), as *Axius novae-zealandiae*; Balss (1933: 87) fig. 1, as *Axius (Axius) novaezealandiae*.

Distribution: endemic; Kermadecs, and Three Kings Islands to Campbell Island; shelf and upper slope, often associated with sponges.

Family CALLIANASSIDAE Dana, 1852
Subfamily CALLIANASSINAE Dana, 1852

***Callianassa filholi* A. Milne-Edwards, 1879**

NZ references: Chilton (1907: 461) pl. 16, figs 1–5; Miller & Batt (1973: 117) fig. 138 (colour photo, whole animal); Sakai (1999: 43) fig. 7a–c; Tudge *et al.* (2000: 143);

Webber (2002a: 50) fig. 5 (colour photo, after Miller & Batt 1973).

Distribution: endemic, Northland to Foveaux Strait; the common NZ ghost shrimp, deep-burrowing in intertidal sand, sandy mud beaches and shallow water.

Colour and ecology: body and appendages pale pink with irregularly shaped transverse red bands on abdominal segments. General ecology covered in Devine (1966).

Subfamily CALLICHIRINAE Manning & Felder, 1991

Corallianassa articulata (Rathbun, 1906)

NZ reference: Chilton (1911: 551), as *Callianassa articulata*.

Other significant references: Rathbun (1906: 892) fig. 47, as *Callianassa articulata*; de Man (1928: 28) fig. 108, as *Callianassa (Callichirus) articulata*; Sakai (1999: 76) fig. 15a–f, as *Glypturus articulatus*; Tudge *et al.* (2000: 144).

Distribution: one specimen recorded from a rock pool on Raoul Island, Kermadecs; described from Hawai'ian Islands in shallow water, also recorded from Gilbert Islands from the littoral.

Corallianassa cf. collaroy (Poore & Griffin, 1979)

NZ material: two specimens of a large callianassid in MNZ from shallow water, Northland east coast; one dug from a vertical mud-lined burrow in gravelly sand at 7 m in Mimiwhangata Bay.

NZ reference: Webber *et al.* (2010: 225).

Significant references to Corallianassa collaroy: Poore & Griffin (1979: 260) figs 24–25, as *Callianassa collaroy*; Sakai (1999: 98), as *Neocallichirus collaroy*; Tudge *et al.* (2000: 144).

Distribution of Corallianassa collaroy: central New South Wales in eastern Australia, Moorea in French Polynesia; burrows in intertidal sand among boulders.

Subfamily VULCANOCALLIACINAE Dworschak & Cunha, 2007

Vulcanocalliax sp.

NZ reference: Lörz *et al.* (2008: 1014) (host of sacculinid *Parthenopia* n. sp.).

Distribution: endemic, only specimen from cold seep off east coast of North Island.

Family CALOCARIDIDAE Ortmann, 1891

Calocaris isochela Zarenkov, 1989

NZ reference: Zarenkov (1989: 25) fig. 2 (whole animal with unnumbered appendage drawings).

Distribution: endemic, described from a single female specimen taken on the Campbell Plateau by *Dmitri Mendeleev* in 570 m.

Family CTENOCHELIDAE Manning & Felder, 1991

Subfamily CTENOCHELINAE Manning & Felder, 1991

Ctenocheles maorianus Powell, 1949

NZ references: Powell (1949: 369) pl. 68, figs 3, 6, 7 (whole animal), figs 4–5; Dell (1955: 149).

Other significant reference: Matsuzawa & Hayashi (1997: 45).

Distribution: endemic, coastal waters and shelf, southernmost records from harbours and inlets at Banks Peninsula, c. 30–75 m; often represented in reference collections by detached chelae only.

Colour: Powell (1949) records the colour as buff, with cheliped palms pink.

Family EICONAXIIDAE Sakai & Ohta, 2005

Eiconaxius kermadeci Bate, 1888

NZ references: Bate (1888: 43) pl. 5, fig. 3 (whole animal); de Man (1925: 4), as *Axius (Eiconaxius) kermadeci*.

Distribution: endemic, taken by *Challenger* expedition off the Kermadec Islands, 1100 m.

Eiconaxius parvus Bate, 1888

NZ reference: Bate (1888: 44) pl. 5, figs 4–5 (whole animal).

Other significant reference: de Man (1925: 4, 42) pl. 3, fig. 7a–f, as *Axius (Eiconaxius) parvus*.

Distribution: taken by *Challenger* expedition off Kermadec Islands, 950 m; Indonesia, 560 m.

Infraorder GEBIIDEA de Saint Laurent, 1979

Family LAOMEDIIDAE Borradaile, 1903

Jaxea novaezealandiae Wear & Yaldwyn, 1966 (Fig. 6)

NZ reference: Wear & Yaldwyn (1966: 4) fig. 1 (whole animal), figs 2–3 (larval stages), fig. 5 (1st post-larval stage).

Distribution: endemic, northern and central NZ (Bay of Plenty, Hawke Bay, Wellington Harbour, Cook Strait), burrowing in muddy or sandy bottoms, c. 4–30 m.

Colour and biology: body and appendages chalky white with a short, dense pile of fine fur-like setae, giving a soft, indistinct grey appearance. Fine, rust-coloured mineral grains (presumably from substrate) usually enmeshed in the setal fur, giving a superficial appearance of pigmentation. Post-larval juveniles (at about carapace length 6 mm) with eyes

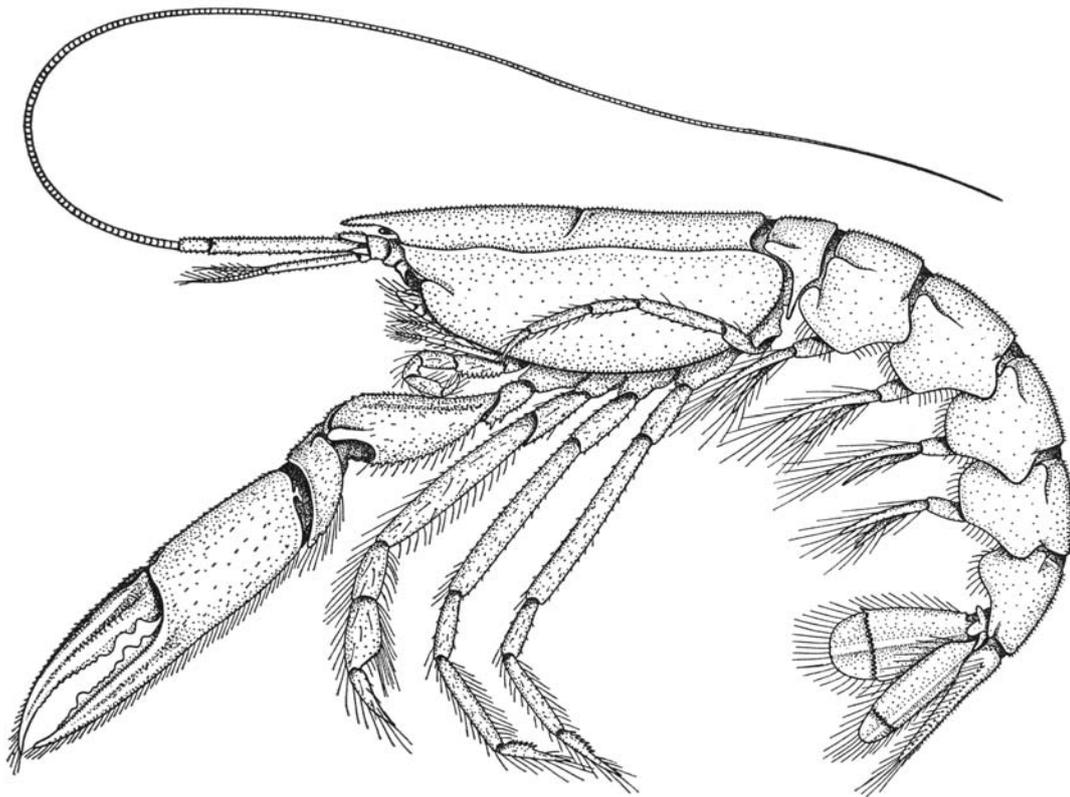


Fig. 6 Infraorder GEBIIDEA: *Jaxea novaezealandiae* Wear & Yaldwyn, 1966 (drawn by R.G. Wear; from Wear & Yaldwyn (1966); reproduced with permission from Dr R.G. Wear, School of Biological Sciences, Victoria University of Wellington).

obvious, cornea black and visible in dorsal view, and with cheliped fingers pearly iridescent. Adults (carapace length up to 16 mm or more) with eyes greatly reduced and not visible in dorsal view.

Family **UPOGEBIIDAE** Borradaile, 1903

Acutigebia danai (Miers, 1876)

NZ references: Chilton (1907: 459), as *Upogebia danai*; Miller & Batt (1973) fig. 139 (photo, whole animal as *Upogebia danai*); Sakai (1982: 69) fig. 146, pl. G, fig. 5, as *Upogebia acutigebia danai*.

Distribution: endemic, mainland and Kermadec Islands, burrows in soft sediments in intertidal and shallow subtidal zones.

Upogebia hirtifrons (White, 1847)

NZ references: Chilton (1907: 457); Sakai (1982: 54) figs 11a, 13c–d, pl. E, figs 7–8, as *Upogebia (Upogebia) hirtifrons*.

Distribution: endemic, North Island and northern South Island, burrows in soft sediments in intertidal and shallow subtidal zones.

Infraorder ACHELATA Scholtz & Richter, 1995

Family **PALINURIDAE** Latreille, 1802

Jasus edwardsii (Hutton, 1875) (Fig. 7)

NZ references: Kensler (1967a: 412) fig. 1 (whole animal); George & Kensler (1970: 293) figs 2, 3, 6, 8 (puerulus and juvenile); Coombs (1974: 726) (whole animal, after Kensler 1967a), pp. 725–732 (colour photos, live animals); Williams (1988: 55) lower fig. (tail sculpture), fig. 56, upper fig. (colour photo, lateral view of tail), as *J. novaehollandiae*, fig. 57, upper fig. (colour illustration, whole animal), fig. 58 (colour photos, dorsal and lateral views of tail), as *J. edwardsii*; Holthuis (1991: 97) figs 186c, 187 (whole animal, after Kensler 1967a), fig. 188 (distribution).

Other significant references: Holthuis (1991: 100) fig. 193 (whole animal), as *J. novaehollandiae*, fig. 194 (distribution); Davie (2002a: 424), as *Jasus (Jasus) edwardsii*; Poore (2004: 200) pl. 2 (colour illustration, after McCoy 1887), fig. 13a (live animals in reef crevice), as *Jasus (Jasus) edwardsii*.

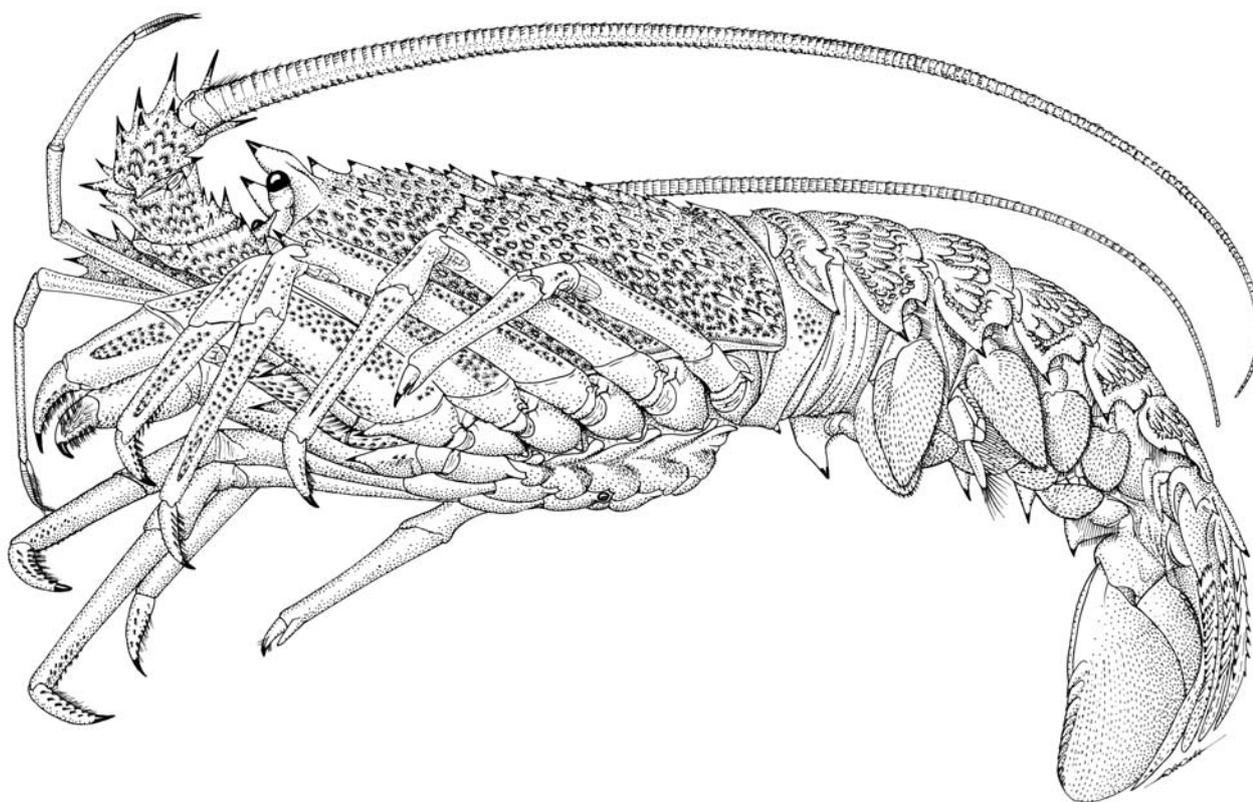


Fig. 7 Infraorder ACHELATA: *Jasus edwardsii* (Hutton, 1875) female (drawn by W.R. Webber; from Webber (1988); reproduced with permission from New Zealand Ministry of Fisheries, Wellington).

Distribution: the common NZ rock or spiny lobster (crayfish), found on rocky coasts of North and South islands, Three Kings Islands, Chatham Islands, Stewart Island/Rakiura, and the Snares, Bounty, Antipodes and Auckland islands (southernmost palinurid locality in the world), c. 1–200 m; eastern Australia south from central New South Wales, Tasmania, southern Australia and southern Western Australia, c. 1–150 m. A major commercial species in NZ and Australia.

Status: Booth *et al.* (1990: 239) consider it impossible to distinguish *Jasus 'alandii'* subgroup rock lobster from Australia and New Zealand on the grounds of morphology, colour pattern, life history characters or biochemical genetics, and therefore regard the two populations as one species, placing *Jasus novaehollandiae* Holthuis, 1963 from Australia as a synonym of *J. edwardsii*.

Colour: sometimes called the 'red crayfish' or 'red rock lobster', *Jasus edwardsii* has a body colour ranging from orange-red, through dark red to purple, greenish and bluish, with legs usually paler and lined with red or orange-red.

***Panulirus* sp., probably *P. femoristriga* (Von Martens, 1872)**

NZ reference: Booth & Webber (2001: 22) (specimens from Kermadec Islands).

Other significant references to *Panulirus femoristriga*: George & Holthuis (1965: 26) pl. 5, fig. a (colour illustration, whole animal); George (1966: 27) middle fig. (colour photo, two whole animals); George (1972: 32) fig. 5 (colour photo, 'blue spot' form), fig. 6 (colour photo, 'white whiskered' form); Williams (1988) fig. 89 upper (tail sculpture), fig. 89 lower (colour photo, tail); Holthuis (1991: 145) fig. 277b (whole animal), fig. 278 (distribution); Chan & Ng (2001: 123) (nomenclature of *P. femoristriga*); Chan (2010: 159).

Distribution: Kermadec Islands; western Pacific from Moluccas to New Guinea, eastern Australia, New Caledonia, Japan and Polynesia; shallow water in rocky areas, and coral reefs.

***Projasus parkeri* (Stebbing, 1902)**

NZ references: Webber & Booth (1988: 81) fig. 1 (whole animal, dorsal view), fig. 2 (whole animal, lateral view);

Holthuis (1991: 159) fig. 298 (whole animal, after Webber & Booth 1988), fig. 299 (distribution).

Other significant references: Griffin & Stoddart (1995: 236); Davie (2002a: 430); Poore (2004: 203) fig. 57b (carapace).

Distribution: northern NZ to Wairarapa, c. 480–970 m; southwestern and southeastern South Africa, southern Indian Ocean including Saint-Paul and Amsterdam islands, and New South Wales.

Colour: ‘medium orange to straw-brown’ in Webber & Booth (1988: 86); colour photo of whole animal in Clark *et al.* (1999: 33) fig. 6.

***Sagmariasus verreauxi* (H. Milne Edwards, 1851)**

NZ references: Kensler (1967b: 207) fig A (photo, whole animal) figs B–C; Kensler (1967a: 412) fig. 2 (whole animal); Doak (1971) pl. 40 (colour photo, large live animal); Heath & Dell (1971: 42) fig. 120 (colour illustration, whole animal green phase); Coombs (1974) fig. 727 (whole animal, after Kensler 1967a), fig. 729 (colour photo, live animal) (all these NZ references as *Jasus verreauxi*); Holthuis (1991: 105) figs 183, 199 (both figs whole animal, after Kensler 1967a), fig. 200 (distribution); Booth & Webber (2001: 21) (colour photo, whole live green-phase female) (justification for use of generic name *Sagmariasus* in place of *Jasus* as used in NZ and Australian references to this species up to this date); Davie (2002a: 425), as *Jasus (Sagmariasus) verreauxi*; Batson (2003: 134) fig. (colour photo, whole animal); Poore (2004: 200) pl. 3 (colour illustration, after McCoy 1887).

Distribution: the NZ and Australian packhorse, smoothtail or green crayfish, living on rocky coasts and sandy or gravel bottoms, c. 1–150 m, with main NZ population from northern North Island south to about Cape Runaway, Bay of Plenty, on the east coast and Manukau Harbour on the west coast; small, isolated populations of immature specimens have also been reported from Hawke Bay, Taranaki, Cook Strait, Kaikoura and Foveaux Strait. Recorded from the Kermadec Islands (but may not be firmly established there) and Three Kings Islands, not known from the Chatham or Subantarctic islands. In Australia, from southern Queensland to Victoria and northern Tasmania. A commercial species in NZ and Australia.

Colour: has two colour phases – immature and smaller adult specimens are usually green, while the larger and very large individuals (*Sagmariasus verreauxi* is the largest known palinurid) are yellow or reddish orange in colour.

Status: Brasher *et al.* (1992: 53) report genetic differentiation between the Australian and NZ populations of *Sagmariasus verreauxi* with this differentiation supported by gene

diversity analysis. In contrast to the findings of Booth *et al.* (1990) on the Australian and NZ populations of the *Jasus lalandii* subgroup, the preliminary *S. verreauxi* findings suggest ‘that larval exchange between adult populations across the Tasman Sea may be limited’, but they are still known by the same name.

Family **SCYLLARIDAE** Latreille, 1825

Subfamily **ARCTIDINAE** Holthuis, 1985

***Arctides antipodarum* Holthuis, 1960**

NZ references: Yaldwyn (1961: 1) fig. 1 (photo, whole animal), fig. 2; Doak (1971) pl. 42 (colour photo, live animal); Holthuis (1991: 175) figs 326a, 327 (whole animal), fig. 328 (distribution); Booth & Webber (2002: 29) (colour photo, whole animal).

Other significant references: Davie (2002a: 440) fig. page 438 (after Holthuis 1991); Poore (2004: 209) fig. 58b (whole animal).

Distribution: northern North Island rocky coasts, shallow water; eastern Australia (New South Wales); c. 5–150 m.

Colour: mottled red and yellow, somewhat obscured by an overall covering of short brown setae, and with a pair of prominent, bright red dorso-lateral patches on the otherwise yellow antero-dorsal half of the 1st abdominal segment (in life, these patches are usually obscured under the posterior margin of the carapace).

***Scyllarides haanii* (De Haan, 1841)**

NZ reference: Booth & Webber (2002: 31) fig. (colour photo, whole animal).

Other significant references: Holthuis (1991: 189) fig. 359 (photo, whole animal), fig. 360 (distribution); Davie (2002a: 443); Poore (2004: 212) fig. 59j (abdomen).

Distribution: taken by divers at Kermadec Islands and in northern NZ waters; Indo-West Pacific from Red Sea to Western and eastern Australia, Indonesia, Taiwan, southern Japan and Hawai‘ian Islands.

Colour: body with mottled pattern of tan, dark brown and purplish markings on yellow-brown background; purplish markings concentrated and especially distinct on 1st abdominal segment.

Subfamily **IBACINAE** Holthuis, 1985

***Ibacus alticrenatus* Bate, 1888**

NZ references: Dell (1955: 148); Atkinson & Boustead (1982: 275) figs 1–7 (stage 1–7 phyllosomas), fig. 8a (nisto), fig. 8b (post-nisto juvenile); Holthuis (1985: 36) fig. 9 (whole animal, after Bate 1888: pl. 9, fig. 2 of NZ syn-

type); Powell (1987: 34) fig. 184 (whole animal); Takeda (1990: 356) fig. 284 (colour photo, whole animal); Holthuis (1991: 200) fig. 382 (whole animal, after Holthuis 1985), fig. 383 (distribution); Booth & Webber (2002: 28) (colour photo, whole animal); Davie (2002a: 440); Poore (2004: 211) fig. 58d (whole animal).

Other significant reference: Brown & Holthuis (1998: 120) pl. 2 (colour photo whole animal).

Distribution: North Island, northern half of South Island and Chatham Islands; eastern and southern Australia including Tasmania; *c.* 80–700 m.

Colour and biology: dorsal surface of carapace and flattened antennal segments red-orange to brown, with darker red spots and marbling, particularly in middle of carapace. All lateral carapace spines tipped with white. First to 5th abdominal segments with anterior border darker red, posterior portion light orange-red; 6th abdominal segment, calcified parts of uropods and telson white; flexible parts of uropods and telson yellow-brown (colour description after Brown & Holthuis 1998, based on Australian material).

***Ibacus brucei* Holthuis, 1977**

NZ references: Holthuis (1977: 191) pl. 1 (whole animal), pl. 2 (colour photos, whole animal, dorsal and ventral); Holthuis (1985: 41) fig. 10 (whole animal, after Holthuis 1977), figs 11–12 (photos, whole animal, dorsal and ventral); Holthuis (1991: 202) fig. 386 (whole animal, after Holthuis 1977), fig. 387 (distribution); Davie (2002a: 441); Poore (2004: 211) fig. 59c (carapace, antennae).

Other significant reference: Brown & Holthuis (1998: 127) pl. 5 (colour photo, whole animal).

Distribution: Kermadec Islands, *c.* 80–120 m (*Galathea* expedition and MNZ collections); eastern Australia (central Queensland south to southern New South Wales), shelf and slope to *c.* 560 m.

Colour: dorsal surface of body with yellowish-brown background overlaid by brick red; median area of carapace with numerous brick-red spots merging laterally into solid brick-red coverage with surface pits lighter in colour; entire abdomen brick red with lighter pits; tips of larger lateral teeth on carapace and abdomen, anterior margin of flattened distal segment of antenna and outer margin of uropodal exopod white (colour description after Holthuis 1985, based on Australian material). Brown & Holthuis (1998) described a variant colour pattern on carapace and abdomen of white or beige background overlaid by faint red stippling.

Subfamily SCYLLARINAE Latreille, 1825

***Antarctus mawsoni* (Bage, 1938)**

NZ reference: Webber *et al.* (2010: 225).

Other significant references: Bage (1938: 10) pl. 4, figs 2, 2a (whole animal, dorsal and ventral), as *Arctus mawsoni*; Hale (1941: 272) pl. 3, figs 1, 2 (photos, whole animal, dorsal and lateral); Holthuis (2002: 528) (*Antarctus* n. g.); Davie (2002a: 445), as *Scyllarus*; Poore (2004: 209) fig. 58a (whole animal), fig. 59a.

Distribution: northern and southern NZ; Tasmania; *c.* 122–440 m.

Colour: a specimen from Papanui Canyon off Otago Harbour, 320 m, was salmon pink with some darker markings.

***Antipodartus aoteanus* (Powell, 1949)**

NZ references: Powell (1949: 368) pl. 68, figs 1–2 (whole animal, dorsal and lateral as *Scyllarus aoteanus*); Booth & Webber (2002: 28) (colour photo, whole animal, repeated at larger scale on p. 1 as *Scyllarus*); Webber *et al.* (2010: 225).

Other significant reference: Holthuis (2002: 551) (*Antipodartus* new generic name).

Distribution: endemic, northern NZ, *c.* 20–100 m.

Colour: body pinkish brown, carapace darker than abdomen; anterior two-thirds of carapace with overlay of dark red; anterior half of first abdominal segment with distinctive transversely oval red spot dorsally, posterior half of 1st abdominal segment with three longitudinal red bands (one dorsal and a dorsolateral pair), other abdominal segments with some irregular red markings; legs banded with red.

***Bathyarctus* sp.**

NZ material: one specimen in MNZ.

Distribution: only specimen known from shelf, northeast of Poor Knights Islands.

Infraorder POLYCHELIDA

Scholtz & Richter, 1995

Family POLYCHELIDAE Wood-Mason, 1875

***Pentacheles laevis* Bate, 1878**

NZ references: O'Shea *et al.* (1999: 50) fig. 23 (photo, whole animal); Galil (2000: 301) fig. 7 (photos, dorsal view cephalothorax, lateral view abdomen); Webber (2002a: 49) fig. 3 (colour photo, whole animal, based on O'Shea *et al.* 1999: fig. 23); Ahyong (2007: 47) fig. 24B (colour photo, whole animal).

Other significant references: Bate (1888: 144) pl. 15, figs 4c, 5; Griffin & Stoddart (1995: 240) fig. 4 (photo, cephalothorax and abdomen), fig. 5, as *Polycheles granulatus*; Ahyong & Brown (2002: 54) fig. 1A–B (colour photos, dorsal and lateral views cephalothorax and abdomen).

Distribution: northern NZ; worldwide in Indo-West Pacific, east Pacific, and western and eastern Atlantic; 212–2505 m (Ahyong 2007).

Colour: carapace, abdomen and telson pale pink; spines tipped with white; anterior appendages, pereopods and uropods darker pink to red.

***Pentacheles validus* A. Milne-Edwards, 1880**

NZ references: Galil (2000: 308) fig. 10 (photos, dorsal view cephalothorax, lateral view abdomen); Ahyong (2007: 49) fig. 24A (colour photo, whole animal).

Other significant reference: Ahyong & Brown (2002: 56).

Distribution: northern NZ; worldwide in Indo-West Pacific, east Pacific, and western and eastern Atlantic; 914–3365 m (Galil 2000).

***Polycheles enthrix* (Bate, 1878)**

NZ references: Bate (1888: 140) pl. 15, fig. 1 (*Challenger* station 170 specimen from off Kermadec Islands – considered by Bate to be the female of his *Polycheles helleri* – was described by Sund (1920: 224) as *Stereomastis kermadecensis*, text figs 14–27, 33 (whole animal), pl. 17 figs 34–36 (whole animal), as *Pentacheles enthrix*; Galil (2000: 322) fig. 16 (photos, dorsal view cephalothorax, lateral view abdomen); Ahyong (2007: 49) fig. 24C (colour photo, whole animal), fig. 25 (anterior margins of carapace).

Other significant references: Griffin & Stoddart (1995: 239) fig. 2 (cephalothorax, abdomen), fig. 3 (lateral view abdomen), as *Polycheles enthrix*; Ahyong & Brown (2002: 65) fig. 7C–D (colour photos, dorsal and lateral views cephalothorax and abdomen), type material of *P. enthrix* (Bate) *P. kermadecensis* (Sund) and *P. helleri* Bate designated.

Distribution: northern NZ; Fiji and Australia; 229–1152 m (Ahyong & Brown 2002).

Colour: body bright red, tail-fan pink, 1st cheliped pink, fingers white.

Note: The specific name used by Bate (1878: 280) was ‘*enthrix*’ not ‘*euthrix*’ as used by Willemoes-Suhm (1875: 23). ‘*Willemoesia euthrix*’ Willemoes-Suhm, 1875 is a *nomen nudum*.

***Polycheles kermadecensis* (Sund, 1920)**

NZ reference: Ahyong & Brown (2002: 68) figs 7A–B (colour photos, dorsal and lateral cephalothorax and abdomen), figs 8–9.

Distribution: taken by *Challenger* expedition off Kermadec Islands; otherwise known only with certainty from eastern Australia.

***Stereomastis nana* (Smith, 1884)**

NZ reference: Galil (2000: 329) fig. 19 (photos, dorsal view cephalothorax, lateral view abdomen).

Other significant reference: Ahyong & Brown (2002: 71).

Distribution: specimens in NIWA collections from Lord Howe Rise; worldwide from Indo-West Pacific (Arabian Sea, Indonesia, southeastern Australia, New Caledonia, Philippines, China Sea and Japan), and North and South Atlantic.

Colour: body red with paler cephalothorax.

***Stereomastis sculpta* (Smith, 1880)**

NZ references: Galil (2000: 340) fig. 24 (photos, dorsal view cephalothorax, lateral view abdomen); Ahyong (2007: 50) fig. 24A (colour photo, whole animal), as *Polycheles sculptus*.

Distribution: West Norfolk Ridge; Australia, Vanuatu, worldwide in Indo-West Pacific, western and eastern Atlantic, and Mediterranean; 200–4000 m (Galil 2000).

Colour: body rosy pink.

***Stereomastis submi* (Bate, 1878)**

NZ references: Takeda (1990: 358) (photo, whole animal); O’Shea *et al.* (1999: 50) (photo, whole animal); Galil (2000: 344) fig. 25 (photos, dorsal view cephalothorax, lateral view abdomen); Ahyong (2007: 51), as *Polycheles submi*.

Other significant reference: Griffin & Stoddart (1995: 249) fig. 12 (photo, whole animal), figs 13–15.

Distribution: NZ; southern Indo-Pacific and Atlantic, and Southern Ocean (off South Africa, southern Australia and Chile).

Colour: body pale pink, spines of carapace and abdomen darker pink (Australian specimens).

***Stereomastis surda* (Galil, 2000)**

NZ reference: Galil (2000: 347) fig. 26 (photos, dorsal view cephalothorax, lateral view abdomen).

Other significant references: Griffin & Stoddart (1995: 246) figs 9–11 (photos, whole animal dorsal and lateral), as *Stereomastis phosphorus*; Ahyong & Brown (2002: 75).

Distribution: Challenger Plateau and Bay of Plenty outer slope; Indo-West Pacific (Indian Ocean, Western, southern and eastern Australia, New Caledonia, Marquesas Islands and Hawai'i) and Nazca Ridge in southeastern Pacific.

Colour: body rose-pink with grey patches on branchial regions; pereopods mainly rose-pink but with proximal half of cheliped merus and distal portion of fingers white (Australian specimens).

***Willemoesia pacifica* Sund, 1920**

NZ reference: Galil (2000: 367) fig. 34 (photos, dorsal view cephalothorax, lateral view abdomen).

Other significant reference: Griffin & Stoddart (1995: 251) figs 16–17 (whole animal dorsal, lateral view abdomen), as *Willemoesia bonaspei*.

Distribution: New Caledonia Trough between West Norfolk Ridge and Lord Howe Rise; Indo-Pacific and Southern Ocean (off South Africa, southern Australia, Kermadec Trench and Juan Fernandez Islands); deep water.

Infraorder ANOMURA MacLeay, 1838

Superfamily CHIROSTYLOIDEA

Ortmann, 1892

Family CHIROSTYLIDAE

Ortmann, 1892

***Chirostylus novaecaledoniae* Baba, 1991**

NZ reference: Schnabel (2009a: 24).

Other significant reference: Baba (1991: 264) figs 1, 8a (colour photo, whole animal).

Distribution: west of Reinga Ridge; New Caledonia; upper slope.

Colour: body and appendages carrot orange with white markings on dorsal surface of carapace (New Caledonian material).

***Gastroptychus novaezelandiae* (Baba, 1974)**

NZ references: Baba (1974: 381) figs 1, 2; Ahyong *et al.* (2007) fig. 142 (colour photo, whole animal); Schnabel (2009a: 24); Schnabel (2009b: 544) fig. 2A–E (diagnostic characters), fig. 3 (distribution); Rowden *et al.* (2010: 73).

Distribution: Northland to southern Campbell Plateau, southwest Pacific, continental slope, 264–732 m (Schnabel 2009b).

Colour: carapace, abdomen, chelipeds and walking legs pale brown with red chromatophores; cheliped hand and distal portion of arm and wrist reddish orange. Specimens from Otago were described by Elizabeth Batham as having a pale translucent orange to pale vermilion body with

chelipeds and walking legs orange, broadly banded with pale orange, and with cornea black.

***Gastroptychus rogeri* (Baba, 2000)**

NZ references: O'Shea *et al.* (1999: 51) fig. 28 (colour photo, whole animal), as the long-armed 'football jersey squat lobster', *Gastroptychus* sp.; Ahyong *et al.* (2007: 142) fig. (colour photo, whole animal); Schnabel (2009a: 25).

Other significant reference: Baba (2000: 246) fig. 1 (photo, whole animal), fig. 2.

Distribution: southern Lord Howe Rise, Northland Plateau, Bounty Plateau; Solander Trough, Tasmania; continental shelf and slope, 604–1200 m (Schnabel 2009a).

Colour: body white with two broad red bands across carapace and a red band across each abdominal segment, chelipeds and walking legs red.

***Uroptychodes epigaster* Baba, 2004**

NZ reference: Schnabel (2009a: 25).

Other significant reference: Baba (2004: 104) fig. 5a–k (female holotype, diagnostic characters).

Distribution: Reinga Ridge; New Caledonia; 410–700 m (Schnabel 2009a).

***Uroptychodes spinimarginatus* (Henderson, 1885)**

NZ references: Henderson (1888: 176) pl. 21, fig. 2 (whole animal), fig. 2a; Schnabel (2009a: 25); Schnabel (2009b: 546) fig. 4A–G (whole animal in parts), fig. 5 (NZ distribution).

Distribution: Kermadec Islands; western Pacific from Japan to New Caledonia; slope, 458–952 m (Schnabel 2009a).

***Uroptychus alcocki* Ahyong & Poore, 2004**

NZ references: Schnabel (2009a: 25); Schnabel (2009b: 549) fig. 5 (NZ region distribution); Rowden *et al.* (2010: 75).

Other significant reference: Ahyong & Poore (2004a: 15) fig. 2A–H (diagnostic characters).

Distribution: Kermadec Ridge and northern NZ to Chatham Rise; eastern Australia, Tasman Sea, Taiwan, Japan; 64–420 m (Schnabel 2009a).

***Uroptychus australis* (Henderson, 1885)**

NZ references: Henderson (1888: 179) pl. 21, fig. 4 (whole animal), pl. 21, fig. 4a–c; Schnabel (2009a: 26); Schnabel (2009b: 551) fig. 5 (NZ region distribution); Rowden *et al.* (2010: 75).

Other significant reference: Ahyong & Poore (2004a: 18) fig. 32A–H (diagnostic characters).

Distribution: Kermadec Ridge and northern NZ to East Coast; eastern and southern Australia, Indonesia; 331–1395 m (Schnabel 2009a).

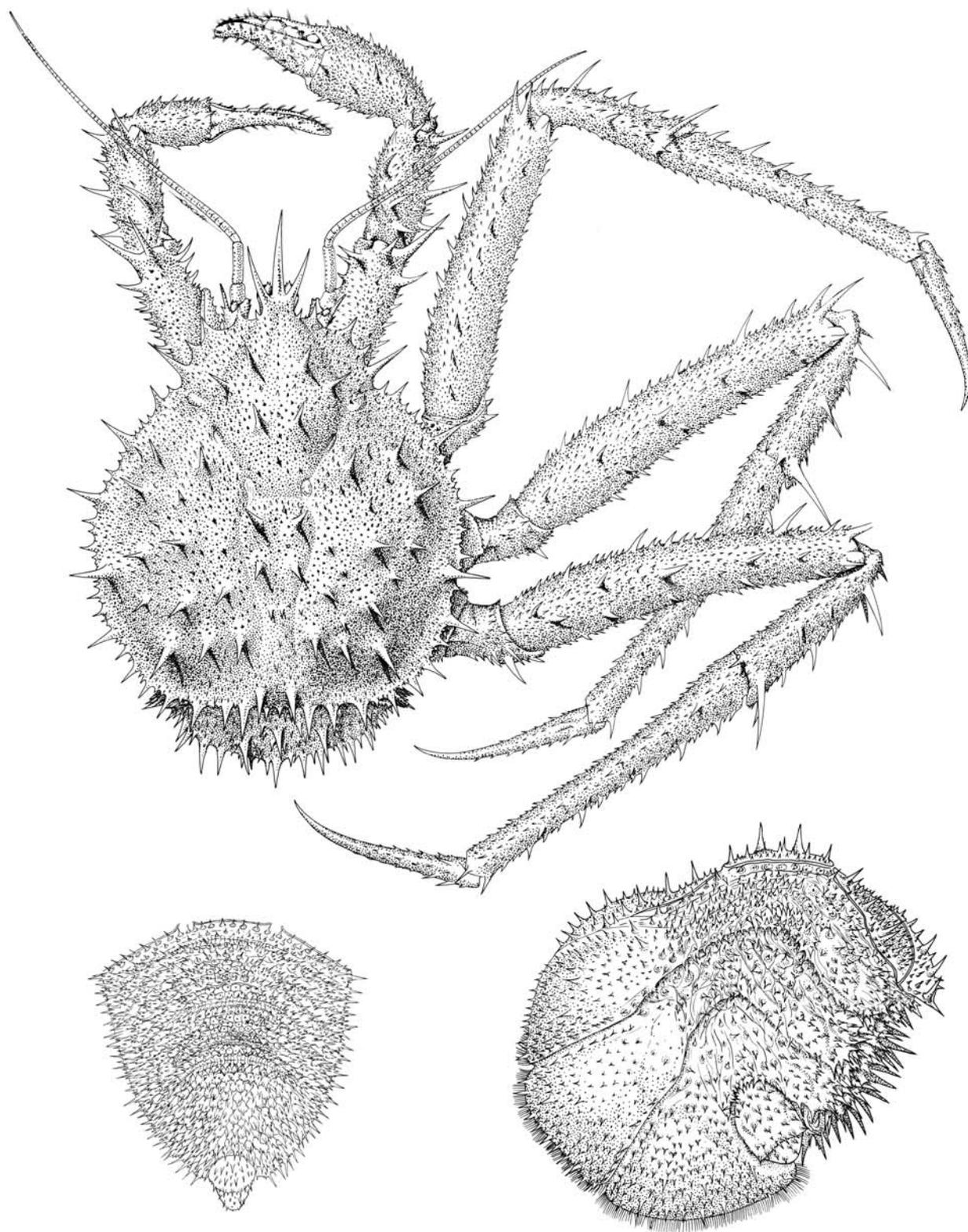


Fig. 8 Infraorder ANOMURA: *Neolithodes brodiei* Dawson & Yaldwyn, 1970 dorsal view of male, and ventral view of male and female abdomens (drawn by W.R. Webber).

***Uroptychus bicavus* Baba & de Saint Laurent, 1992**

NZ reference: Schnabel (2009a: 26).

Other significant reference: Baba & de Saint Laurent (1992: 323) fig. 1a–g (diagnostic characters).

Distribution: southern Norfolk Basin; North Fiji Basin at hydrothermal vent; 2340–2750 m (Schnabel 2009a).

***Uroptychus cardus* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 27).

Other significant reference: Ah Yong & Poore (2004a: 31) fig. 7A–H (diagnostic characters).

Distribution: northern Chatham Rise; Solander Trough, off Tasmania; 899–120 m (Schnabel 2009a).

***Uroptychus empheres* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 27).

Other significant reference: Ah Yong & Poore (2004a: 34) fig. 8A–I (diagnostic characters).

Distribution: NZ; Tasmania; 800–900 m (Schnabel 2009a).

***Uroptychus flindersi* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 27).

Other significant reference: Ah Yong & Poore (2004a: 37) fig. 9A–G (diagnostic characters).

Distribution: northern NZ on West Norfolk Ridge, Reinga Ridge, Pureroa Seamount; Tasmania; 509–714 m (Schnabel 2009a).

***Uroptychus* cf. *gracilimanus* (Henderson, 1885)**

NZ reference: Schnabel (2009a: 27).

Significant reference to Uroptychus gracilimanus: Tirimizi (1964: 392) figs 6–9 (diagnostic characters).

Distribution: Bay of Plenty; New South Wales, Japan, east China Sea and Zanzibar; 920–1011 m (Schnabel 2009a).

***Uroptychus kaitara* Schnabel, 2009**

NZ references: Schnabel (2009a: 28); Schnabel (2009b: 553) fig. 6A–N (female holotype), fig. 7 (distribution).

Distribution: endemic, Kermadec Islands; slope.

***Uroptychus longicheles* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 28).

Other significant reference: Ah Yong & Poore (2004a: 55) fig. 15A–I (diagnostic characters).

Distribution: West Norfolk Ridge, Lord Howe Rise; east of Brisbane; 306–376 m (Schnabel 2009a).

***Uroptychus maori* Borradaile, 1916**

NZ references: Borradaile (1916: 92) fig. 6 (whole animal); Schnabel (2009a: 28); Schnabel (2009b: 555) figs 8A–J, 9A–D (male holotype), fig. 5 (distribution).

Distribution: endemic, West Norfolk Ridge to Bay of Plenty; 180–700 m (Schnabel 2009a).

***Uroptychus novaezealandiae* Borradaile, 1916**

NZ references: Borradaile (1916: 93) fig. 7 (whole animal); Schnabel (2009a: 29); Schnabel (2009b: 559) fig. 10A–G (female holotype), fig. 11 (whole animal, after Borradaile 1916), fig. 5 (NZ region distribution).

Distribution: endemic, North Cape; 120 m (Borradaile 1916).

***Uroptychus paku* Schnabel, 2009**

NZ references: Schnabel (2009a: 29); Schnabel (2009b: 562) fig. 12A–K (female holotype), fig. 7 (distribution).

Distribution: endemic, Kermadec Islands; shelf-slope depths, 122 m (Schnabel 2009a).

***Uroptychus paracrassior* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 29).

Other significant reference: Ah Yong & Poore (2004a: 66) fig. 19 A–H (diagnostic characters).

Distribution: Reinga Ridge; Queensland; 364–526 m (Schnabel 2009a).

***Uroptychus pilosus* Baba, 1981**

NZ references: Baba (1981: 126) fig. 10a–b (male holotype carapace), fig. 11a–e (male holotype appendages); Schnabel (2009a: 30), as *U. pilosus*; Baba *et al.* (2008: 40) (*Uroptychus* cf. *pilosus* of Ah Yong & Poore (2004a) and Schnabel (2009a) n. sp., in preparation by Baba).

Other significant reference: Ah Yong & Poore (2004a: 71) fig. 21A–I (diagnostic characters).

Distribution: West Norfolk Ridge; eastern Australia (Ah Yong & Poore 2004a; Schnabel 2009a).

***Uroptychus politus* (Henderson, 1885)**

NZ references: Henderson (1888: 178) pl. 6, fig. 2 (whole animal), fig. 2a–b; Baba (1974: 387) fig. 5; Schnabel (2009a: 30); Schnabel (2009b: 564) fig. 5 (NZ region distribution).

Distribution: Kermadec Islands; Loyalty Islands; slope, 1098–1240 m (Schnabel 2009a).

***Uroptychus raymondi* Baba, 2000**

NZ reference: Schnabel (2009a: 30).

Other significant reference: Baba (2000: 250) fig. 3A–I (diagnostic characters).

Distribution: Chatham Rise; Solander Trough, Tasmania, Victoria; 644–1082 m (Schnabel 2009a).

***Uroptychus rutua* Schnabel, 2009**

NZ references: Schnabel (2009a: 30); Schnabel (2009b: 564) fig. 13A–K (female holotype), fig. 7 (distribution).

Distribution: endemic, Kermadec Islands; 165–179 m (Schnabel 2009a).

***Uroptychus scambus* Benedict, 1902**

NZ references: Schnabel (2009a: 30); Schnabel (2009b: 567) fig. 5 (NZ region distribution).

Other significant references: Benedict (1902: 297) fig. 41; Alcock & McGilchrist (1905) pl. 70, fig. 4 (whole animal), pl. 71, fig. 1 (whole animal), pl. 71, fig. 1a–d, as *U. glyphodactylus*.

Distribution: northern NZ; Indo-West Pacific; at slope depths and deeper, 296–2084 m (Schnabel 2009a).

***Uroptychus spinirostris* (Ahyong & Poore, 2004)**

NZ reference: Schnabel (2009a: 30).

Other significant reference: Ahyong & Poore (2004a: 9) fig. 1A–G (diagnostic characters), as *Gastroptychus spinirostris*.

Distribution: Northland Plateau, Bay of Plenty, Norfolk Ridge; Queensland; 176–526 m (Schnabel 2009a).

***Uroptychus thermalis* Baba & de Saint Laurent, 1992**

NZ reference: Schnabel (2009a: 31).

Other significant reference: Baba & de Saint Laurent (1992: 324) fig. 2a–g (diagnostic characters).

Distribution: Bay of Plenty; North Fiji Basin (hydrothermal vent), Queensland; 1396–2000 m (Schnabel 2009a).

***Uroptychus toka* Schnabel, 2009**

NZ references: Schnabel (2009a: 31); Schnabel (2009b: 568) fig. 14A–K (female holotype), fig. 7 (distribution).

Distribution: endemic, Kermadec Ridge; slope, 350 m (Schnabel 2009a).

***Uroptychus tomentosus* Baba, 1974**

NZ references: Baba (1974: 384) fig. 3 (whole animal), fig. 4; Schnabel (2009a: 31); Schnabel (2009b: 570) fig. 15A–H (female paratype), fig. 16 (distribution).

Distribution: endemic, from off North Cape, around both North and South islands, south to Bounty Plateau; a relatively common species from shelf and upper slope, 80–535 m (Schnabel 2009a).

Colour: fresh specimens from Otago waters have been recorded as uniform pale warm pink or pale yellowish pink, while a fresh specimen from Cook Strait was pale salmon pink with cornea pale brown.

***Uroptychus webberi* Schnabel, 2009**

NZ references: Schnabel (2009a: 31); Schnabel (2009b: 572) fig. 17A–M (female holotype), fig. 7 (distribution).

Distribution: endemic, Kermadec Islands; slope, 610 m (Schnabel 2009a).

***Uroptychus yaldwyni* Schnabel, 2009**

NZ references: Schnabel (2009a: 32); Schnabel (2009b: 575) fig. 18A–K (female holotype), fig. 7 (distribution); Rowden *et al.* (2010: 75).

Distribution: endemic, Kermadec Islands; slope, 398 m (Schnabel 2009a).

Family **EUMUNIDIDAE**

A. Milne-Edwards & Bouvier, 1900

***Eumunida australis* de Saint Laurent & Macpherson, 1990**

NZ references: de Saint Laurent & Macpherson (1990: 664) figs 2d, 4d, 5d, 6d,h, 10d, 11 (photo, whole animal); de Saint Laurent & Poupin (1996: 343, 364); Schnabel (2009a: 24).

Distribution: West Norfolk Ridge, Northland Plateau, Bay of Plenty, Challenger Plateau and west coast of South Island; eastern Australia from Queensland to New South Wales; 380–910 m (Schnabel 2009a).

Other name used: *Eumunida picta* in Gordon (1930: 742) for the Challenger Plateau specimen, now the holotype of *E. australis*.

Superfamily GALATHEOIDEA

Samouelle, 1819

Family **GALATHEIDAE** Samouelle, 1819

***Allogalatea elegans* (Adams & White, 1848)**

NZ reference: Schnabel (2009a: 37).

Other significant references: Adams & White (1848) pl. 12 fig. 7 (painting, whole animal); Ahyong (2007: 13).

Distribution: Kermadec Islands, Lord Howe Rise; Indo-West Pacific from eastern Africa to Japan, Western Australia and Queensland, and east to Fiji; 0–146 m (Schnabel 2009a).

***Phylladorhynchus ikedai* (Miyake & Baba, 1965)**

NZ reference: Schnabel (2009a: 48).

Other significant reference: Miyake & Baba (1965: 588) fig. 3 (holotype female carapace, abdomen), fig. 4A–G (as *Galathea ikedai* holotype diagnostic characters).

Distribution: West Norfolk Ridge, Norfolk Ridge; Red Sea to southern Japan, New Caledonia to Kei Islands; 55–510 m (Schnabel 2009a).

***Phylladorhynchus integrirostris* (Dana, 1852)**

NZ reference: Schnabel (2009a: 48).

Other significant reference: Ahyong (2007: 42) fig. 21A–G (female diagnostic characters).

Distribution: Kermadec Ridge and Snares Islands, southern Lord Howe Rise, Norfolk Ridge; widespread in Pacific, Atlantic and Indian oceans; 0–570 m (Schnabel 2009a).

***Phylladorhynchus pusillus* (Henderson, 1885)**

NZ references: Baba (1969: 4); Haig (1973: 282).

Other significant references: Henderson (1888: 121) pl. 12, figs 1, 1a–b, as *Galathea pusilla*, based on eastern Australian material; Miyake & Baba (1967: 234) fig. 6, as *Galathea pusilla*, material from east China Sea; Baba (1991: 486) fig. 4e–f (New Caledonian waters); Davie (2002b: 66); Poore (2004: 238) fig. 66b (carapace); Ah Yong (2007: 42) fig. 20B (colour photo, female), fig. 22A–N (female diagnostic characters), as *P. cf. pusillus*; Schnabel (2009a: 48); Rowden *et al.* (2010: 73).

Distribution: widespread around NZ from Norfolk Ridge to southern Campbell Plateau; eastern and western Pacific from Japan to Australia to Chile; 14–2286 m (Schnabel 2009a).

Family **MUNIDIDAE** Ah Yong, Baba,
Macpherson & Poore, 2010

***Agononida incerta* (Henderson, 1888)**

NZ reference: Schnabel (2009a: 36).

Other significant reference: Henderson (1888: 130) pl. XIII, fig. 4 (whole animal), pl. XIII, fig. 4a (3rd maxilliped), as *Munida incerta*.

Distribution: Kermadec and Colville ridges; southern and eastern Africa, southwest Australia, and western Pacific from Japan to eastern Australia and east to Tonga; 70–754 m (Schnabel 2009a).

***Agononida marini* (Macpherson, 1994)**

NZ references: Ah Yong (2007: 11) fig. 6D (colour photo, female); Schnabel (2009a: 36); Rowden *et al.* (2010: 75).

Other significant references: Macpherson (1994: 492) fig. 30a–g (diagnostic characters), fig. 77 (colour photos, female paratype), as *Munida marini*; Ah Yong & Poore (2004b: 9).

Distribution: northern NZ; New Caledonia and eastern Australia; 315–615 m (Schnabel 2009a).

***Agononida nielbrucei* Vereshchaka, 2005**

NZ references: Vereshchaka (2005: 137) fig. 1A–F (diagnostic characters); Ah Yong (2007: 11) fig. 6B (colour photo, female), fig. 6C (colour photo, male); Schnabel (2009a: 36); Rowden *et al.* (2010: 75).

Distribution: southern Norfolk and West Norfolk ridges, northeastern NZ, south to Chatham Rise; 69–800 m (Schnabel 2009a).

***Agononida procera* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 37).

Other significant references: Ah Yong & Poore (2004b: 10) fig. 1A–F (female holotype); Ah Yong (2007: 13) fig. 6E (colour photo, female).

Distribution: Three Kings Ridge, Northland Plateau, Bay of Plenty, Kermadec Islands, southern Lord Howe Rise; eastern Australia and New Caledonia; 450–960 m (Ah Yong 2007).

***Agononida squamosa* (Henderson, 1885)**

NZ reference: Schnabel (2009a: 37).

Other significant reference: Henderson (1888: 131) pl. XIII, fig. 1 (whole animal), fig. 1a–b (chela, 3rd maxilliped), as *Munida squamosa*.

Distribution: West Norfolk Ridge and southern Norfolk Ridge; southwest Pacific from New Caledonia to Admiralty Islands, and Queensland to Tonga; 200–591 m (Schnabel 2009a).

***Munida acacia* Ah Yong, 2007**

NZ references: Ah Yong (2007: 15) fig. 9A–I (female holotype), fig. 10A (colour photo, female holotype); Schnabel (2009a: 40).

Distribution: West Norfolk Ridge; 508–560 m (Ah Yong 2007).

***Munida chathamensis* Baba, 1974**

NZ references: Baba (1974: 388) fig. 6 (whole animal), fig. 7; Schnabel (2009a: 40).

Distribution: Chatham Rise to Macquarie Ridge; 990–1697 m (Schnabel 2009a).

Colour: body pink to orange, cornea golden (Baba 1974).

***Munida eclepsis* Macpherson, 1994**

NZ reference: Schnabel (2009a: 40).

Other significant reference: Macpherson (1994: 463) fig. 15a–g (diagnostic characters), fig. 70 (colour photo, female holotype).

Distribution: Three Kings Ridge, Kermadecs; New Caledonia, Fiji and Tonga; 142–790 m (Schnabel 2009a).

***Munida endeavourae* Ah Yong & Poore, 2004**

NZ references: Vereshchaka (2005: 140) fig. 3A–F (diagnostic characters), as *M. grievae*; Ah Yong (2007: 25) fig. 10E (colour photo, female); Schnabel (2009a: 41).

Other significant reference: Ah Yong & Poore (2004b: 29) fig. 5A–I (diagnostic characters).

Distribution: far northern New Zealand; southeastern Australia; 554–2756 m (Schnabel 2009a).

***Munida erato* Macpherson, 1994**

NZ reference: Schnabel (2009a: 41).

Other significant reference: Macpherson (1994: 466) fig. 17a–g (diagnostic characters).

Distribution: West Norfolk Ridge, Northland Plateau to East Cape Ridge; New Caledonia and Chesterfield Islands; 209–450 m (Schnabel 2009a).

***Munida exilis* Ah Yong, 2007**

NZ references: Ah Yong (2007: 25) fig. 13A–I (female holotype), fig. 14A (colour photo, male paratype); Schnabel (2009a: 41).

Distribution: southern Norfolk Ridge and West Norfolk Ridge; 469–800 m (Ah Yong 2007).

***Munida gracilis* Henderson, 1885**

NZ references: Henderson (1888: 143) pl. 14, fig. 4 (whole animal), fig. 4a–b; Macpherson (1994: 471) fig. 19; Schnabel (2009a: 41); Rowden *et al.* (2010: 73).

Distribution: entire NZ shelf south to Auckland Islands excluding far southern Campbell Plateau, Tasman Sea; 44–1211 m (Schnabel 2009a).

***Munida gregaria* (Fabricius, 1793)**

NZ references: Dell (1963a: 63) (whole animal ‘*subrugosa*’ stage); Heath & Dell (1971: 68) fig. 203 (colour illustration, whole animal ‘*gregaria*’ stage); Williams (1973: 197) figs 1–3, pl. 1 (photos, whole animals) (*Munida subrugosa* (White, 1847) shown to be adult of *M. gregaria*); Takeda (1990: 359) fig. 287 (colour photo, whole animal); Batson (2003: 60) fig. (colour photo, mass stranding of ‘*gregaria*’ stage); Davie (2002b: 63); Poore (2004: 234) pl. 13c,f (colour photos, live animals in habitat); Ah Yong & Poore (2004b: 32); Schnabel (2009a: 41).

Other significant reference: Matthews (1932: 469) fig. 1, pl. 4, figs 1–6 (Falkland Islands material of *Munida gregaria* and *M. subrugosa* treated as different spp.).

Distribution: coastal waters from Cook Strait south to Campbell Island; New South Wales, Tasmania, southern Chile and Argentina, Falkland Islands; 0–1080 m (Schnabel 2009a).

Status: the bright red pelagic juvenile (or ‘*gregaria*’) stage of this species forms large shoals in coastal waters and metamorphoses into the benthic adult ‘*subrugosa*’ stage.

***Munida icela* Ah Yong, 2007**

NZ references: Ah Yong (2007: 31) fig. 16A–I (diagnostic characters); Schnabel (2009a: 42).

Distribution: West Norfolk Ridge; 521–539 m (Ah Yong 2007).

***Munida isos* Ah Yong & Poore, 2004**

NZ references: Vereshchaka (2005: 139) fig. 2, as *M. gordonii*; Ah Yong (2007: 31); Schnabel (2009a: 42); Rowden *et al.* (2010: 73).

Other significant reference: Ah Yong & Poore (2004b: 34) fig. 6A–I (diagnostic characters).

Distribution: Kermadec Ridge to Solander Trough and Macquarie Ridge; New South Wales to Tasmania; ‘typical seamount taxon’, 462–2756 m (Schnabel 2009a).

***Munida kapala* Ah Yong & Poore, 2004**

NZ references: Schnabel (2009a: 42); Rowden *et al.* (2010: 75).

Other significant reference: Ah Yong & Poore (2004b: 38) fig. 7A–H (diagnostic characters).

Distribution: Kermadec Ridge to northern Chatham Rise; eastern Australia; 240–885 m (Schnabel 2009a).

***Munida notialis* Baba, 2005**

NZ references: Baba (2005: 117) fig. 45a–l (holotype male diagnostic characters); Schnabel (2009a: 43).

Distribution: Fiordland; southeast Australia; 30–290 m (Schnabel 2009a).

***Munida psylla* Macpherson, 1994**

NZ reference: Schnabel (2009a: 43).

Other significant reference: Macpherson (1994: 517) fig. 42a–g (holotype female diagnostic characters).

Distribution: Kermadec Islands; New Caledonia, Loyalty Islands; 38–573 m (Schnabel 2009a).

***Munida spinicruris* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 43).

Other significant reference: Ah Yong & Poore (2004b: 42) fig. 8A–I (male holotype diagnostic characters).

Distribution: Kermadec Ridge; Tasman Basin; 106–555 m (Schnabel 2009a).

***Munida zebra* Macpherson, 1994**

NZ reference: Schnabel (2009a: 44).

Other significant reference: Macpherson (1994: 556) fig. 63a–g (diagnostic characters), fig. 89 (colour photo, male holotype).

Distribution: Northland Plateau to Bay of Plenty; New Caledonia, Loyalty and Kei islands; 200–600 m (Schnabel 2009a).

***Onconida alaini* Baba & de Saint Laurent, 1996**

NZ reference: Schnabel (2009a: 47).

Other significant reference: Baba & de Saint Laurent (1996: 483) fig. 4a–c (P5 distal segments male and female),

fig. 26a–k (female holotype diagnostic characters), fig. 33a–b (colour photos, male and female paratypes).

Distribution: West Norfolk Ridge; New Caledonia, Solomon and Chesterfield islands; 200–757 m (Schnabel 2009a).

***Paramunida antipodes* Ah Yong & Poore, 2004**

NZ references: Schnabel (2009a: 47); Rowden *et al.* (2010: 75).

Other significant reference: Ah Yong & Poore (2004b: 65) fig. 16A–G (male holotype diagnostic characters).

Distribution: Kermadec Ridge; eastern Australia; 328–590 m (Schnabel 2009a).

***Tasmanida norfolkiae* Ah Yong, 2007**

NZ references: Ah Yong (2007: 45) fig. 23A–L (female holotype diagnostic characters); Schnabel (2009a: 49).

Distribution: West Norfolk Ridge; 521–539 m (Ah Yong 2007).

Family **MUNIDOPSIDAE** Whiteaves, 1874

***Galacantha quiquei* Macpherson, 2007**

NZ references: Ah Yong (2007: 3) fig. 2A–B (colour photos, male); Schnabel (2009a: 38).

Other significant reference: Macpherson (2007: 15) fig. 6A–C (photos, holotype male carapace and abdomen), fig. 7A–G (diagnostic characters), fig. 55A (colour photo, male holotype).

Distribution: Reinga Basin, New Caledonia Trough; southwest Pacific from Wallis and Futuna to Norfolk Ridge; 835–1478 m (Schnabel 2009a).

***Galacantha rostrata* A. Milne-Edwards, 1880**

NZ references: Ah Yong (2007: 4) fig. 2C–D (colour photos, atypical male from West Norfolk Ridge); Schnabel (2009a: 38).

Other significant references: Baba & Poore (2002: 239) fig. 5 (female carapace and abdomen); Macpherson (2007: 18) fig. 8A–D (lateral carapace and rostrum).

Distribution: New Caledonia Basin, Kermadec Ridge, Bay of Plenty, Hikurangi Trench; cosmopolitan; 1486–3215 m (Schnabel 2009a).

***Galacantha valdiviae* Balss, 1913**

NZ reference: Schnabel (2009a: 38).

Other significant references: Balss (1913: 224); Macpherson (2007: 29) fig. 15A–C (photos, ovigerous female carapace, abdomen), fig. 16A–E (ovigerous female diagnostic characters).

Distribution: Bay of Plenty; Indo-West Pacific from eastern Africa to Japan to Queensland; 955–1644 m (Schnabel 2009a).

***Leiogalathea laevirostris* (Balss, 1913)**

NZ reference: Schnabel (2009a: 39).

Other significant references: Balss (1913: 221); Ah Yong (2007: 14) fig. 8A–J (female).

Distribution: northern and northeastern NZ region, including Lord Howe Rise, Norfolk Ridge, Kermadec Islands, down to Chatham Rise; Indo-Pacific from Madagascar to Japan to Tuamotu; 142–2148 m (Schnabel 2009a).

***Munidopsis antonii* (Filhol, 1884)**

NZ reference: Schnabel (2009a: 44).

Other significant references: Baba (2005: 132) fig. 52 (photo, syntype female), fig. 53a–b (syntype female carapace), fig. 54a–c, e–f (syntype female diagnostic characters); Osawa & Takeda (2007: 137) figs 3C–D (photos, female); Taylor *et al.* (2010: 9) fig. 3 (carapace compared with that of other *Munidopsis* species).

Distribution: Hikurangi Trench, Tasman Basin, New Caledonia Basin; cosmopolitan; 2516–4510 m (Schnabel 2009a).

***Munidopsis bractea* Ah Yong, 2007**

NZ references: Ah Yong (2007: 5) fig. 3A (colour photo, whole female), fig. 4A–J (holotype male diagnostic characters); Schnabel (2009a: 44).

Distribution: southern Norfolk Ridge, Lord Howe Rise, 430–740 m (Ah Yong 2007).

***Munidopsis ceres* Macpherson, 2007**

NZ material: specimens in NIWA collections from Chatham Rise, 487–821 m (Kareen Schnabel, pers. comm. 2010).

NZ reference: Rowden *et al.* (2010: 73).

Other significant reference: Macpherson (2007: 50) fig. 24A–B (photos, holotype carapace and abdomen), fig. 25A–H (diagnostic characters).

Distribution: NZ; New Caledonia; 500–1074 m (Macpherson 2007).

***Munidopsis comarge* Taylor, Ah Yong & Andreakis, 2010**

N.Z. reference: Taylor *et al.* (2010: 3) fig. 1A–O (holotype female diagnostic characters).

Distribution: southeastern NZ; southeastern and southwestern Australia; 458–1000 m (Taylor *et al.* 2010).

***Munidopsis kaiyoae* Baba, 1974**

NZ references: Baba (1974: 390) fig. 8 (whole animal), fig. 9; Schnabel & Bruce (2006: 52) fig. 2 (paratype female right antennule); Schnabel (2009a: 45).

Distribution: endemic, eastern NZ from Bay of Plenty to Pukaki Rise, Challenger Plateau, 479–1050 m (Schnabel 2009a).

Colour: body white, cornea yellow.

***Munidopsis marginata* (Henderson, 1885)**

NZ references: Henderson (1888: 161) pl. 19, fig. 2 (whole animal), pl. 19, fig. 2a, as *Elasmonotus marginatus*; Schnabel & Bruce (2006: 54); Schnabel (2009a: 45).

Other significant references: Baba & Poore (2002: 237) fig. 4A (whole carapace, abdomen), figs B–I; Poore (2004: 237), fig. 65d (carapace); Taylor *et al.* (2010: 12) fig. 4 (carapace compared with that of other *Munidopsis* species).

Distribution: eastern NZ; eastern Australia; 1750–2308 m (Schnabel 2009a).

Colour: body white, cornea orange (fresh female in MNZ from Mernoo Slope carrying 15 relatively large red eggs).

***Munidopsis maunga* Schnabel & Bruce, 2006**

NZ references: Schnabel & Bruce (2006: 55) fig. 3A–L (holotype male diagnostic characters); Schnabel (2009a: 45).

Distribution: endemic, Kermadec volcanic arc, 636–751 m (Schnabel & Bruce 2006).

***Munidopsis papanui* Schnabel & Bruce, 2006**

NZ references: Schnabel & Bruce (2006: 59) figs 4A–J, 5A–D (male holotype diagnostic characters), fig. 6 (photos, whole male holotype and female paratype); Schnabel (2009a: 45).

Distribution: endemic, southeastern NZ, 420 m (Schnabel & Bruce 2006).

***Munidopsis proales* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 46).

Other significant references: Ah Yong & Poore (2004b: 54) fig. 12A–L (holotype female diagnostic characters); Taylor *et al.* (2010: 12) fig. 4 (carapace compared to that of other *Munidopsis* species).

Distribution: Bay of Plenty; Western Australia; 513–1400 m (Schnabel 2009a).

***Munidopsis serricornis* (Lovén, 1852)**

NZ reference: Schnabel (2009a: 46); Rowden *et al.* (2010: 73).

Other significant references: Lovén (1852: 22); Ah Yong & Poore (2004b); Taylor *et al.* (2010: 12) fig. 4 (carapace compared to that of other *Munidopsis* spp.).

Distribution: Bay of Plenty, Chatham Rise, Macquarie Ridge; Tasmania; 392–1100 m (Ah Yong & Poore 2004b; Schnabel 2009a).

***Munidopsis tasmaniae* Ah Yong & Poore, 2004**

NZ reference: Schnabel (2009a: 46).

Other significant references: Ah Yong & Poore (2004b: 59) fig. 14A–L (male holotype diagnostic characters); Taylor

et al. (2010: 12) fig. 4 (carapace compared to that of other *Munidopsis* species).

Distribution: northern Chatham Rise, Macquarie Ridge; Tasmania; 119–1135 m (Schnabel 2009a).

***Munidopsis treis* Ah Yong & Poore, 2004**

NZ reference: Ah Yong (2007: 10) fig. 3C (colour photo, female).

Other significant reference: Ah Yong & Poore (2004b: 62) fig. 15A–L (holotype female diagnostic characters); Taylor *et al.* (2010: 12) fig. 4 (carapace compared to that of other *Munidopsis* species).

Distribution: West Norfolk Ridge, Northland Plateau; South Australia, Chesterfield Islands, New Caledonia; 366–912 m (Schnabel 2009a).

***Munidopsis victoriae* Baba & Poore, 2002**

NZ reference: Schnabel (2009a: 47).

Other significant references: Baba & Poore (2002: 247) figs 11A–B, 12A–I (female holotype diagnostic characters); Taylor *et al.* (2010: 12) fig. 4 (carapace compared to that of other *Munidopsis* species).

Distribution: Bay of Plenty to Chatham Rise, Puysegur Bank; Victoria; 690–1270 m (Schnabel 2009a).

Family PORCELLANIDAE Haworth, 1825***Pachycheles pisoides* (Heller, 1865)**

NZ references: Chilton (1911: 551), as *P. lifuensis*; Haig (1966: 290).

Other significant references: Grant & McCulloch (1907: 155) pl. 1, fig. 2 (whole animal from Norfolk Island), pl. 1, fig. 2a; Davie (2002b: 100).

Distribution: Kermadec Islands, intertidal zone and shallow water; Indo-West Pacific from Indian Ocean to Western Australia and Norfolk Island, extending through Micronesia to Hawai'i and Tuamotu Islands.

***Petrocheles spinosus* (Miers, 1876)**

NZ references: Bennett (1932: 479) pl. 60, fig. 5 (whole animal); Bennett (1964: 99) fig. 105 (photo, whole animal); Haig (1964: 356); McLay (1988: 64) fig. 9a (whole animal), fig. 9b.

Distribution: endemic, North and South islands; intertidal zone to 100 m.

Colour: grey with bluish tinge, fingertips reddish, spines ochreous.

***Petrolisthes elongatus* (H. Milne Edwards, 1837)**

NZ references: Haig (1964: 366); Miller & Batt (1973) fig. 94 (colour photo, whole animal); Jones (1977: 259)

fig. 2A (whole animal), fig. 2B–C; Powell (1987: 36) fig. 173 (whole animal); McLay (1988: 52) fig. 7a (whole animal), fig. 7b–c; Walsby (1990: 125) (two close-up colour photos, filter-feeding); Davie (2002a: 102); Poore (2004: 244) fig. 69c–d (whole animal), pl. 14a (colour photo, whole animal); Osawa (2007: 22) (small male reported from the lagoon in New Caledonia, but this record needs verification because *P. elongatus* is (1) very variable throughout its NZ range, (2) a very shallow-water species, (3) considered to have been accidentally introduced to Tasmania, (4) not otherwise known from New Caledonia).

Other significant reference: Poore (2004: 244) fig. 69c (whole animal with right limbs only), fig. 69d, pl. 14a (colour photo, whole animal under rock overhang).

Distribution: probably originally endemic to NZ, North and South islands, and Stewart Island/Rakiura, upper littoral to just below low-tide level; Tasmania (most likely introduced with shipments of live Foveaux Strait oysters to Hobart during late 1800s and 1900s, as were a number of other invertebrates – see Dartnell 1969).

Colour: variable coloration, from black and blue to greyish, greenish or even pink; 2nd maxillipeds bright blue (see Walsby 1990: 125 upper photo).

***Petrolisthes lamarckii* (Leach, 1820)**

NZ reference: Chilton (1911: 551), as *P. lamarckii* var. *rufescens*.

Other significant references: Borradaile (1898: 464) pl. 36, fig. 1a–b (whole animal); Haig (1964: 362); Davie (2002b).

Distribution: Kermadec Islands, intertidal zone and shallow water; Indo-West Pacific from east Africa to Indonesia, eastern Australia, Philippines, Samoa and Tuamotu Islands.

***Petrolisthes novaezelandiae* Filhol, 1885**

NZ references: Bennett (1932: 476) pl. 60, figs 3–4 (whole animal); Haig (1964: 364); McLay (1988: 60) fig. 8a (whole female), fig. 8b (whole male).

Distribution: endemic, North and South islands, Stewart Island/Rakiura, intertidal zone (rarely) to 75 m.

Colour: males reddish, females greyish with red spots.

Superfamily HIPPOIDEA Latreille, 1825

Family ALBUNEIDAE Stimpson, 1858

***Albunea microps* Miers, 1878**

NZ reference: Chilton (1911: 551).

Other significant references: Thomassin (1969: 140) fig. 2 (whole animal), fig. 3b, but NOT pl. 2; Boyko & Harvey

(1999: 383) figs 1, 4; Boyko (2002: 246) figs 81–82 (including 81A whole carapace); Davie (2002b: 27).

Distribution: Kermadec Islands, 25 m; Indo-West Pacific including eastern Australia, Madagascar to Indonesian and Philippine archipelagos, and to New Caledonian and Japanese waters.

Colour: in preservative, light pink (Japanese material).

Superfamily LITHODOIDEA Samouelle, 1819

Family LITHODIDAE Samouelle, 1819

Until 2009 there were thought to be about seven species of Lithodidae in New Zealand waters. Ah Yong (2010b) published a revision of the Australasian and Ross Sea lithodids, which lists 13 species in the New Zealand region. This revision described new species and synonymised some other species previously thought to be in our fauna. The 13 species are listed and annotated below, but readers are referred to Ah Yong (2010b) for details of the taxonomic changes and for full synonymies.

***Lithodes aotearoa* Ah Yong, 2010**

NZ references: Dell (1963a: 62) fig. (whole animal); Yaldwyn & Dawson (1970: 279) fig. 1 (photo, adult male), fig. 2 (photos, carapace and abdominal somite 2); McLay (1988: 22) fig. 1a–e (whole animal and diagnostic characters); Takeda (1990: 360) fig. 288 (colour photo, whole animal); Webber (1997: 81) fig. 4 (photo, whole animal); O'Shea *et al.* (1999: 49) fig. 15 (colour photo, whole animal); Webber & Naylor (2004a) fig. 78 (colour photo, whole animal), fig. 79 (rostrum); Naylor *et al.* (2005: 41) figs (colour photo, whole animal and diagnostic characters); Ah Yong *et al.* (2007: 154) fig. (colour photo, whole animal and diagnostic characters), as *Lithodes murrayi*; Ah Yong (2010b: 16) figs 5–11 (photos, male holotype and several adult and juvenile specimens of both sexes), fig. 12 (distribution), cover photo, pl. 1A–B (colour photos, male holotype and female), pl. 4C (colour photo, live animal in Kaikoura Canyon).

Distribution: endemic, southern West Norfolk Ridge to southern Campbell Rise including Challenger Plateau and Chatham Rise, and Louisville Ridge, c. 250–1500 m (Ah Yong 2010b).

Colour: body and appendages purple to bright red.

***Lithodes jessica* Ah Yong, 2010**

NZ reference: Ah Yong (2010b: 41) figs 21–25 (photos, female holotype, male paratype, diagnostic characters), fig. 26 (distribution).

Distribution: northern NZ from southern Lord Howe Rise to southeast of Hawke Bay; Ritchie Bank area; 680–1100 m (Ahyong 2010b).

***Lithodes macquariae* Ahyong, 2010**

NZ reference: Ahyong (2010b: 48) figs 27–30 (photos, male holotype, female paratype, juvenile paratype, diagnostic characters), fig. 31 (distribution), pl. 2E (colour photo juvenile female).

Distribution: south and southwest of NZ, Macquarie Ridge, Solander Trough and vicinity of Auckland Islands; 16–1140 m (Ahyong 2010b).

Colour: overall deep red (Ahyong 2010b).

***Lithodes robertsoni* Ahyong, 2010**

NZ reference: Ahyong (2010b: 66) figs 38–42 (photos, male holotype, female paratype, male paratype, male specimen, diagnostic characters), fig. 31 (distribution), pl. 1F (colour photo, male holotype).

Distribution: endemic, mid-southern NZ, Challenger Plateau to Chatham Rise to Bounty Trough to Snares Islands; 935–1259 m (Ahyong 2010b).

Colour: overall deep red (Ahyong 2010b).

***Neolithodes brodiei* Dawson & Yaldwyn, 1970 (Fig. 8)**

NZ references: Dawson & Yaldwyn (1970: 227); Dawson & Yaldwyn (1985: 70); Dawson (1989: 318) frontispiece (photo, whole juvenile); McLay (1988: 36) fig. 3 (female and chelae); Takeda (1990: 361) fig. 289 (colour photo, whole animal); Webber (1997: 81) fig. 1 (colour photo, adult), fig. 2 (photo, juvenile), fig. 3; Batson (2003: 137) fig. (colour photo, whole animal); Clark & Rowden (2004: 25) (off Balleny Islands, Antarctica, but record needs to be confirmed; misspelt as *brodei*); Webber & Naylor (2004a: 79) figs (colour photos, whole animal, rostrum); Naylor *et al.* (2005: 39) figs (colour photos, whole animal and rostrum); Ahyong *et al.* (2007: 155) figs (colour photos, whole animal and rostrum); Ahyong (2010b: 74) figs 43–47 (photos, males, females, juveniles, diagnostic characters), fig. 48 (distribution), pl. 2A (colour photo, ovigerous female).

Distribution: NZ region from southern Norfolk Ridge to Campbell Plateau, southern Louisville Ridge; 950–1150 m (Ahyong 2010b).

Colour: body, spines, chelipeds and walking legs uniform bright red.

***Neolithodes bronwynae* Ahyong, 2010**

NZ reference: Ahyong (2010b: 83) figs 48–51 (photos, male holotype whole animal and diagnostic characters),

fig. 52 (photos, male paratype), pl. 2B (colour photo, male holotype).

Distribution: Bay of Plenty, Lord Howe Rise; 1515–1920 m (Ahyong 2010b).

Colour: overall deep red (Ahyong 2010b).

***Paralomis dawsoni* Macpherson, 2001**

NZ references: McLay (1988: 42), as *Paralomis* n. sp.; O’Shea *et al.* (1999: 49) fig. 16 (colour photo, whole animal as *Paralomis* sp.); Kay (2002) (colour photo, whole animal front view); Webber & Naylor (2004b: 62) fig. (colour photo, whole animal); Naylor *et al.* (2005: 46) fig. (colour photo, whole animal); Ahyong *et al.* (2007: 156) fig. (colour photo, whole animal); Dawson (2008: 7) fig. 8 (colour photo, dorso-lateral view); Ahyong (2010b: 116) figs 67–72A (photos, males, females, juvenile, diagnostic characters), fig. 73 (distribution), pl. 3B (colour photo, male).

Other significant references: Macpherson (1990: 225) fig. 2c (photo, whole female) fig. 4, as *Paralomis* sp.; Macpherson (2001: 802) fig. 4A (photo, whole female), fig. 4B–C (described from New Caledonian material trapped outside reef).

Distribution: northern Challenger Plateau and continental slope off eastern North Island; New Caledonia; deep water.

Colour: body and appendages orange-red with yellow in grooves, between carapace pustules, and between cheliped and leg spines.

***Paralomis echidna* Ahyong, 2010**

NZ reference: Ahyong (2010b: 125) figs 74–76 (photos, female holotype), fig. 77A–E (diagnostic characters), figs 78–80 (photos, ovigerous female and male), fig. 81 (distribution).

Distribution: Tasman Sea on southern Norfolk Ridge; Gascoyne Seamount and off Victoria; 636–817 m (Ahyong 2010b).

***Paralomis hirtella* de Saint Laurent & Macpherson, 1997**

NZ references: Clark & O’Shea (2001: 15) (a small-bodied *Paralomis* ‘similar to but not conspecific with *P. jamsteci*’ and different from *P. dawsoni*); Webber & Naylor (2004b: 63) fig. (colour photo, whole animal), as *P. aff. jamsteci*; Dawson (2008: 1) (first record in NZ waters) figs 1–5 (colour photos, male and female); Ahyong (2010b: 142) figs 88–91 (photos, male, female, juveniles of both sexes), fig. 81 (distribution), pl. 4B (numerous crabs in situ on Monowai Caldera).

Other significant reference: de Saint Laurent & Macpherson (1997: 722) fig. 1 (photo, whole male), figs 2–3 (described

from hydrothermal environments in the Lau and North Fiji basins, southwest Pacific).

Distribution: southern Kermadec Ridge (Brothers and Monowai seamounts); Lau and North Fiji basins; deep hydrothermal waters (Ahyong 2010b).

Colour: uniformly creamy white in preservative. Often with light brown iron precipitates on external cuticle (Ahyong 2010b). See also colour of specimens illustrated by Dawson (2008).

***Paralomis poorei* Ahyong, 2010**

NZ reference: Ahyong (2010b: 148) figs 92–94 (photos, male holotype), fig. 95A–D (diagnostic characters), fig. 96 (photos, ovigerous female, paratype male, juvenile males), fig. 81 (distribution), pl. 3E (colour photo, juvenile male paratype).

Distribution: seamounts on Chatham Rise, southeastern Australia and southwestern Australia; 900–1156 m (Ahyong 2010b).

Colour: translucent pink-orange overall (Ahyong 2010b).

***Paralomis staplesi* Ahyong, 2010**

NZ reference: Ahyong (2010b: 156) figs 98–100 (photos, male holotype), fig. 81 (distribution), pl. 3H (colour photo, male holotype).

Distribution: Kermadec Ridge; Tasmania; 1958–2312 m (Ahyong 2010b).

Colour: overall purplish-red (Ahyong 2010b).

***Paralomis webberi* Ahyong, 2010**

NZ reference: Ahyong (2010b: 169), figs 109–111 (photos, ovigerous female holotype), fig. 112A–E (female holotype diagnostic characters), fig. 81 (distribution).

Distribution: endemic, Rumble III Seamount, southern Kermadec Ridge, 532–1255 m (Ahyong 2010b).

***Paralomis zealandica* Dawson & Yaldwyn, 1971**

NZ references: Dawson & Yaldwyn (1971: 51) fig. 1 (whole animal dorsal and ventral); McLay (1988: 40) fig. 4 (whole animal); Dawson (1989: 318); Webber (1997: 82); O'Shea *et al.* (1999: 49) fig. 17 (colour photo, whole animal); Batson (2003: 137) fig. (colour photo, whole animal); Webber & Naylor (2004b: 62) fig. (colour photo, whole animal); Naylor *et al.* (2005: 46) fig. (colour photo, whole animal); Ahyong *et al.* (2007: 156) fig. (colour photo, whole animal); Ahyong (2010b: 175) figs 114–118 (photos, males including holotype, females, small specimens), fig. 119 (distribution), pl. 2F (colour photo, female), pl. 4F (colour photo, live animal on bottom).

Distribution: endemic, eastern central, southeastern and southern NZ; 254–1212 m (Ahyong 2010b).

Colour: body and appendages ivory with peach-coloured tinges, spines on carapace and appendages pinkish red.

Superfamily PAGUROIDEA Latreille, 1802

Family DIOGENIDAE Ortmann, 1892

***Calcinus imperialis* Whitelegge, 1901**

NZ reference: Forest & McLaughlin (2000: 79) fig. 25.

Other significant references: Davie (2002b: 40); Poore (2004: 253) fig. 71b (chela).

Distribution: Kermadec Islands, 7–30 m; Indo-West Pacific from Cocos and Christmas islands through Philippine Islands and Japan, southeastern Australia, Lord Howe and Norfolk islands, New Caledonia, French Polynesia and Hawai'i.

Colour: anterior region of carapace olive green, spotted or margined with blue; chelipeds brownish grey or olive, spines purplish blue; free finger with two red spots, one on each side near base; walking legs ringed with black or brown, olive green or yellow, dactyls white with medium black or brown ring (from Lord Howe Island and French Polynesian material).

***Cancellus frontalis* Forest & McLaughlin, 2000**

NZ reference: Forest & McLaughlin (2000: 97) fig. 32.

Distribution: endemic, Kermadec Islands; 275–402 m.

***Cancellus laticoxa* Forest & McLaughlin, 2000**

NZ reference: Forest & McLaughlin (2000: 90) figs 28, 29.

Distribution: endemic, north and east coasts of North Island; 49–200 m.

Colour: in preservative, carapace tinted red or yellow with patches of white and red; eye stalks yellow; chelipeds and walking legs pink and red.

***Cancellus rhynchogonus* Forest & McLaughlin, 2000**

NZ reference: Forest & McLaughlin (2000: 94) fig. 31.

Distribution: endemic, Kermadec Islands; 84–146 m or deeper.

Colour: in preservative, carapace with reddish patches; eye stalks reddish orange; chelipeds and walking legs spotted with red.

Shelter: pumice pebbles.

***Cancellus sphaerogonus* Forest & McLaughlin, 2000**

NZ reference: Forest & McLaughlin (2000: 92) fig. 30.

Distribution: endemic, off east coast of North Island; 341–373 m.

Colour: in preservative, carapace pinkish yellow.

***Dardanus arrosor* (Herbst, 1796)**

NZ reference: Forest & McLaughlin (2000: 81) fig. 26, pl. 2, fig. 3 (colour photo, live animal in shell).

Other significant references: Davie (2002b: 46); Poore (2004: 257) fig. 71i–j, pl. 15c (colour photo, whole animal).

Distribution: northern and southern NZ shelf, 15–165 m or deeper; tropical and warm temperate eastern Atlantic, and Indo-West Pacific from South Africa to Japan and eastern Australia.

Colour: carapace reddish yellow with vivid red and white patches; eye stalks pink with proximal red ring, a mid-length pink ring and a distal pink ring; chelipeds and walking legs yellowish red to violet red; setae yellow.

Shelter: gastropod shells.

***Dardanus hessii* (Miers, 1884)**

NZ reference: Forest & McLaughlin (2000: 85) fig. 27.

Other significant reference: Davie (2002b: 48).

Distribution: Kermadec Islands, shallow shelf; Indo-West Pacific from Bay of Bengal to Indonesia and Vietnam.

Colour: carapace grey-green mixed with violet and yellow; eye stalks with longitudinal dorsal stripe of grey-green outlined with white and lateral stripe of violet-carmine; chelipeds with yellow bands and carmine spines; walking legs with yellow and violet-grey patches and bands (from Vietnamese material).

***Paguristes barbatus* (Heller, 1862)**

NZ reference: Forest & McLaughlin (2000: 59) figs 16–17.

Distribution: endemic, northern NZ; 20–37 m.

Colour: carapace and appendages brown; eye stalks blue; chelipeds and walking legs brown, tipped with black.

Shelter: gastropod shells.

***Paguristes pilosus* (H. Milne Edwards, 1836)**

NZ references: Schembri & McLay (1983: 28) fig. 5a–b (chela); Forest & McLaughlin (2000: 67) figs 21, 22a–b, 23a,c,e,g, pl. 2, figs 1–2 (colour photo, live animals in shells).

Distribution: endemic, North Island and north and east coasts of South Island (south to Otago); 15–201 m.

Colour: eye stalks whitish; chelipeds whitish at base, pale orange at extremity of fingers; walking legs white, tinged with orange.

Shelter: gastropod shells.

***Paguristes setosus* (H. Milne Edwards, 1848)**

NZ reference: Forest & McLaughlin (2000: 73) figs 22c–d, 23b,d,f, 24, pl. 1, fig. 3 (colour photo, live animal in shell).

Distribution: endemic, North and South islands; intertidal zone to 24 m.

Colour: overall colour orange-red with thick greyish-yellow setal fur; eye stalks red with narrow white band adjacent to black corneas; cheliped finger tips and walking leg dactyl tips black.

Shelter: gastropod shells.

***Paguristes subpilosus* Henderson, 1888**

NZ reference: Forest & McLaughlin (2000: 63) figs 18–20, pl. 1, fig. 2 (colour photo, live animal in shell).

Distribution: endemic, North and South islands, Chatham Islands; 18–400 m.

Colour: carapace, chelipeds and walking legs light orange-red with some more intense red patches; eye stalks intense purple with a white border between purple stalk and black cornea.

Shelter: gastropod shells.

Family **PAGURIDAE** Latreille, 1802***Bathypaguropsis cruentus* de Saint Laurent & McLaughlin, 2000**

NZ reference: de Saint Laurent & McLaughlin (2000: 117) figs 37a,c–e, 38a–c.

Distribution: endemic, southern North Island shelf; 12–88 m.

Colour: left cheliped and distal segments of walking legs blood red.

Shelter: gastropod shells.

***Bathypaguropsis yaldwyni* McLaughlin, 1994**

NZ references: Schembri & McLay (1983: 28) figs 7a–b (left and right chelae), as ‘Pagurid smooth apricot’ n. gen., n. sp.; McLaughlin (1994: 471) figs 1A, 2–3; de Saint Laurent & McLaughlin (2000: 120) figs 37b,d,f, 38b,d; Poore (2004: 272) fig. 77a (chela).

Distribution: northern and southern NZ; southeastern Australia and Tasmania; 256–695 m.

Colour: eye stalks, chelipeds and walking legs uniform light orange-brown.

Shelter: gastropod shells.

***Catapagurus spinicarpus* de Saint Laurent & McLaughlin, 2000**

NZ reference: de Saint Laurent & McLaughlin (2000: 146) fig. 46.

Distribution: endemic, Kermadec Islands; 149–165 m.

***Diacanthurus ecpHYma* McLaughlin & Forest, 1997**

NZ reference: de Saint Laurent & McLaughlin (2000: 142) fig. 45.

Other significant reference: Davie (2002b: 78).

Distribution: Kermadec Islands, 155–201 m; Western Australia and New Caledonia.

Colour: in preservative, chelipeds reddish orange, walking legs reddish orange on white background (from New Caledonian material).

***Diacanthurus rubricatus* (Henderson, 1888)**

NZ references: Schembri & McLay (1983: 28) fig. 21 (left chela), fig. 24 (eye stalk), as '*Pagurus rubricatus*'; de Saint Laurent & McLaughlin (2000: 139) fig. 44, pl. 3, fig. 4 (colour photo, live animal in shell), front cover (same colour photo enlarged); Batson (2003: 136) fig. (different colour photo of live animal in shell).

Distribution: endemic, northern and southern NZ, Chatham Islands; 15–2134 m.

Colour: eye stalks (short and wide) white with red longitudinal stripe ventrally; antennae uniform reddish brown; chelipeds and walking legs yellow-brown to white with bright red bands distally on meri, bright red patch proximally and purple longitudinal stripe dorsally on carpi.

Shelter: gastropod shells often bearing hydrozoans or anemones.

***Diacanthurus spinulimanus* (Miers, 1876)**

NZ references: Schembri & McLay (1983: 28) fig. 20 (left chela), fig. 25 (eye stalk), as '*Pagurus spinulimanus*'; de Saint Laurent & McLaughlin (2000: 135) fig. 43, pl. 3, fig. 2 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ, Chatham Islands; 2–274 m.

Colour: eye stalks (long and narrow) white with median pale orange band; antennae reddish brown with numerous regularly spaced white bands; chelipeds and walking legs orange-brown with distinctive purple and dark red patches at articulation of carpi and meri.

Shelter: gastropod shells, often bearing anemones. Several individuals of a commensal sphaeromatid isopod commonly found within shell shelters.

***Lophopagurus (Australeremus) cookii* (Filhol, 1883)**

NZ references: Schembri & McLay (1983: 28) fig. 10a–b (left and right chelae), fig. 11 (chelae slotted together to form operculum), as *Australeremus cookii*; McLaughlin & Gunn (1992: 70) fig. 9, as *Australeremus cookii*; de Saint Laurent & McLaughlin (2000: 166) fig. 53, pl. 4, fig. 4 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ; 11–267 m or deeper.

Colour: eye stalks white with yellow or brown markings; antennae red with numerous narrow white bands; 2nd and 3rd maxillipeds vivid deep blue; chelipeds and walking legs reddish brown with red patch on palm of chelae.

Shelter: gastropod shells, bryozoan tubes and scaphopod shells.

***Lophopagurus (Australeremus) cristatus* (H. Milne Edwards, 1836)**

NZ references: McLaughlin & Gunn (1992: 77) fig. 11, as *Australeremus cristatus*; de Saint Laurent & McLaughlin (2000: 171) fig. 55.

Distribution: endemic, eastern NZ; 30–274 m.

Colour: in preservative, a red-orange patch at articulation of fixed and free fingers of both chelae.

Shelter: gastropod shells.

***Lophopagurus (Australeremus) eltaninae* (McLaughlin & Gunn, 1992)**

NZ references: McLaughlin & Gunn (1992: 92) fig. 15, as *Australeremus eltaninae*; de Saint Laurent & McLaughlin (2000: 181) fig. 59.

Distribution: endemic, northern NZ; 31–146 m or deeper.

Colour: in preservative, eye stalks mottled orange-red; cheliped hands overall reddish orange, marginal teeth darker; walking legs with reddish-orange bands.

Shelter: usually bryozoan tubes but sometimes pieces of sponge.

***Lophopagurus (Australeremus) kirkii* (Filhol, 1883)**

NZ references: McLaughlin & Gunn (1992: 80) fig. 12, as *Australeremus kirkii*; de Saint Laurent & McLaughlin (2000: 174) fig. 56, pl. 5, fig. 4 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ; 2–88 m.

Colour: in preservative, eye stalks white; chelipeds mainly red-orange; walking legs orange.

***Lophopagurus (Australeremus) laurentae* (McLaughlin & Gunn, 1992)**

NZ references: Schembri & McLay (1983: 28) fig. 13a–b (left and right chelae), as *Pylopagurus* n. sp.; McLaughlin & Gunn (1992: 74) figs 8A,C,E, 10, as *Australeremus laurentae*; de Saint Laurent & McLaughlin (2000: 169) fig. 54, pl. 5, fig. 3 (colour photo live animal in bryozoan tube).

Distribution: endemic, northern and southern NZ, Chatham Islands; 7–144 m.

Colour: eye stalks uniform pale brown; antennae purple-brown with narrow white bars; chelipeds and walking legs purple-brown with white mottling.

Shelter: often found in bryozoan tubes.

***Lophopagurus (Australeremus) stewarti* (Filhol, 1883)**

NZ references: Schembri & McLay (1983: 28) fig. 12a–b (left and right chelae), fig. 14 (dactyl of left 1st walking leg), as *Pylopagurus stewarti*; McLaughlin & Gunn (1992: 83) fig. 8B,D,F,13, as *Australeremus stewarti*; de Saint Laurent & McLaughlin (2000: 179) fig. 58, pl. 5, figs 1–2 (colour photos, live animals in bryozoan tubes).

Distribution: endemic, western North Island and eastern South Island; 28–1280 m.

Colour: eye stalks pale orange; antennae reddish with narrow white bands; chelipeds reddish pink to orange with purple band on meri; walking legs orange with white bands.

Shelter: bryozoan and polychaete worm tubes, scaphopod shells and, occasionally, gastropod shells.

***Lophopagurus (Australeremus) triserratus* (Ortmann, 1892)**

NZ reference: de Saint Laurent & McLaughlin (2000: 177) fig. 57.

Other significant references: McLaughlin & Gunn (1992: 87) fig. 1, pl. 1 (photo, whole animal from Japan), as *Australeremus triserratus*; Poore (2004: 274) fig. 77f (right cheliped), as *Lophopagurus triserratus*.

Distribution: Bay of Plenty, 110–183 m; China, Japan and Indonesia, and southeastern Australia.

Colour: NZ material in preservative with carapace and legs reddish brown and with a pair of dark reddish-brown spots before and after cervical groove.

Shelter: includes serpulid worm tubes.

***Lophopagurus (Lophopagurus) foresti* McLaughlin & Gunn, 1992**

NZ references: Schembri & McLay (1983: 28) figs 8a–b (left and right chelae), as *Lophopagurus 'thompsoni'*; McLaughlin & Gunn (1992: 52) figs 1A,C,E, 3; de Saint Laurent & McLaughlin (2000: 161) fig. 51, pl. 4, fig. 3 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ; intertidal zone to 220 m or deeper.

Colour: cheliped free and fixed fingers, and also walking legs with longitudinal vermilion stripes; in preservative, these stripes appear orange.

Shelter: gastropod shells, sometimes bearing anemones.

***Lophopagurus (Lophopagurus) lacertosus* (Henderson, 1888)**

NZ references: McLaughlin & Gunn (1992: 61) fig. 6; de Saint Laurent & McLaughlin (2000: 153) fig. 48, pl. 4, fig. 2 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ, Subantarctic Islands; 36–790 m or deeper.

Colour: chelipeds and walking legs orange-red with white markings.

Shelter: gastropod shells.

***Lophopagurus (Lophopagurus) ?nanus* (Henderson, 1888)**

NZ reference: de Saint Laurent & McLaughlin (2000: 156) fig. 49.

Other significant references: McLaughlin & Gunn (1992: 65) figs 1B,D,F, 7; Davie (2002b: 80); Poore (2004: 274) fig. 77d–e (left cheliped), pl. 16d (colour photo, live animal in mollusc shelter), as *Lophopagurus nanus*.

Distribution: northwest of Three Kings Islands, Wanganella Bank; southeastern Australia and Tasmania.

***Lophopagurus (Lophopagurus) nodulosus* McLaughlin & Gunn, 1992**

NZ references: Schembri & McLay (1983: 28) figs 9a–b (left and right chelae), as *Lophopagurus* n. sp.; McLaughlin & Gunn (1992: 55) fig. 4A–H; de Saint Laurent & McLaughlin (2000: 163) fig. 52.

Distribution: endemic, southeastern South Island and Subantarctic Islands; 11–400 m.

Colour: antennae reddish with narrow white bands; chelipeds and walking legs reddish orange with darker bands.

***Lophopagurus (Lophopagurus) pumilis* de Saint Laurent & McLaughlin, 2000**

NZ references: Schembri & McLay (1983: 28), as *Pagurus* n. sp. B; de Saint Laurent & McLaughlin (2000: 150) fig. 47, pl. 3, fig. 1 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ; 4–187 m.

Colour: eye stalks white with irregular maroon and greenish stripes; chelipeds greenish with white markings; walking legs with alternating bands of green-brown, maroon and yellow, also with longitudinal maroon stripes.

Shelter: gastropod shells or, occasionally, bryozoan tubes.

***Lophopagurus (Lophopagurus) thompsoni* (Filhol, 1885)**

NZ references: McLaughlin & Gunn (1992: 47) fig. 2; de Saint Laurent & McLaughlin (2000: 157) fig. 50, pl. 4, fig. 1 (colour photo, live animals in shells).

Distribution: endemic, northern and southern NZ; 40–1951 m or deeper.

Colour: eye stalks orange-red proximally, blue distally; antennae strongly barred with dark reddish brown and white; chelipeds and walking legs orange-red with longitudinal reddish stripes and white areas.

Shelter: gastropod shells.

?*Michelopagurus* sp.

NZ reference: de Saint Laurent & McLaughlin (2000: 132) fig. 42.

Distribution: endemic, known only from a single NIWA station in northern Bay of Plenty, 400–585 m.

Pagurixus hectori (Filhol, 1883)

NZ references: Schembri & McLay (1983: 28) fig. 26a–b (chelae; misspelt as *Pagurixis*); de Saint Laurent & McLaughlin (2000: 184) fig. 60, pl. 6, fig. 4 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ, Subantarctic Islands; intertidal zone to 18 m.

Colour: eye stalks with pale blue, orange and white bands; antennae dark reddish with narrow white bands; chelipeds dark brown with narrow blue band at base of carpus, dactyls and fixed fingers pale blue; walking legs with pale blue, then dark brown, then pale orange bands distally on each segment.

Shelter: gastropod shells.

Pagurixus kermadecensis de Saint Laurent & McLaughlin, 2000

NZ reference: de Saint Laurent & McLaughlin (2000: 187) fig. 61.

Distribution: endemic, Kermadec Islands and northern NZ; intertidal zone.

Colour: in preservative, chelipeds and walking legs red.

Shelter: gastropod shells.

Pagurodes inarmatus Henderson, 1888

NZ reference: de Saint Laurent & McLaughlin (2000: 129) fig. 41.

Distribution: off eastern coasts of North and South islands, Chatham Islands, 1165–3250 m; western Indian Ocean, Marion Island in southern Indian Ocean, Great Australian Bight.

Shelter: gastropod shells, sometimes with encrusting anemones.

Pagurojacquiesia polymorpha (de Saint Laurent & McLaughlin, 1999)

NZ reference: de Saint Laurent & McLaughlin (2000: 127) fig. 40.

Distribution: Kermadec Islands, 165–274 m; Philippine Archipelago, New Caledonia and Vanuatu.

Colour: in preservative, eye stalks orange; chelipeds whitish with orange band at mid-length of both fixed and free fingers, palms orange; walking legs whitish with three orange bands on dactyls (based on holotype from Vanuatu).

Shelter: gastropod shells.

Pagurus albidianthus de Saint Laurent & McLaughlin, 2000

NZ references: Schembri & McLay (1983: 28) fig. 19 (dactyl of left 1st walking leg), as *Pagurus* n. sp. A; de Saint Laurent & McLaughlin (2000: 199) fig. 65, pl. 6, fig. 3 (colour photo, live animal in shell).

Distribution: endemic, North and South islands; 3–28 m.

Colour: eye stalks pale brown; antennae pale brown with faint white bands; chelipeds and walking legs mainly white with longitudinal pink stripes laterally and medially, and pale blue patches dorsally.

Shelter: gastropod shells.

Pagurus iridocarpus de Saint Laurent & McLaughlin, 2000

NZ reference: de Saint Laurent & McLaughlin (2000: 192) fig. 63.

Distribution: endemic, Kermadec Islands; 84–113 m.

Colour: not known, but specific name refers to partially uncalcified area of iridescent integument on dorsal surface of right cheliped carpus (also sometimes present on left cheliped carpus).

Shelter: gastropod shells.

Pagurus novizealandiae (Dana, 1852)

NZ references: Schembri & McLay (1983: 28) fig. 17 (right cheliped), as *P. novizealandiae*; de Saint Laurent & McLaughlin (2000: 196) pl. 6, fig. 2 (colour photo, live animal in shell).

Distribution: endemic, northern and southern NZ, Auckland Islands; intertidal zone to 28 m.

Colour: eye stalks pale bluish green proximally, white distally; antennae yellow with black stripes; chelipeds and walking legs bluish green with bright blue bands at carpal-meral articulation and tufts of golden setae.

Shelter: gastropod shells.

***Pagurus sinuatus* (Stimpson, 1858)**

NZ reference: de Saint Laurent & McLaughlin (2000: 190) fig. 62.

Other significant references: Davie (2002b: 84); Poore (2004: 276) fig. 78a (right cheliped), pl. 16g (colour photo, live animal in mollusc shelter).

Distribution: Kermadec Islands, ?intertidal zone; Western and southeastern Australia.

Colour: carapace orange-red with darker red-violet patches; eye stalks pale pink with band of orange at mid-length; antennae orange; chelipeds with free finger orange or orange-violet, fingertip cream, carpus and merus orange or orange-red, spines and tubercles on chelipeds pale; 1st and 2nd walking legs with segments distinctly banded with red or maroon at mid-length, dactyls violet distally (based on Australian material).

Shelter: gastropod shells.

***Pagurus traversi* (Filhol, 1885)**

NZ references: Schembri & McLay (1983: 28) fig. 23 (left chela); de Saint Laurent & McLaughlin (2000: 206) fig. 66, pl. 6, fig. 1 (colour photo, live animal in shell).

Distribution: endemic, eastern North and South islands, Stewart Island/Rakiura; intertidal zone to 15 m.

Colour: eye stalks greenish blue with lighter markings; antennae dark red with narrow white bars; antennules orange; chelipeds and walking legs dark blue-green with small pale blue spots and pale blue patches at carpal-meral articulations.

Shelter: gastropod shells.

***Porcellanopagurus chiltoni* de Saint Laurent & McLaughlin, 2000**

NZ reference: de Saint Laurent & McLaughlin (2000: 107) fig. 34.

Distribution: Kermadec Islands; New Caledonia; intertidal zone.

Shelter: single valve of bivalve shells, or limpet shells.

***Porcellanopagurus edwardsi* Filhol, 1885**

NZ references: Forest (1951: 83) fig. 1 (whole animal), figs 2–12; McLay (1988: 48) fig. 6a–d (male, modified after Forest 1951); de Saint Laurent & McLaughlin (2000: 110) fig. 35 (whole animal).

Distribution: endemic, southern South Island, Stewart Island/Rakiura, Subantarctic Islands; 1–198 m or deeper.

Colour: in preservative, overall reddish orange.

Shelter: single valve of bivalve shells (for more detailed information on bivalve shells used as shelter by *Porcellanopagurus edwardsi*, see McLay 1988: 50).

***Porcellanopagurus filholi* de Saint Laurent & McLaughlin, 2000**

NZ references: Borradaile (1916: 111) fig. 1 (whole ovigerous female), figs 2, 3, 5–8, 10A, 13a, as *P. ?edwardsi*; de Saint Laurent & McLaughlin (2000: 114) fig. 36, pl. 3, fig. 3 (colour photo, live animal under bivalve shell).

Distribution: northern and central NZ, Chatham Islands; eastern Australia, New Caledonia; 79–1392 m or deeper.

Colour: chelipeds and walking legs orange-red.

Shelter: single valve of bivalve shells, or limpet shells (sometimes with covering of colonial hydrozoan).

***Porcellanopagurus tridentatus* Whitelegge, 1900**

NZ reference: de Saint Laurent & McLaughlin (2000: 105) fig. 33.

Other significant references: Davie (2002b: 85); Poore (2004: 276) fig. 78d (dorsal view carapace and abdomen), pl. 16h (colour photo, whole animal carrying single valve of bivalve shell as shelter).

Distribution: Kermadec Islands, 138–140 m or deeper; eastern Australia, Lord Howe and Norfolk islands, New Caledonia.

***Propagurus deprofundis* (Stebbing, 1924)**

NZ reference: de Saint Laurent & McLaughlin (2000: 123) fig. 39.

Other significant references: Davie (2002b: 85); Poore (2004: 277) fig. 78c–e (right cheliped, P2 dactyl).

Distribution: Norfolk Ridge to western and eastern North and South islands, Chatham Rise, 304–891 m; south-eastern South Africa, Tasmania, southeastern Australia, Philippine Archipelago, Hawai'i.

Colour: in preservative, carapace with orange patches; eye stalks orange; chelipeds whitish with orange band at mid-length of both free and fixed fingers, palms and other segments with orange patches; walking legs whitish with three orange bands on dactyls, propodi with orange band at mid-length and orange spot on lateral face proximally, other segments with orange patches.

Shelter: gastropod shells.

Family PARAPAGURIDAE Smith, 1882***Oncopagurus* sp.**

NZ reference: Lemaitre (2000: 218) fig. 69.

Distribution: endemic, known only from one damaged specimen from Kermadec Islands, 320 m.

Shelter: gastropod shell.

***Paragiopagurus diogenes* (Whitelegge, 1900)**

NZ reference: Lemaitre (2000: 219) fig. 70 (eastern Australian specimen).

Other significant references: Davie (2002b: 90); Poore (2004: 282) fig. 81e (right cheliped) pl. 17a (colour photo, live animal in mollusc shelter).

Distribution: Kermadec Islands, 219–274 m; China, Japan, Australia.

Colour: general colour orange or reddish; chelipeds with fingers creamy white, dorsal surface of carpus and hand orange or reddish, and iridescent; walking legs orange or reddish; carpi of chelipeds and walking legs with dark red band proximally (based on Australian material).

Shelter: gastropod shells.

***Paragiopagurus hirsutus* (de Saint Laurent, 1972)**

NZ reference: Lemaitre (2000: 221) fig. 71 (eastern Australian specimen).

Other significant reference: Davie (2002b: 90).

Distribution: eastern slope of Norfolk Ridge, 357–487 m; Indo-West Pacific, questionably off eastern South Africa, unquestionably from China Sea, Philippine Archipelago, Australia.

Shelter: gastropod shells.

***Parapagurus abyssorum* (Filhol, 1885)**

NZ reference: Lemaitre (2000: 224) fig. 72 (North Atlantic specimen).

Distribution: *Galathea* station 575, eastern Tasman Sea, 3710 m; North Atlantic, western and southeastern Pacific; recorded range 2500–4360 m.

Shelter: formed by *Epizoanthus* species, or occasionally actinians.

***Parapagurus bouvieri* Stebbing, 1910**

NZ reference: Lemaitre (2000: 225) fig. 73.

Other significant references: Davie (2002b: 90); Poore (2004: 284) fig. 79 (animal in zoanthid shelter), fig. 81f–i, pl. 17b (colour photo, animal in zoanthid shelter).

Distribution: recorded in NZ waters from one specimen, Bay of Plenty, depth unknown; southeastern Atlantic, southwestern Indian Ocean and southern Australia.

Colour: carapace pinkish, cornea dark crimson, antennae pink, basal segments of chelipeds with reddish patches, 1st and 2nd walking legs red with conspicuous white stripe along upper and lower margins (based on South African material).

Shelter: formed by zoanthids, usually *Epizoanthus* species.

***Parapagurus latimanus* Henderson, 1888**

NZ reference: Lemaitre (2000: 229) fig. 75 (specimen from northeast of Chatham Islands, not from ‘SE Pacific’ as stated in caption).

Other significant references: Davie (2002b: 91); Poore (2004: 284) fig. 81j–k (walking leg 4 propod and dactyl).

Distribution: northern and southern NZ including Challenger Plateau and Chatham Rise at 413–2500 m; western Indian Ocean, southern Australia, Indonesian Archipelago, Japan, New Caledonia.

Shelter: formed by zoanthids, usually *Epizoanthus* species.

***Parapagurus richeri* Lemaitre, 1999**

NZ reference: Lemaitre (2000: 227) fig. 74 (New Caledonian specimen).

Other significant references: Davie (2002b: 91); Poore (2004: 284) fig. 81l (walking leg 4 propod and dactyl).

Distribution: *Galathea* station in Kermadec Trench, 2640 m; southeastern Indian Ocean, South China Sea, central and western Pacific.

Shelter: gastropod shells (often with anthozoan polyps), occasionally scaphopod shells.

***Sympagurus dimorphus* (Studer, 1883)**

NZ reference: Lemaitre (2000: 214) fig. 68, pl. 7 (colour photo, live animal in shell).

Other significant references: Davie (2002b: 920); Poore (2004: 285) fig. 82b,e (right cheliped, walking leg 4 propod and dactyl).

Distribution: the commonest NZ parapagurid; northern and southern NZ including Challenger Plateau, northern Campbell Plateau, Chatham Rise, 210–984 m or deeper; southern South Atlantic, southern Indian Ocean, western and eastern South Pacific.

Colour: overall colour cream with some orange-red markings.

Shelter: gastropod shells, usually with attached actinian or zoanthid polyps.

***Sympagurus burkenroadi* Thompson, 1943**

NZ references: Lemaitre (2000: 211) fig. 67a–k (Western Australian specimen diagnostic characters); Lemaitre (2004: 134) (*S. papposus* synonymised with *S. burkenroadi*).

Other significant reference: Davie (2002b: 92).

Distribution: only NZ record is from a single collection in Bay of Plenty, depth unknown; western Indian Ocean, Indonesian Archipelago and Australia.

Shelter: formed by zoanthids, usually *Epizoanthus* species.

Family **PYLOCHELIDAE** Bate, 1888***Cheiroplatea pumicicola*** Forest, 1987

NZ references: Forest (1987: 108) figs 3b, 5e, 23, 24a–e, 31, pl. 6, figs E–F, pl. 9; Forest & McLaughlin (2000: 36) figs 6–7.

Distribution: Kermadec Islands, 490–1156 m; New Caledonia.

Shelter: burrows in rounded pumice pebbles.

Pylocheles mortensenii Boas, 1926

NZ references: Forest (1987: 51) fig. 2a (whole animal in schematic pumice burrow), figs 3a, 5a–b, 7a, 8, 9a–d, 10a–b, 12, 41a, pl. 2, fig. C (Japanese specimen); Forest & McLaughlin (2000: 33) fig. 5.

Other significant reference: Davie (2002b: 111).

Distribution: Kermadec Islands, 320 m, and Tasman Bay in northern South Island, depth not recorded; Indo-West Pacific from Indonesia to Japan and Australia.

Colour: uniformly intense rose (from Japanese material).

Shelter: non-NZ specimens recorded from excavations in sponge, coral, limestone and pumice pieces.

Trizocheles brachyops Forest & de Saint Laurent, 1987

NZ references: Forest (1987: 186) figs 47b, 61d, 62, 63a; Forest & McLaughlin (2000: 52) figs 13a–e, 14.

Distribution: southeast of Lord Howe Rise, off Kermadec Islands and southeast coast of North Island, 565–950 m.

Shelter: Kermadec specimens from burrows in pumice.

Trizocheles perplexus Forest, 1987

NZ references: Forest (1987: 208) figs 47f, 59e, 66f; Forest & McLaughlin (2000: 41) figs 8–9.

Distribution: endemic, Kermadec Islands, 398–590 m, and Tasman Bay, northern South Island.

Trizocheles pilgrimi Forest & McLaughlin, 2000

NZ reference: Forest & McLaughlin (2000: 54) fig. 15.

Distribution: Kermadec Islands, 545–590 m; New Caledonia.

Trizocheles spinosus (Henderson, 1888)

NZ references: Batham (1970: 45) fig. 1, pl. 1 (photos, whole animal), as *Myxtopagurus* n. sp.; Probert *et al.* (1979: 381), as *Mixtopagurus spinosus*; Schembri & McLay (1983: 28), as *Mixtopagurus* n. sp.; Forest (1987: 205) figs 4d, 6c–d, 47e, 66i, 69d, 71a–b (b from New Caledonian specimen), pl. 2A (photo, whole animal), pls 3D, 5C–E; Forest & McLaughlin (2000: 49) figs 10a, 12a–e, 13f–l, pl. 1, fig. 1 (colour photo, live animal in shell), figs 10b, 11, 12f–h, 13j–k, as *T. spinosus spinosus*; Poore (2004: 287);

McLaughlin & Lemaitre (2008: 53) fig. 1a–i (metazoea, diagnostic features); McLaughlin & Lemaitre (2009: 203) (*T. spinosus bathamae* and *T. s. spinosus* merged under current name).

Other significant references: Forest (1987: 202) figs 47d, 66g, 69c, 70 (southeastern Australian specimens); Davie (2002b: 112) fig. page 109 (whole animal, after Henderson 1888); Poore (2004: 287) fig. 83 (whole animal).

Distribution: North, South and Chatham islands, 127–550 m; eastern and southeastern Australia, New Caledonia.

Colour: carapace whitish with diffuse orange blotches; eye stalks light orange, cornea dark brown; chelipeds and walking legs white and orange, irregularly mottled and barred (Batham 1970, for Otago specimens).

Shelter: found in pumice, sponges and gastropod shells.

Infraorder BRACHYURA Linnaeus, 1758

Section DROMIACEA De Haan, 1833

Superfamily DROMIOIDEA De Haan, 1833

Family **DROMIIDAE** De Haan, 1833***Lewindromia unidentata*** (Rüppell, 1830)

NZ references: Chilton (1911: 554), as *Dromia unidentata*; McLay (1993: 192) figs 7, 18a (photo, whole animal), as *Cryptodromiopsis unidentata*; Guinot & Tavares (2003: 74) fig. 11a–c (male and female sterna, male abdomen); Takeda & Webber (2006: 232), as *Cryptodromiopsis unidentata*.

Other significant references: McLay (1993: 192) fig. 8a–k (diagnostic characters of carapace, abdomen and appendages), as *Cryptodromiopsis*; Davie (2002b: 161), as *Cryptodromiopsis*; Ng *et al.* (2008: 35).

Distribution: Kermadec Islands on subtidal coral; Indo-Pacific from Red Sea and east Africa, through Southeast Asia, Indonesia, eastern Australia and New Caledonia to Japan, Hawai'i and Easter Island; shallow water and shelf.

Shelter: caps of sponges, ascidians, actinians or colonial cnidarians.

Metadromia wilsoni (Fulton & Grant, 1902)

NZ references: Dell (1968: 14) figs 5–7, pl. 2 (photo, whole animal as *Petalomera wilsoni*); McLay (1988: 68) fig. 10a (whole animal), fig. 10b–f, as *P. wilsoni*; McLay (1991: 470) figs 6, 7, 8, pl. 1B (photo, whole animal as *P. wilsoni*); McLay (2009: 15) fig. 4a–b (colour photos, whole male, dorsal, anterior).

Other significant references: McLay (1993: 156) fig. 16e (photo, whole animal); Ikeda (1998: 57) pl. 3, figs 1–4 (colour photos, whole animals); Davie (2002b: 162), as

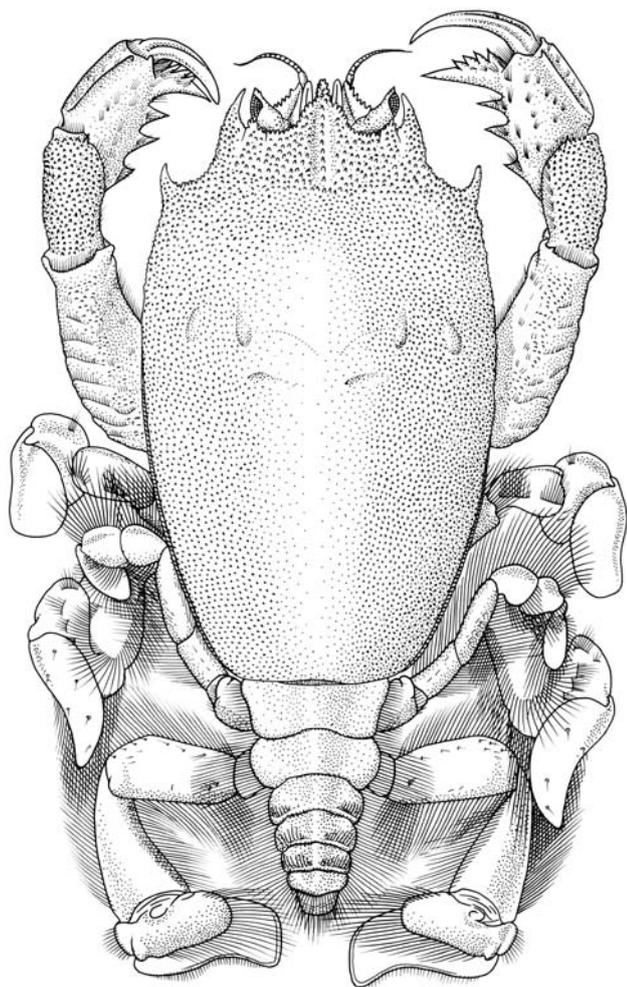


Fig. 9 Infraorder BRACHYURA: *Notosceles pepeke* Dawson & Yaldwyn, 2000 (drawn by W.R. Webber; from Dawson & Yaldwyn (2000)).

Dromia wilsoni; Poore (2004: 304) fig. 84b (whole animal), pl. 17f (colour photo, whole animal), fig. 84b (whole animal), pl. 17f (colour photo, whole animal without cap).

Distribution: northern NZ south to Tasman Bay and Kaikoura (not known from Kermadec or Chatham islands); St Helena in South Atlantic, Indo-Pacific from South Africa to southern and eastern Australia, New Caledonia, Japan and French Polynesia; shallow water, shelf and slope.

Colour: shaggy covering of dark khaki setae over entire animal; cap may be brightly coloured.

Shelter: small specimens carry sponge or ascidian caps (see Dell 1974: 1244 for colour photo of crab carrying red

ascidian cap). Large specimens have not been recorded carrying caps.

***Tumidodromia dormia* (Linnaeus, 1763)**

NZ reference: McLay (2009: 19) figs 5a–b (colour photos, whole male, dorsal, anterior), fig. 6a–b (colour photos, male sternite, female sternite).

Other significant reference: Davie (2002b: 162), as *Dromia dormia*.

Distribution: Kermadec Islands; Indo-West Pacific.

Family **DYNOMENIDAE**

Ortmann, 1892

***Dynomene pilumnoides* Alcock, 1900**

NZ reference: McLay (2009: 12) fig. 3a–b (colour photos, whole female, whole male, dorsal).

Other significant references: McLay (1999: 494) figs 3c–d, 8d–e, 12e–f, 14c (electron micrographs, diagnostic characters), fig. 17d (photo, whole ovigerous female), fig. 21a–g (diagnostic characters); Davie (2002b: 168) fig. page 167 (whole animal); Poore (2004: 308) fig. 88a,c (carapace, chela); Ng *et al.* (2008: 37).

Distribution: Monowai Seamount north of Kermadec Islands; New South Wales, Indo-West Pacific.

Colour: red to yellowish.

***Metadynomene tanensis* (Yokoya, 1933)**

NZ reference: McLay (2009: 11) fig. 2a–b (colour photos, whole ovigerous female, dorsal, anterior).

Other significant references: McLay (1999: 521) figs 4d, 6c, 7f, 9d–e, 13c,e–f, 14e (electron micrographs, diagnostic characters), fig. 25b (photo, female), fig. 27a–g (diagnostic characters); Ng *et al.* (2008: 37).

Distribution: East Cape; western Pacific from Taiwan to Vanuatu.

Superfamily **HOMOLODROMIOIDEA**

Alcock, 1900

Family **HOMOLODROMIIDAE**

Alcock, 1900

***Dicranodromia delli* Ahyong, 2008**

NZ references: Ahyong (2008: 7) figs 2A–B, 3A–D (ovigerous female holotype, whole animal and parts), fig. 4 (front, maxilliped 3, P5 dactyl); McLay (2009: 8) fig. 1a (colour photo, antero-lateral view).

Distribution: endemic, Bay of Plenty to Chatham Rise.

***Dicranodromia spinulata* Guinot, 1995**

NZ references: Ahyong (2008: 11) fig. 1C (photo, whole male, dorsal); McLay (2009: 6) fig. 1b (colour photo, antero-lateral view).

Other significant references: Guinot (1995: 225) figs 21A–C, 22A–B, 25D; Ng *et al.* (2008: 39).

Distribution: from east of North Cape to Chatham Rise; New Caledonia.

***Homolodromia kai* Guinot, 1993**

NZ references: Dawson (2002: 6) figs 1c, 2c–d, pl 1a (whole animal), figs 1d–f, 2a–f, 3 (distribution map), as *Homolodromia* spp.; Ahyong (2008: 11) fig. 1B (photo, whole male, dorsal).

Other significant references: Guinot (1995: 197) figs 5B, 9 (photo, whole animal), fig. 10; Ho & Ng (1999: 1123) fig. 1 (whole animal); Poore (2004: 311) fig. 89e (carapace); Ng *et al.* (2008: 39).

Distribution: northeastern NZ; South China Sea, Indonesia, New Caledonia and Vanuatu; continental slope.

Superfamily HOMOLOIDEA De Haan, 1839

Family HOMOLIDAE De Haan, 1839

***Dagnaudus petterdi* (Grant, 1905)**

NZ references: Dell (1955: 147) fig. 1 (photos, whole animal), as *Latreillopsis petterdi*; Takeda & Miyake (1969: 159) figs 1a–c, pl. 1, figs A–B (photos, whole males), as *L. petterdi*; McLay (1988: 78) fig. 13 (whole male), as *Paromola petterdi*; Takeda (1990: 363) fig. 291 (colour photo, whole animal as *L. petterdi*); Ahyong (2008: 5) fig. 1A (photo, whole male, dorsal).

Other significant references: Guinot & Richer de Forges (1995: 418) figs 44, 45a (photo, whole male from New Caledonia), fig. 45b–e (photo, whole male from New South Wales); Davie (2002b: 234); Poore (2004: 312) fig. 90a (whole animal, dorsal); Ng *et al.* (2008: 40).

Distribution: northern to southern NZ; Western, southern and eastern Australia, New Caledonia; shelf edge and slope.

Colour: body and appendages pale, mottled with red, walking legs with obvious red bands and red dactyls, cheliped fingers and cornea black.

***Homola orientalis* Henderson, 1888**

NZ references: Yaldwyn & Dawson (1976: 92) fig. 1 (photo, whole animal); McLay (1988: 72) fig. 11a–d (whole animal).

Other significant references: Guinot & Richer de Forges (1995: 331) figs 9e, 10, 12A–B, 13h, 16c (photos, whole animal from Hawai'i), fig. 16d (photo, holotype from Philippines), fig. 16e (photo, whole animal from French Polynesia), fig. 16f; Davie (2002b: 235) fig. page 233 (whole animal); Poore (2004: 312) fig. 89d (carapace); Ng *et al.* (2008: 40).

Distribution: one specimen from Bay of Plenty, 256 m; Indo-Pacific from east Africa and Gulf of Aden, through Indian Ocean, southern and eastern Australia, Philippines and New Caledonia to Japan, Hawai'i and French Polynesia; shelf and slope.

Colour: body and appendages red or orange, cheliped hand pale, cheliped fingers black (Ikeda 1998: pl. 6c – colour photos, whole animals).

***Homola ranunculus* Guinot & Richer de Forges, 1995**

NZ material: two specimens in MNZ from Kiwi Seamount, Three Kings Rise, 538–677 m.

NZ reference: Webber *et al.* (2010: 226).

Other significant references: Guinot & Richer de Forges (1995: 344) figs 13g, 15, 16a (photo, whole animal), fig. 16b (photo, carapace); Ng *et al.* (2008: 40).

Distribution: Three Kings Rise, Norfolk Ridge; New Caledonia.

***Homolochunia kullar* Griffin & Brown, 1976**

NZ material: one NZ specimen from off North Cape, 620–635 m.

NZ reference: Webber *et al.* (2010: 226).

Other significant references: Griffin & Brown (1976: 249) figs 1–3 (photos, whole animal dorsal and ventral); Guinot & Richer de Forges (1995: 432) figs 49, 50a–b (photo, whole animal), fig. 51g; Davie (2002b: 235); Poore (2004: 314) fig. 89c (carapace); Ng *et al.* (2008: 40).

Distribution: northern NZ; eastern Australia, New Caledonia.

***Yaldwynopsis spinimanus* (Griffin, 1965)**

NZ references: Griffin (1965: 87) fig. 1 (photo, whole animal), fig. 2, as *Paromola spinimana*; McLay (1988: 82) fig. 14a (whole animal), fig. 14b–e, as *Paromola spinimana*.

Other significant references: Guinot & Richer de Forges (1995: 437) figs 52, 53a (photo, whole animal from Japan), figs 53b,g, 54; Davie (2002b: 237); Ng *et al.* (2008: 41).

Distribution: northern NZ mainland shelf; Japan, ?eastern Australia, ?Hawai'i.

Colour: carapace and legs uniform bright orange, cheliped fingers black.

Family **LATREILLIIDAE** Stimpson, 1858***Eplumula australiensis*** (Henderson, 1888)

NZ references: Dell (1963b: 245) fig. 1 (whole animal), figs 2–3, as *Latreillia australiensis*; McLay (1988: 76) fig. 12a (whole animal), fig. 12b–c, as *Latreillia australiensis*; Castro *et al.* (2003: 605) fig. 2 (whole animal), figs 3A, 4 (distribution map).

Other significant references: Williams (1982: 230) fig. 8 (distribution map); Davie (2002b: 250) fig. page 249 (whole animal); Poore (2004: 316), fig. 9 (whole animal, dorsal), pl. 18d (colour photo, whole animal); Ng *et al.* (2008: 41).

Distribution: northern NZ (not known from Kermadecs); southwestern, southern and eastern Australia; shelf and slope.

Colour: white and purplish with red markings.

Section RANINOIDA De Haan, 1839

Family **RANINIDAE** De Haan, 1839

Subfamily LYREIDINAE Guinot, 1993

Lyreidus tridentatus De Haan, 1841

NZ references: Griffin (1970a: 94) fig. 1 (distribution map), figs 2–5, 6a,e,f,j–n,o, 7a–b, 8a–b,f–g, pl. 7A (photos, whole animal from Queensland); McLay (1988: 84) fig. 15a (whole animal), fig. 15b–e; Dawson & Yaldwyn (1994: 8) (bibliography); Takeda & Webber (2006: 192) fig. 1A (photo, whole young male, dorsal); Ah Yong (2008: 11) fig. 1E (photo, female), fig. 28F (colour photo, male).

Other significant references: Sakai (1976) pl. 21, fig. 2 (colour illustration, whole animal); Feldmann (1992: 945) fig. 1 (photos, whole male dorsal and ventral); Davie (2002b: 486) fig. page 486 (whole animal); Poore (2004: 322) fig. 94a (whole animal, dorsal) pl. 18e (colour photo, whole live animal, lateral); Ng *et al.* (2008: 42).

Distribution: Kermadec Islands, North Island south to Cape Campbell in northern South Island or possibly to Banks Peninsula, shelf and slope; western Pacific, Australia and New Caledonia to Japan.

Colour: body and appendages pinkish orange.

Subfamily RANINOIDINAE Lörenthey, 1929

Notosceles pepeke Dawson & Yaldwyn, 2000 (Fig. 9)

NZ reference: Dawson & Yaldwyn (2000: 54) fig. 1 (whole animal), figs 2–6.

Other significant reference: Ng *et al.* (2008: 42).

Distribution: endemic, northern NZ, Kermadec Islands; shelf and upper slope.

Section CYCLODORIPPOIDA Ortmann, 1892

Family **CYMONOMIDAE** Bouvier, 1897***Cyonomus aequilonius*** Dell, 1971

NZ references: Dell (1971: 59) figs 11–15; McLay (1988: 92) fig. 17; Ah Yong & Brown (2003: 1372); Ah Yong (2008: 12) fig. 1F (photo, whole animal).

Other significant reference: Ng *et al.* (2008: 32).

Distribution: endemic, one specimen from Bay of Plenty, 730 m.

Cyonomus bathamae Dell, 1971

NZ references: Dell (1971: 56) figs 1, 2 (whole male), figs 3, 4 (whole female), figs 5–10; McLay (1988: 88) fig. 16a (whole male), fig. 16b–c (whole female), fig. 16d.

Other significant reference: Ng *et al.* (2008: 32).

Distribution: endemic, southern NZ, Chatham Rise south to Otago; slope.

Cyonomus clarki Ah Yong, 2008

NZ reference: Ah Yong (2008: 13) fig. 1D (photo, whole animal, ovigerous female holotype), fig. 6A–D (whole animal and parts).

Distribution: endemic, northern Chatham Rise.

Section EUBRACHYURA de Saint Laurent, 1980

Subsection HETEROTREMATA Guinot, 1977

Superfamily AETHROIDEA Dana, 1851

Family **AETHRIDAE** Dana, 1851***Actaeomorpha erosa*** Miers, 1877

NZ references: Chilton (1911: 555); Takeda & Webber (2006: 198) fig. 5A (photo, male, dorsal).

Other significant references: Barnard (1950: 361) fig. 69a–b; Sakai (1976: 293) fig. 165 (whole animal); Ng *et al.* (2008: 44).

Distribution: Kermadec Islands on coral and dredged to 22 m; Indo-Pacific, from Natal and Mauritius to Western and northern Australia, Japan, Hawai'i; sandy bottoms near coral reefs.

Superfamily BELLIOIDEA Dana, 1852

Family BELLIIDAE Dana, 1852

***Heterozius rotundifrons* A. Milne-Edwards, 1867**

NZ references: Miller & Batt (1973: 74) fig. 93 (colour photo, live male and female); Dell (1974: 1244) (colour photo, whole female with egg mass); Guinot (1976: 28) figs 2D, 5J–K, 6J–L, 7D, 8D, 9D, 10D, 11C, 12E, 13G–I, pl. 1, figs 6–10 (photo, whole male); Jones (1978: 783) fig. 2a (whole male), fig. 2b–c (carapace outline female), fig. 2d; McLay (1988: 252) fig. 56a (whole male), fig. 56b; Walsby (1990: 124) (colour photos, live females).

Other significant references: Salva & Feldmann (2001: 18) fig. 13C–D (photos, whole animal dorsal and ventral); Ng *et al.* (2008: 46) fig. 23 (colour photo).

Distribution: endemic, North, South and Chatham islands (not known from Kermadecs); littoral and intertidal zones.

Colour: body and appendages pinkish to olive green, often coated with fine mud; cheliped fingers pale yellow, female egg mass bright red.

Superfamily BYTHOGRAEOIDEA Williams,

1980

Family BYTHOGRAEIDAE Williams,

1980

***Gandalfus puia* McLay, 2007**

NZ references: Clark & O'Shea (2001: 15), as *Bythograea* n. sp.; McLay (2007: 5) figs 1A–F, 2A–G (carapace and appendages), figs 3A–B, 4A–B (photos, male holotype dorsal and frontal), fig. 5A–D (photos, male gonopods); Ah Yong (2008: 26) fig. 5C (photo, holotype male, whole animal).

Other significant reference: Ng *et al.* (2008: 47).

Distribution: endemic, Kermadec Ridge from Bay of Plenty to Kermadec Islands.

Superfamily CALAPPOIDEA De Haan,

1833

Family CALAPPIDAE H. Milne Edwards,

1837

***Mursia microspina* Davie & Short, 1989**

NZ reference: McLay (2009: 360) fig. 16a–b (colour photos, female, dorsal, anterior), fig. 17a–b (colour photos, female ventral, dorsal), fig. 18a–b (colour photos, male, ventral, anterior).

Other significant references: Davie & Short (1989: 172) figs 9–10 (photo, whole animal); Galil (1993: 365) fig. 4e (photo, whole animal), figs 6h–i, 8e–f, 12 (colour photo, whole animal); Davie (2002b: 128); Ng *et al.* (2008: 49).

Distribution: northern NZ including Kermadec Islands, slope; eastern Australia, New Caledonia, Japan.

Colour: carapace and appendages light to medium peach colour; margin of buccal cavity with two orange-red spots; inner face of cheliped palms with strong red patch.

Superfamily CANCROIDEA Latreille,

1802

Family ATELECYCLIDAE Ortmann,

1893

***Pteropeltarion novaezelandiae* Dell, 1972**

NZ references: Dell (1972: 56) figs 1–9, 10–11 (photos, whole male dorsal and ventral); McLay 1988: 184, fig. 42a (whole female), fig. 42b–e; Guinot (1989: 350) pl. 5, fig. G (photo, whole male, incorrectly labelled *Trichopeltarion novaezelandiae*).

Other significant references: Salva & Feldmann (2001: 51) fig. 31A–B (photos, whole animal dorsal and ventral); Ng *et al.* (2008: 51).

Distribution: endemic, northern and southern NZ including Campbell Plateau (not known from Kermadecs), slope.

Colour: white in preservative.

***Trichopeltarion fantasticum* Richardson & Dell, 1964**

NZ references: Richardson & Dell (1964: 148) figs 1–10 (including carapace outlines of immature specimens), fig. 11 (whole male); Takeda & Miyake (1969: 163) pl. 3, fig. B (photo, whole male); Dell (1974: 1240) fig. 3 (colour photo, whole male); McLay (1988: 186) fig. 43a (whole male), fig. 43 b–d; Takeda (1990: 371) fig. 299 (colour photo, whole male); Ah Yong (2008: 16) fig. 5A (photo, male, whole animal), fig. 28C (colour photo, female, whole animal).

Other significant references: Salva & Feldmann (2001: 37) fig. 16A–F (photos, whole animals showing change in carapace shape with increasing size), fig. 17A (photo, whole mature male with enlarged cheliped), fig. 20A–B (photos, mature female dorsal and ventral); Ng *et al.* (2008: 51).

Distribution: endemic, northern and southern NZ including Chatham Rise (not known from Kermadecs); shelf and slope.

Colour: carapace and legs greyish white, hairs on legs yellowish orange, cornea reddish orange.

***Trichopeltarion janetae* Ahyong, 2008**

NZ references: Ahyong (2008: 17) fig. 7A–B (photos, male holotype, whole animal and carapace), fig. 8A–F (photos, holotype appendages), fig. 9A–E (photos, holotype anterior and female paratype), fig. 10A–B (photos, male paratype whole animal and female paratype whole animal), fig. 11A–C (holotype appendages); McLay (2009: 34) fig. 15 (colour photo, female whole animal).

Distribution: Bay of Plenty seamounts, Chatham Rise, Bollons Seamount; Tasmanian seamounts.

Family **CANCRIDAE** Latreille, 1802***Glebocarcinus amphioetus* (Rathbun, 1898)**

NZ material: found during a NIWA 2001–03 survey of alien invasive species in NZ ports. Probably accidentally introduced on Asian fishing boats; two size classes present, suggesting establishment and breeding, though no adults yet collected.

NZ references: McLay (2004: 21); Webber *et al.* (2010: 226).

Other significant references: Rathbun (1930: 205) pl. 91, figs 1–5 (photos, whole animals); Sakai (1976: 319) pl. 109, figs 1–8 (colour illustrations, whole animals); Nations (1979: 154) fig. 183 (use of subgenus *Glebocarcinus*), figs 2, 4 (distribution maps); Ng *et al.* (2008: 53).

Distribution: Gisborne and Bluff harbours; previously known from rocky beaches and shallow water of Japan and northern China, southern California, Baja California and Gulf of California, Mexico.

Colour: juveniles with various strongly contrasting carapace patterns of dark red, yellow and blue. Adult carapace mottled with dark green around areas of tubercles, chelipeds streaked with dark green and walking legs irregularly banded with dark green (Japanese specimens).

***Metacarcinus novaezealandiae* (Hombron & Jacquinot, 1846)**

NZ references: McNeill & Ward (1930: 377) pl. 61, figs 3–6 (photo, whole juveniles), fig. 7 (photo, whole male from Tasmania); Heath & Dell (1971: 40) fig. 112 (colour illustration, whole animal); Miller & Batt (1973: 73) fig. 90 (colour photo, whole animal); Nations (1979: 180, 184) (use of subgenus *Metacarcinus*), figs 6, 15 (distribution maps, misspelt as *Cancer novaezealandiae*); Powell (1987: 36) fig. 189 (whole animal), as *C. novaezealandiae*; McLay (1988) fig. 44a–b (whole male).

Other significant references: Davie (2002b: 133) fig. page 167 (whole animal); Poore (2004: 402) fig. 124a (whole

animal), pl. 22b (colour photo, whole animal); Ng *et al.* (2008: 53).

Distribution: northern and southern NZ including Chatham and Auckland islands (not known from Kermadecs), intertidal zone and shallow shelf; southeastern Australia and Tasmania (Poore 2004). Probably accidentally introduced to Australia from NZ with oysters (see Dartnall 1969 for discussion of introductions to Tasmania).

Colour: dark brown or dark red with darker rim around carapace margin, cheliped finger tips black, walking legs banded with red; juvenile crabs may be dark green with dark brown spots.

***Romaleon gibbosulum* (De Haan, 1835)**

NZ material: a new record for NZ in 2004, found during a NIWA survey of alien invasive species in NZ ports. Probably accidentally introduced on Asian fishing boats; two size classes present, suggesting establishment and breeding, though no adults yet collected.

NZ references: McLay (2004: 21); Webber *et al.* (2010: 226).

Other significant references: Sakai (1976: 318) pl. 108, figs 1–2 (colour illustrations, whole animals); Nations (1979: 154, 184) fig. 3 (distribution map) (use of subgenus *Romaleon*), as *Cancer (R.) gibbosulum* and incorrectly attributed to ‘Rathbun 1898’; Ng *et al.* (2008: 53).

Distribution: Wellington, Lyttelton and Timaru harbours; previously known from shallow water, Japan and northern China.

Colour: Juveniles with carapace mottled with green and yellow, walking legs banded with red on pale background. Adults with purplish-red patches around areas of tubercles, chelipeds and walking legs irregularly streaked and banded with red (Japanese specimens).

Note: between 1907 and 1914, a small-scale organised attempt was made to introduce the European edible crab *Cancer pagurus* Linnaeus, 1758 to NZ coastal waters. Live crabs were imported from the UK and kept in holding ponds at the Portobello Marine Fish-Hatchery and Biological Station in Otago Harbour. It was estimated that several million larvae were hatched out and liberated in the harbour over those years. Mature adults of both sexes were also liberated, but no trace of free-living European edible crabs have been found in Otago Harbour or in other NZ waters during or since the attempted introduction. A detailed account of this project is given in Thomson & Anderton (1921), including a photo of a whole *C. pagurus* on p. 49.

Superfamily DORIPPOIDEA MacLeay, 1838
Family **ETHUSIDAE** Guinot, 1977

Ethusina castro Ah Yong, 2008

NZ reference: Ah Yong (2008: 26) fig. 12A (photo, ovigerous holotype female), fig. 13A–B (photos, female holotype, anterior and ventral), fig. 14A–E (holotype female, parts), fig. 28A–B (colour photos, female holotype, dorsal, ventral).

Distribution: endemic, Gisborne Knolls northeast of New Zealand.

Ethusina rowdeni Ah Yong, 2008

NZ reference: Ah Yong (2008: 29) fig. 12B (photo, holotype male), fig. 13C–D (photos, male holotype, anterior and ventral), fig. 14F–L (holotype male, parts).

Distribution: endemic, Whakatane Seamount, eastern New Zealand.

Superfamily ERIPHIOIDEA MacLeay,
1838

Family **OZIIDAE** Dana, 1851

Bountiana norfolcensis (Grant & McCulloch, 1907)

NZ reference: Takeda & Webber (2006: 216) fig. 13A (photo, ovigerous female, dorsal).

Other significant references: Davie & Ng (2000: 267) fig. 1A–B (photos, male lectotype, dorsal and ventral), fig. 2A–B (photos, female, dorsal and frontal), figs 3A, 4A (photos, orbit and maxilliped 3), fig. 5 (male gonopods); Davie (2002b: 180) fig. page 179 (whole animal); Ng *et al.* (2008: 65).

Distribution: Kermadec Islands; New South Wales, Lord Howe Island, Norfolk Island.

Ozius truncatus H. Milne Edwards, 1834

NZ references: Chilton (1911: 556), as *Ozius lobatus*; Heath & Dell (1971: 40) fig. 114 (colour illustration, whole animal); Miller & Batt (1973: 73) fig. 91 (colour photo, whole animal); McLay (1988: 234) fig. 52a (whole male), fig. 52b–c; Takeda & Webber (2006: 216) fig. 13B (photo, male dorsal).

Other significant references: Hale (1927: 160) fig. 161 (whole animal); Davie (2002b: 182); Poore (2004: 452) fig. 145i (whole animal), pl. 24g (colour photo, whole animal from front); Ng *et al.* (2008: 65).

Distribution: northern NZ from Kermadec Islands south to about Cook Strait; Norfolk and Lord Howe islands, Western and southern Australia; intertidal zone.

Colour: body dark reddish brown above, paler below; both free and fixed fingers of chelae black, walking legs reddish brown with golden fringe of hairs.

Superfamily GONEPLACOIDEA
MacLeay, 1838

Family **GONEPLACIDAE** MacLeay, 1838
Subfamily GONEPLACINAE MacLeay, 1838

Goneplax marivenae Komatsu & Takeda, 2004

NZ reference: Takeda & Webber (2006: 221) fig. 16A (photo, male dorsal), as *Goneplax*.

Other significant references: Komatsu & Takeda (2004: 1244) figs 1a–k, 2a–f, 3a–e (carapace, abdomen, sternum and all appendages); Castro (2007: 693) fig. 28A (photo, female), fig. 29 (thoracic sternum), as *Goneplacoides marivenae*; Ng *et al.* (2008: 80).

Distribution: Kermadec Islands; Philippine Islands.

Neommatocarcinus huttoni (Filhol, 1886)

NZ references: Bennett (1964: 74) figs 79–83, 135 (photo, whole animal), as *Ommatocarcinus macgillivrayi*; Takeda & Miyake (1969: 175) figs 5–6, pl. 2, fig. A (photo, whole male); Jenkins (1975: 46) fig. 9, pl. 7, fig. 3a (photo, male carapace), figs 3b–c, 4a–b, as *Ommatocarcinus huttoni*; McLay (1988: 262) fig. 58a (whole male), fig. 58b; Takeda (1990: 375) fig. 303 (photo, whole animal), as *Ommatocarcinus huttoni*.

Other significant reference: Ng *et al.* (2008: 80).

Distribution: endemic, northern and southern NZ including Chatham Islands (not known from Kermadecs); shelf and slope.

Colour: McLay (1988: 262) regards *Neommatocarcinus huttoni* as ‘one of New Zealand’s most beautiful crabs’, in the sense of being ‘colourful’. He describes the colour as carapace yellowish vermillion, gastric region darker, white behind orbit and postero-lateral margins, gastro-cardiac boundary purple, infra-orbital lobe and anterior margin of buccal cavern brick red; chelipeds and walking legs mainly creamy white, cheliped merus brick red on upper border, proximal two-thirds of inside surface yellow, remainder of merus purple, cheliped carpus with purple outer surface, upper border of palm orange, upper border of walking leg meri purplish red, upper and lower borders of carpi and upper border of propodi pale purple.

Pycnoplax meridionalis (Rathbun, 1923)

NZ reference: Ah Yong (2008: 33) fig. 15A (photo, male), fig. 29A (colour photo, male).

Other significant references: Rathbun (1923: 99) pl. 18, fig. 1 (whole male), figs 2, 3 (photo, whole male ventral view), fig. 4 (photo, whole female ventral view); Davie (2002b: 194) fig. page 189 (whole animal), as *Carcinoplax*; Castro (2007: 669); Ng *et al.* (2008: 80), as *Carcinoplax*.

Distribution: northern NZ (not known from Kermadecs), upper slope; southeastern and southern Australia, shelf and upper slope.

Colour: body pale in preservative with most (in males) or at least distal half (in females) of both free and fixed fingers dark blackish brown (in contrast to *Pycnoplax victoriensis*).

***Pycnoplax victoriensis* (Rathbun, 1923)**

NZ references: Dell (1960: 4) pl. 1, lower (photo, whole animal); Takeda & Miyake (1969: 172); McLay (1988: 258) fig. 57a (whole male) fig. 57b–d; Takeda (1990: 374) fig. 302 (photo, whole animal); Ah Yong (2008: 34) fig. 15B (photo, female), fig. 29B (colour photo, male).

Other significant references: Rathbun (1923: 101) pl. 19, fig. 1 (whole male), figs 2, 3 (photo, whole male, ventral); Davie (2002b: 194), as *Carcinoplax*; Castro (2007: 671) fig. 18 (photo, female thoracic sternum); Ng *et al.* (2008: 80), as ‘*Carcinoplax*’.

Distribution: northern and southern NZ including Chatham Rise (not known from Kermadecs), outer shelf and slope; southeastern and southern Australia.

Colour: carapace and chelipeds pale pink with dark yellow along frontal margins; only tips (in contrast to *Pycnoplax meridionalis*) of both cheliped fingers pale blackish brown; walking legs creamy white, with distal parts of meri pink.

***Thyraplax truncata* Castro, 2007**

NZ reference: Ah Yong (2009a: 66) fig. 1A–C (whole female and parts), as *Thyraplax*.

Other significant reference: Castro (2007: 683) fig. 25A–D (male holotype carapace, abdomen, gonopods), fig. 26 (photo, male holotype).

Distribution: Kermadec Islands; Fiji, New Caledonia.

Family **MATHILDELLIDAE**

Karasawa & Kato, 2003

***Intesius richeri* Crosnier & Ng, 2004**

NZ reference: Ah Yong (2008: 42) fig. 15C–G (photos, female, cephalothorax dorsal, ventral, and chelae).

Other significant references: Crosnier & Ng (2004: 266) fig. 2 (colour photo, male holotype), fig. 3A (photo, front portion of carapace), figs 4A–B, 5A–D (abdomen and diagnostic appendages); Ng *et al.* (2008: 83).

Distribution: southern Kermadec Ridge, Norfolk Ridge.

***Mathildella mclayi* Ah Yong, 2008**

NZ reference: Ah Yong (2008: 43) figs 19–20 (photos, male, whole and parts), fig. 21 (male holotype, parts), fig. 29C (colour photo, whole female paratype).

Distribution: endemic, southern Kermadec Ridge.

***Neopilumnoplax nieli* Ah Yong, 2008**

NZ reference: Ah Yong (2008: 48) figs 22–23 (photos, male holotype, whole and parts), fig. 24 (male holotype, parts), fig. 29D (colour photo, whole male paratype).

Distribution: southern Kermadec Ridge to Chatham Rise, at cold seeps; southeastern and southwestern Australia.

Superfamily **LEUCOSIOIDEA**

Samouelle, 1819

Family **LEUCOSIIDAE** Samouelle,

1819

Subfamily **EBALIINAE** Stimpson, 1871

***Bellidilia cheesmani* (Filhol, 1886)**

NZ references: Bennett (1964: 20) figs 1–4, 107, as *Ebalia laevis*; Takeda & Miyake (1969: 161) figs 2a–c, as *Ebalia laevis*; McLay (1988: 94) fig. 18a (whole animal), fig. 18b–c, as *Ebalia laevis*; Takeda (1990: 364) fig. 292 (colour photo, whole animal), as *Ebalia laevis*; Tan (1995: 473) figs 2, 4e–f as *Dittosa cheesmani*; Ah Yong (2008: 38) fig. 17A–B (photos, male and ovigerous female).

Other significant reference: Ng *et al.* (2008: 89).

Distribution: endemic, North, South and Chatham islands (not known from Kermadecs); shelf and slope.

Colour: body and appendages pale with heavy mottling of red-brown, cornea black.

***Ebalia humilis* Takeda, 1977**

NZ reference: Komatsu & Takeda (2007: 61) fig. 1A (photo, ovigerous female dorsal).

Distribution: Kermadec Islands; Ogasawara Islands, Japan; 31–84 m.

***Ebalia jordani* Rathbun, 1906**

NZ reference: Komatsu & Takeda (2007: 62) fig. 1B (photo, female dorsal).

Distribution: Kermadec Islands; Hawai'i; 55–385 m.

***Ebalia tuberculosa* (A. Milne-Edwards, 1873)**

NZ references: Miers (1886: 306) pl. 25, figs 1, 1a (whole animal); Stephenson (1970: 193) fig. 1 (photo, whole animal); Ah Yong (2008: 38) fig. 17A–B (photos, male and female).

Other significant references: Barnard (1950: 368) fig. 70h–k; Davie (2002b: 260) fig. b on page 256 (whole animal); Poore (2004: 336) fig. 98e (whole animal); Ng *et al.* (2008: 90).

Distribution: northern NZ, south to western approaches to Cook Strait (not known from Kermadecs), outer shelf and slope; South Africa, Western, southern and eastern Australia, Hawai‘i.

***Ebalia webberi* Komatsu & Takeda, 2007**

NZ reference: Komatsu & Takeda (2007: 62) fig. 2A–B (photos, male holotype dorsal and ventral), fig. 3a–i (diagnostic characters).

Distribution: endemic, Kermadec Islands; 110–146 m.

***Merocryptus lambriformis* A. Milne-Edwards, 1873**

NZ references: Bennett (1964: 22) fig. 108 (photo, male and female, ventral); McLay (1988: 98) fig. 19a (whole animal), fig. 19b–c.

Other significant references: Rathbun (1923: 133) pl. 32, figs 2–3 (photos, whole male and female); Davie (2002b: 260); Poore (2004: 336) fig. 98f (whole animal), pl. 19e (colour photo, whole animal); Ng *et al.* (2008: 91).

Distribution: northern NZ (not known from Kermadecs), shelf and upper slope; western Pacific, southern and eastern Australia to Japan and Samoa.

Colour: mottled reddish purple (Australian specimen).

***Tanaoa distinctus* (Rathbun, 1894)**

NZ reference: Galil (2003: 402) fig. 1B (photo, whole animal), fig. 3C–D.

Other significant reference: Ng *et al.* (2008: 94).

Distribution: northern Kermadec Ridge, slope; western and central Pacific, from Wallis and Guam to Hawai‘i, Samoa and Society Islands.

Colour: NZ specimens recorded as orange-red in life.

***Tanaoa pustulosus* (Wood-Mason, 1891)**

NZ references: Yaldwyn & Dawson (1976: 95) fig. 2 (photo, whole animal), figs 3–5, as *Randallia pustulosa*; McLay (1988: 100) fig. 20 (whole animal), as *Randallia pustulosa*; McLay (2009: 25) figs 7–9 (colour photos, male, female, dorsal, anterior, ventral).

Other significant references: Doflein (1904: 42) pl. 14, figs 1–5 (photos, male and female whole animals, dorsal and ventral) but NOT fig. 6, as *Randallia pustulosa*; Chen (1989: 217) fig. 15a (whole immature male), fig. 15b–f, pl. 4, fig. 1 (photo, whole animal), as *Randallia pustulosa*; Galil (2003: 404) fig. 1D (photo, whole male), fig. 3G–H; Ng *et al.* (2008: 94).

Distribution: northern NZ (not known from Kermadecs), slope; Indo-West Pacific, from east Africa to Western Australia, Indonesia, Japan.

Colour: in preservative, NZ specimens have red tubercles on a pinkish-orange body.

Superfamily MAJOIDEA Samouelle, 1819

Family EPIALTIDAE MacLeay, 1838

Subfamily EPIALTINAE MacLeay, 1838

***Huenia heraldica* (De Haan, 1837)**

NZ references: Chilton (1911: 562) (one small specimen from Kermadec Islands, 22 m), as *Maja (Huenia) proteus*; Takeda & Webber (2006: 194) fig. 2A (photo, female).

Other significant references: Sakai (1976: 207) fig. 112a–c, pl. 71, figs 1–2 (colour illustrations, whole male and female); Griffin & Tranter (1986a: 84) fig. 24c–d; Davie (2002b: 284); Ng *et al.* (2008: 100).

Distribution: Kermadec Islands; western Pacific, from northwestern and eastern Australia to Indonesia and Japan; shallow water.

Colour: carapace and appendages pale, mottled with dark green (Japanese specimens).

Status: Chilton’s (1911a) record from the Kermadecs is not reviewed in Griffin & Tranter (1986a).

Subfamily PISINAE Dana, 1851

***Leptomaia tuberculata* Griffin & Tranter, 1986**

NZ references: Griffin & Tranter (1986a: 163) figs 32d–f, 54a–f; Davie (2002b: 325); Takeda & Webber (2006: 195) fig. 3C (photo, whole female).

Other significant reference: Ng *et al.* (2008: 103).

Distribution: Kermadec Islands, shallow shelf; Middleton Reef (Tasman Sea), Lord Howe Island.

***Oxypleurodon wanganella* Webber & Richer de Forges, 1995**

NZ reference: Webber & Richer de Forges (1995: 510) fig. 4C–E (photo, whole animal), figs 5A–B, 6A–C, fig. 7 left.

Other significant reference: Ng *et al.* (2008: 105).

Distribution: endemic, Wanganella Bank; slope.

***Rochinia abyongi* McLay, 2009**

NZ reference: McLay (2009: 30) fig. 12a–b (colour photos, male holotype, dorsal and ventral), fig. 13a–g (male holotype, carapace, abdomen, appendages).

Distribution: endemic, southern Kermadec Ridge.

***Rochinia riversandersoni* (Alcock, 1895)**

NZ references: Yaldwyn & Dawson (1976: 98) figs 6–9 (photos, female and male dorsal, female lateral, and male ventral); McLay (2009: 30) (indicates presence of *R. riversandersoni* at Kermadecs).

Other significant references: Griffin & Tranter (1986a: 175) (key to 29 Indo-West Pacific *Rochinia* spp.); Griffin & Tranter (1986b: 366) (key to 5 species of the *R. riversandersoni* group; NZ record named as *Rochinia* ‘Kermadec species’); Ng *et al.* (2008: 105).

Distribution: southern end of Three Kings Ridge, Kermadec Islands; slope. Distribution of *Rochinia riversandersoni sensu lato*, Indo-West Pacific, from east Africa to Philippines and South China Sea.

Family **HYMENOSOMATIDAE**

MacLeay, 1838

***Amarinus lacustris* (Chilton, 1882)**

NZ references: Melrose (1975: 84) fig. 41A (whole male), fig. 41B–K, as *Haliscarcinus lacustris*; Lucas (1980: 201) fig. 4D (carapace outline of female), figs 7B, 10E; Powell (1987: 32) fig. 173 (whole animal), as *H. lacustris*; McLay (1988: 345) fig. 72a (whole male), fig. 72b–d; Davie (2002b: 242); Poore (2004: 393) fig. 119b (carapace).

Other significant reference: Ng *et al.* (2008: 108).

Distribution: northern NZ mainland south to Hamilton (only freshwater crab in NZ); Norfolk and Lord Howe islands, southeastern Australia (Victoria, South Australia and Tasmania); freshwater lakes and streams.

Colour: brown or reddish brown.

***Elamena longirostris* Filhol, 1885**

NZ references: Takeda & Miyake (1969: 181) fig. 7a (carapace outline of female), fig. 7b–f; Melrose (1975: 93) fig. 45A (whole male), fig. 45B–C; McLay (1988: 350) fig. 73a (whole male), fig. 73b–d.

Other significant reference: Ng *et al.* (2008: 108).

Distribution: endemic, northern and southern NZ (not known from Kermadecs or Chathams); shallow coastal water and shelf.

Colour: general colour pale brown; carapace greyish brown, walking legs darker brown.

***Elamena momona* Melrose, 1975**

NZ references: Melrose (1975: 102) fig. 51A (whole male), figs 51B–G, 52; McLay (1988: 352) fig. 74a (whole male), fig. 74b–e.

Other significant reference: Ng *et al.* (2008: 108).

Distribution: endemic, northern and southern NZ (not known from Kermadecs or Chathams).

***Elamena producta* Kirk, 1878**

NZ references: Melrose (1975: 95) fig. 46A (whole male), fig. 46B–C (carapace outlines of immature males), fig. 46D–E (whole female), fig. 46F–I, figs 47–49, 50 (photos, live animals), pl. 1, fig. B (colour illustration, whole female); McLay (1988: 354) fig. 75a (whole male), fig. 75b–e.

Other significant references: Ng *et al.* (2008: 108); Teske *et al.* (2009: 28) (molecular sequence data testing relationships of some hymenosomatid genera).

Distribution: endemic, northern and southern NZ, Chatham Islands (not known from Kermadecs), intertidal rock pools (often reported from within shells of living paua *Haliotis iris*).

Colour: carapace varying from blackish brown to olive brown, red-brown, purple, cream (e.g. Melrose 1975: pl. 1, fig. B) or white, with varying symmetrical transverse streaks or circular patches of contrasting colour; striking white patches often present at base of last pair of walking legs (e.g. Melrose 1975: fig. 50c); chelipeds and walking legs purple with white bands and patches; cheliped fingers white distally, and walking leg dactyls with two white bands.

***Haliscarcinus cookii* Filhol, 1885**

NZ references: Melrose (1975: 44) figs 1–2 (carapace and abdomen with external anatomy labelled), figs 3–4 (mouthparts with morphological details labelled), fig. 16A (whole male), fig. 16B–H (whole female dorsal and ventral), fig. 16I–J, figs 17–18, 21 (photos, live animals), pl. 2, figs A–D, F (colour illustrations, whole males and females); McLay (1988: 358) fig. 76a (whole male), fig. 76b–e.

Other significant references: Ng *et al.* (2008: 108); Teske *et al.* (2009: 28) (molecular sequence data testing relationships of some hymenodomatid genera).

Distribution: endemic, northern and southern NZ, Chatham Islands (not known from Kermadecs); intertidal zone and shallow water.

Colour: carapace coloration varies greatly (e.g. Melrose 1975: pl. 2). In males, carapace is black or brown, usually with splotches of white, yellow, green or orange; in females, carapace ranges from white through yellow brown or reddish yellow to green or black with splotches or marks of contrasting colours; chelipeds and legs usually banded in both sexes.

***Halicarcinus innominatus* Richardson, 1949**

NZ references: Melrose (1975: 26) figs 5–7 (mouthparts with morphological details labelled), fig. 8A (whole male), fig. 8B–C (whole female, dorsal and ventral), figs 9–11, pl. 1, figs C–F (colour illustrations, whole females and males); Lucas (1980: 182); McLay (1988: 362) fig. 77a (whole male), fig. 77b–d; Davie (2002b: 245); Poore (2004: 394) fig. 120c (carapace).

Other significant references: Ng *et al.* (2008: 108); Teske *et al.* (2009: 28) (molecular sequence data testing relationships of some hymenosomatid genera).

Distribution: northern and southern NZ, Chatham Islands (not known from Kermadecs), intertidal zone, usually associated with the mussel *Perna*; Tasmania (probably accidentally introduced from NZ with oysters – see Dartnall 1969 for discussion of introductions to Tasmania).

Colour: light or dark brown; mature males usually dark brown, especially along central area of carapace, rest of carapace tinged with blue-grey, green or red (e.g. Melrose 1975: pl. 1, fig. D); females frequently with disruptive coloration of yellow, white or brown patches (e.g. Melrose 1975: pl. 1, fig. C).

***Halicarcinus planatus* (Fabricius, 1775)**

NZ references: Bennett (1964: 86) fig. 128 (photo, whole male from Kerguelen); Melrose (1975: 34) fig. 12A (carapace outline of male), figs 12B–F, 13; McLay (1988: 370) fig. 79a (carapace outline of male) fig. 79b–e; Davie (2002b: 246); Poore (2004: 395) fig. 121d (front and dorsal).

Other significant references: Garth (1958: 31) pl. 1, fig. 1 (photo, whole male dorsal and ventral from Chile); Richer de Forges (1977: 71) figs 1–5, 8 (photo, whole male dorsal and ventral from Kerguelen); Ng *et al.* (2008: 108).

Distribution: Auckland and Campbell islands, intertidal and shallow water; circum-subantarctic in southern Chile, Straits of Magellan, Falkland Islands, South Orkneys, and Prince Edward, Kerguelen and Macquarie islands.

Colour: slate blue, greyish brown or reddish brown with banded legs (Chilean specimens).

***Halicarcinus tongi* Melrose, 1975**

NZ references: Melrose (1975: 88) fig. 43A (whole male), fig. 43B (whole female), figs 43C–G, 44; McLay (1988: 374) fig. 80a (whole male), fig. 80b–d.

Other significant reference: Ng *et al.* (2008: 108).

Distribution: endemic, North Island and northern South

Island, Antipodes Islands (not known from Kermadecs nor Chathams), shelf and upper slope.

Colour: greyish brown or yellow-brown in preservative.

***Halicarcinus varius* (Dana, 1851)**

NZ references: Melrose (1975: 59) fig. 25A (whole male), figs 25B, 26A (whole female), figs 26B–E, 27–28, pl. 2, fig. E (colour illustration, whole female); McLay (1988: 376) fig. 81a (whole male), fig. 81b–d.

Other significant references: Ng *et al.* (2008: 108); Teske *et al.* (2009: 28) (molecular sequence data testing relationships of some hymenosomatid genera).

Distribution: endemic, northern and southern NZ, Chatham Islands (not known from Kermadecs); intertidal zone and shallow water.

Colour: carapace of large males predominantly dark brown, of smaller males and females pale green; cheliped fingers with red or orange band proximally and white tips, walking legs without bands; white or yellow blotches often present at base of last pair of legs.

***Halicarcinus whitei* (Miers, 1876)**

NZ references: Melrose (1975: 69) fig. 31A (whole male), figs 31B–E, 32, 33, 35 (photos, live animals), pl. 1, fig. A (colour illustration, whole immature male); McLay (1988: 380) fig. 82a (whole male), fig. 82b–d.

Other significant reference: Ng *et al.* (2008: 108).

Distribution: endemic, northern and southern NZ (not known from Kermadecs or Chathams); intertidal zone and shallow water.

Colour: carapace green, yellow, grey or brown, often speckled with white or black; dactyls of legs white distally, red band across cheliped fingers, dark bands sometimes present on walking legs. Carapace and chelipeds with felt of fine, dark hairs, increasing in density with crab size and maturity (e.g. Melrose 1975: fig. 35).

***Halimena aotearoa* Melrose, 1975**

NZ references: Melrose (1975: 106) fig. 53A (whole female), fig. 53B (whole immature male), figs 53C–J, 54; Lucas & Hicks (1981: 1) fig. 1; McLay (1988: 384) fig. 83a (whole immature male), fig. 83b–d.

Other significant reference: Ng *et al.* (2008: 108).

Distribution: endemic, northern and southern NZ (not known from Kermadecs or Chathams), sub-littoral zone and shallow water.

Colour: carapace reddish brown with pale brown or cream patches, red band across carapace at base of rostrum; tips of dactyls white.

***Hymenosoma depressum* Hombron & Jacquinot, 1846**

NZ references: Melrose (1975: 110) fig. 55A–B (whole female), fig. 55C (carapace outline of male), figs 55D, 56–58, as *Cyclohombromia depressa*; Lucas (1980: 166); McLay (1988: 386) fig. 84a (whole female), fig. 84b–d.

Other significant references: Ng *et al.* (2008: 109); Teske *et al.* (2009: 28) (molecular sequence data testing relationships of some hymenosomatid genera).

Distribution: endemic, northern and southern NZ, Auckland Islands (not known from Kermadecs or Chathams); intertidal zone and shallow water.

Colour: carapace and legs with pattern of black and yellow chromatophores, cheliped fingers black, walking leg dactyls orange or yellow.

***Neohymenicus pubescens* (Dana, 1851)**

NZ references: Melrose (1975: 77) fig. 36A (whole male), fig. 36B–C (whole female), figs 36D–F, 37–40 (photos, living animals), as *Halicarcinus pubescens*; Lucas (1980: 208); McLay (1988: 390) fig. 85a (whole male), fig. 85b–d.

Other significant references: Ng *et al.* (2008: 109); Teske *et al.* (2009: 28) (molecular sequence data testing relationships of some hymenodomatid genera).

Distribution: endemic, northern and southern NZ (not known from Kermadecs or Chathams); intertidal zone and shallow water.

Colour: grey-brown or yellow-brown.

Family **INACHIDAE** MacLeay, 1838***Achaeus akanensis* Sakai, 1938**

NZ reference: Griffin & Tranter (1986a: 5) figs 1a–f, 5a–b.

Other significant references: Davie (2002b: 290); Ng *et al.* (2008: 110).

Distribution: Kermadec Islands (one record from *Galathea* expedition, 60 m); western Pacific, northern Australia, Indonesia, Philippines, Japan.

***Achaeus curvirostris* (A. Milne-Edwards, 1873)**

NZ references: Griffin (1965: 38) text figs 1–8 (whole animal and diagnostic characters), as *A. fissifrons*; Griffin (1966: 38) fig. 5.1–8 (including whole animal), fig. 19.3–4, as *A. fissifrons*; Griffin & Tranter (1986a: 9); McLay (1988: 118) fig. 26a (whole animal), fig. 26b–c; Takeda & Webber (2006: 192) fig. 1B (photo, male).

Other significant references: Davie (2002b: 291); Poore (2004: 358) fig. 106a (whole animal); Ng *et al.* (2008: 110).

Distribution: northern and central NZ, south to Farewell Spit, Kermadec Islands, shelf; Indo-West Pacific from east Africa to Australia, Philippines and Japan.

***Achaeus kermadecensis* Webber & Takeda, 2005**

NZ reference: Webber & Takeda (2005: 45) fig. 1a (whole animal, dorsal), fig. 1b (cephalothorax, dorsal), fig. 1c (cephalothorax and abdomen, ventral).

Other significant reference: Ng *et al.* (2008: 110).

Distribution: endemic, Raoul Island (Kermadec Islands); 100 m+.

***Cyrtomaia cornuta* Richer de Forges & Guinot, 1988**

NZ references: Webber & Richer de Forges (1995: 509); Ahyong (2008: 35) fig. 16A (photo, male cephalothorax, dorsal).

Other significant references: Richer de Forges & Guinot (1988: 44) figs 3A–C, pl. 2a (photo, whole animal), pls b–c; Ng *et al.* (2008: 110).

Distribution: northern North Island (not known from Kermadecs), slope; northern Norfolk Ridge (south of New Caledonia).

***Cyrtomaia lamellata* Rathbun, 1906**

NZ references: Guinot & Richer de Forges (1982: 69) figs 45, 46, 49A (photo, whole animal), figs 49B,F, 52B, as *C. hispida*; Griffin & Tranter (1986a: 26); McLay (1988: 104) fig. 22a (whole animal), fig. 22b–d; Takeda & Webber (2006: 194) fig. 1C (photo, young male).

Other significant reference: Ng *et al.* (2008: 111).

Distribution: northern and southern NZ (not known from Kermadecs), shelf; northern and western Pacific, from Hawai'i to Japan, Indonesia and New Caledonia.

***Dorhynchus ramusculus* (Baker, 1906)**

NZ references: Griffin (1966) fig. 4.1–6 (including whole animal); Griffin & Tranter (1986a: 21); McLay (1988: 116) fig. 25a (whole animal), fig. 25b–d; Davie (2002b: 293); Ahyong (2008: 36) fig. 16B–C (photos, cephalothorax, lateral and dorsal); McLay (2009: 26) fig. 10a–b (colour photos, male, dorsal and ventral).

Other significant references: Poore (2004: 360) fig. 108j (anterior region, ventral); Ng *et al.* (2008: 111).

Distribution: northern NZ, slope; southern Australia.

***Platymaia maoria* Dell, 1963**

NZ references: Dell (1963b: 248) fig. 4 (whole animal), figs 5–13; McLay (1988: 108) fig. 23a (whole animal), fig. 23b–d; Takeda (1990: 365) fig. 293 (colour photo, whole animal); Ahyong (2008: 37) fig. 16D (photo, female cephalothorax, dorsal).

Other significant references: Griffin & Tranter (1986a: 46) fig. 10g–h, pl. 5a; Davie (2002b: 296); Poore (2004: 364) fig. 109e–f (front dorsal, lateral); Ng *et al.* (2008: 112).

Distribution: northern NZ including Challenger Plateau (not known from Kermadecs); eastern Australia; slope.

Colour: carapace pale pinkish red, walking legs pale with a broad red band on carpus and merus.

***Platymaia wyvillethomsoni* Miers, 1886**

NZ reference: Takeda & Webber (2006: 194) fig. 1d (photo, carapace).

Other significant references: Griffin & Tranter (1986a: 47) fig. 10c–d, pl. 5b; Davie (2002b: 297); Poore (2004: 364) fig. 107c (whole animal), fig. 109g–i (front dorsal, lateral and orbit) (includes *Platymaia* aff. *wyvillethomsoni* Miers, 1886 in the fauna of southern Australia); Ng *et al.* (2008: 112).

Distribution: Kermadec Islands (not known from mainland New Zealand); Japan, Philippines, Indonesia and, probably, South Australia.

***Trichoplatus buttoni* A. Milne-Edwards, 1876**

NZ references: Griffin (1966: 30) fig. 3.1–9 (including whole animal), fig. 19.1–2, as *Naxia buttoni*; Griffin & Tranter (1986a: 61); McLay (1988: 130) fig. 30a (whole animal), fig. 30b.

Other significant reference: Ng *et al.* (2008: 112).

Distribution: endemic, North, South and Chatham islands (not known from Kermadecs); low-tide level to about 60 m.

***Vitjazmaia latidactyla* Zarenkov, 1994**

NZ references: Webber & Richer de Forges (1995: 503) figs 1–2, 3A (photo, whole animal), figs 3B–C, 4A; Poore (2004: 365) fig. 109j (front dorsal); Ah Yong (2008: 37) fig. 16E (photo, female cephalothorax, dorsal).

Other significant reference: Ng *et al.* (2008: 112).

Distribution: Wanganella Bank, northern and central NZ including Challenger Plateau, Chatham Rise and Chatham Islands (not known from Kermadecs), slope to at least 1290 m (one of the deepest majids known, but see *Teratomaia richardsoni* in list below recorded from c. 7000 m); western Indian Ocean, southern and eastern Australia, Lord Howe Rise.

Colour: spines of rostrum and carapace bright red-orange, remainder of carapace, female abdomen and most dorsal surfaces of legs unpigmented; male abdomen, sternum and tips of cheliped fingers light orange-red; 3rd to 5th walking legs with carpus, propodus and dactyl light red-

orange dorsally, strongly red-orange ventrally. Freshly caught animals are often dun (grey-brown) overall due to a covering of fine silt caught amongst the small setae of the carapace and legs (*vide* Webber & Richer de Forges 1995).

Family **INACHOIDIDAE** Dana, 1851

***Pyromaia tuberculata* (Lockington, 1877)**

NZ references: Webber & Wear (1981: 370) figs 209–210 (whole zoea, one lateral and posterior), figs 211–217; McLay (1988: 112) fig. 24 (whole animal); McLay (2004: 21); McLay (2009: 29) fig. 11 (colour photo, female); Poore (2004: 366) fig. 110 (whole animal), pl. 20c (colour photo, whole animal).

Other significant references: Rathbun (1925: 133) pl. 10, fig. 3 (photo, whole female), pl. 218, fig. 104 (whole male and diagnostic characters); Garth (1958: 85) pl. E, fig. 7, pl. 6, fig. 1 (photo, whole animal); Sakai (1971: 142) fig. 4 (whole male), fig. 5 (male anterior pleopods); Sakai (1976: 168) fig. 92a (whole animal), fig. 92b, pl. 51, fig. 2 (colour illustration, whole animal); Davie (2002b: 300) fig. page 299 (whole animal); Ng *et al.* (2008: 115).

Distribution: accidentally introduced to NZ (possibly on ships from Japan) and established in Waitemata and Whangarei harbours and Firth of Thames; accidentally introduced to Western Australia (probably from Japan) and to Japan (probably from western North America); possibly accidentally introduced from southern Brazil to Argentine continental shelf of western Atlantic; natural range northern California to Pacific coast of Colombia, shallow water and shelf.

Colour: body and appendages pale with greenish-blue markings (Japanese specimens).

Family **MAJIDAE** Samouelle, 1819

Subfamily **EURYNOLAMBRINAE**

Števc̆ić, 1994

***Eurynolambrus australis* H. Milne Edwards & Lucas, 1841**

NZ references: Krefft (1952: 574) figs 1–12 (including carapace outlines of juvenile and adult crabs); Griffin (1966: 46) fig. 8.1–8 (including whole male); Miller & Batt (1973: 73) fig. 92 (colour photo, whole animal); Dell (1974: 1240) fig. (colour photo, whole animal); Griffin & Tranter (1986a: 104, 116); McLay (1988: 124) fig. 28a (whole male), fig. 28b–c.

Other significant reference: Ng *et al.* (2008: 116).

Distribution: endemic, northern and southern NZ, Chatham Islands (not known from Kermadec or Subantarctic islands); intertidal zone and inner shelf.

Colour: carapace orange or purplish red, flecked with white; legs mottled red with white markings, cheliped fingers purple with inner edge of fixed finger and tip of free finger white.

Subfamily MAJINAE Samouelle, 1819

Eurynome bituberculata Griffin, 1964

NZ references: Griffin (1966: 43) figs 6.1–5, 7.1–4 (including whole male), fig. 20.1–2; McLay (1988: 102) fig. 21a (whole animal), fig. 21b–e; Ah Yong (2008: 40) fig. 18A (photo, whole animal).

Other significant reference: Ng *et al.* (2008: 116).

Distribution: endemic, North Island (not known from Kermadecs), outer shelf.

Colour: carapace and appendages salmon pink, tubercles white.

Jacquinotia edwardsii (Jacquinot, 1853)

NZ references: Griffin (1963: 237) figs 1–3, 4 (whole juvenile crab) (juveniles originally described as *Campbellia kohli* Balss); Griffin (1966: 86) fig. 18.1–10 (including whole male), fig. 23.5–6; Dell (1974: 1237) fig. (colour photo, whole animal); McLay (1988: 176) fig. 41a (whole male), fig. 41b–d; Takeda (1990: 369) fig. 297 (colour photo, whole male).

Other significant reference: Ng *et al.* (2008: 116).

Distribution: endemic, southern NZ (northern limit Kaikoura) including Chatham and Subantarctic islands; intertidal zone and shallow water at Subantarctic Islands, ranging down to upper slope at more northerly latitudes.

Colour: carapace orange-red; chelipeds and walking legs orange-red to yellowish white with large red blotches on upper surface of cheliped palm and merus; walking legs with irregular bright red band on merus, scattered red patches on other segments and with dactyl tips black.

Leptomithrax australis (Jacquinot, 1853)

NZ references: Griffin (1966: 66) figs 13.1–8 (including whole male), figs 14.7–10, 14.15–17, fig. 22.3–4; Webb (1972: 31) pls 17–18 (photos, whole female and male); Griffin & Tranter (1986a: 208) (key to all 13 known *Leptomithrax* spp.); McLay (1988: 148) fig. 34a (whole male), fig. 34b–d.

Other significant reference: Ng *et al.* (2008: 117).

Distribution: endemic, southern NZ (Cook Strait south

including Chatham and Subantarctic islands, intertidal zone to mid-shelf.

Colour: carapace orange-red to dark red; cheliped palm (especially in males, see Webb 1972: pl. 18) with a characteristic white pattern in the form of an irregular network on a red background (this white pattern is structural and does not disappear after preservation), fingers white; walking legs pale with some orange red markings.

Leptomithrax garricki Griffin, 1966

NZ references: Griffin (1966: 69) figs 14.11–12, 14.18–20, 22.5–6, pl. 1 (photos, whole male, dorsal and ventral), pl. 2 (photos, whole female, dorsal and ventral); Takeda & Miyake (1969: 185) pl. 3, fig. A (photo, whole male); Dell (1974: 1239) (photo, whole male, ventral); McLay (1988: 152) fig. 35a (whole male), fig. 35b–g; Takeda (1990: 367) fig. 295 (photo, whole animal); Ah Yong (2008: 42) fig. 18B (photo, whole animal).

Other significant reference: Ng *et al.* (2008: 117).

Distribution: endemic, central NZ and Chatham Rise, outer shelf and slope.

Colour: carapace yellowish brown to greenish white, mottled with bright red; cheliped with orange tubercles and bright red markings on palm; walking legs with irregular orange markings.

Leptomithrax longimanus (Miers, 1876)

NZ references: Griffin (1966: 62) fig. 12.1–7 (including whole male), figs 14.1–6, 14.13–14, 22.1–2; McLay (1988: 156) fig. 36a (whole animal), fig. 36b–d.

Other significant reference: Ng *et al.* (2008: 117).

Distribution: northern and southern NZ (not known from Kermadecs); intertidal zone to shelf and slope; Middleton Reef (north of Lord Howe Island).

Colour: carapace and walking legs yellowish brown, chelipeds in adult male dark brown with yellowish markings on palm.

Leptomithrax longipes (Thomson, 1902)

NZ references: Chilton (1911b: 289) pl. LVIII, figs 1–3 (photos, specimens with *Balanus decorus* on carapaces); Bennett (1964: 54) figs 35, 49, 50 (showing distinctive white swelling on outer face of 3rd maxilliped), figs 51, 121 (photo, whole male); Griffin (1966: 75) fig. 15.1–12 (including whole male), fig. 23.1–2, frontispiece (photo, whole male); McLay (1988: 160) fig. 37a (whole male), fig. 37b–d; Takeda (1990: 366) fig. 294 (colour photo, whole male); O'Shea *et al.* (1999: 50) fig. 19 (colour photo, whole male).

Other significant reference: Ng *et al.* (2008: 117).

Distribution: northern and southern NZ and Chatham Rise (not known from Kermadecs), Macquarie Island; shelf and slope.

Colour: carapace and legs (except for cheliped hands) pale yellowish white, mottled with bright red; hands white with prominent, irregularly oval, bright red patch on inside of palm; walking legs with red-banded segments; distinctive white swelling on each 3rd maxilliped (see Dell 1963a: 31–32) can be used to confirm specific identification.

***Leptomithrax tuberculatus mortenseni* Bennett, 1964**

NZ references: Bennett (1964: 52) figs 36, 46–48, 119–120 (photo, whole male dorsal and ventral), as *Leptomithrax* (*Australomithrax*) *mortenseni*; Griffin (1966: 73) fig. 20.3–4, as *Leptomithrax* (*Austromithrax*) *mortenseni*; McLay (1988: 166) fig. 38a (outline whole animal), fig. 38b–e.

Distribution: endemic, northern NZ and Kermadec Islands; inner shelf. *Leptomithrax t. tuberculatus* (Whitelegge, 1900) is known from southeastern Australia.

***Naxia spinosa* (Hess, 1865)**

NZ references: Chilton (1911: 562), as *Halimus spinosus*; Griffin & Tranter (1986a: 219) figs 74e–f, 75e–f; Takeda & Webber (2006: 196) fig. 2C–D (photos, male with camouflage, and cleared of camouflage).

Other significant references: Hale (1927: 127) fig. 125 (photo, whole animal); Poore (2004: 375) fig. 115e–f (left anterior, dorsal and ventral), fig. 116c (maxilliped 3); Ng *et al.* (2008: 117).

Distribution: Kermadec Islands, intertidal zone; southwestern, southern and southeastern Australia, littoral zone.

***Notomithrax minor* (Filhol, 1885)**

NZ references: Borradaile (1916: 105) fig. 15 (whole juvenile as *Paramithrax parvus*); Griffin (1966: 53) fig. 10.1–12 (including whole male), fig. 21.3–4; Griffin & Tranter (1986a: 220) (key to all four known *Notomithrax* species); McLay (1988: 134) fig. 31a (whole male), fig. 31b–d; Davie (2002b: 307); Poore (2004: 376) fig. 113e (carapace), pl. 21c (colour photo, whole animal with camouflage).

Other significant reference: Ng *et al.* (2008: 117).

Distribution: northern and southern NZ (not known from Kermadecs), intertidal zone and shallow shelf, most often found in harbours; southeastern Australia including Tasmania.

Colour: body and appendages pale yellowish; upper surfaces of chelae dark red or purple, tips of fingers white; carapace

and walking legs thickly covered with brownish hairs. Individuals often with attached green or red algae, or attached sponges.

***Notomithrax peronii* (H. Milne Edwards, 1834)**

NZ references: Griffin (1966: 50) fig. 9.1–12 (including whole male), fig. 21.1–2; McLay (1988: 138) fig. 32a (whole male), fig. 32b–d.

Other significant reference: Ng *et al.* (2008: 117).

Distribution: endemic, northern and southern NZ, Chatham Islands (not known from Kermadecs); intertidal zone and inner shelf.

Colour: chelipeds greenish brown, tips of fingers white, carapace and walking legs with brownish hairs. Individuals often covered with attached green or red algae.

***Notomithrax spinosus* (Miers, 1879)**

NZ references: Griffin & Tranter (1986a: 221) figs 73e–g, 76a–d (including male carapace); Takeda & Webber (2006: 196) fig. 2B (photo, male).

Other significant references: Miers (1879: 9) pl. 4, fig. 5 (whole animal as *Paramithrax spinosus*); Ng *et al.* (2008: 117).

Distribution: Kermadec Islands (two records from *Galathea* expedition); Norfolk Island; shelf.

***Notomithrax ursus* (Herbst, 1788)**

NZ references: Griffin (1966: 57) fig. 11.1–12 (including whole male), fig. 21.5–6; Heath & Dell (1971: 38) fig. 107 (colour illustration, whole animal); McLay (1988: 142) fig. 33a (whole male), fig. 33b–d; Davie (2002b: 307); Poore (2004: 376) fig. 113f (carapace), pl. 21d (colour photo, whole animal).

Other significant reference: Ng *et al.* (2008: 117).

Distribution: northern and southern NZ, Chatham Islands (not known from Kermadecs); southeastern Australia; intertidal zone and inner shelf.

Colour: chelipeds orange to dark red, upper surface of cheliped palm with irregular white mark or cluster of irregular white marks, tips of fingers white; sternum and base of legs often dark blue with bilaterally symmetrical white markings; carapace and walking legs with brownish hairs. Individuals often covered with attached green, red or brown algae.

***Prismatopus filholi* (A. Milne-Edwards, 1876)**

NZ references: Dell (1960: 2) figs 1, 4–6, pl. 1 (photo, whole animal), as *Acanthophrys filholi*; Griffin (1966: 82) fig. 17.1–12 (including whole male), fig. 20.5–6, as *Chlorinoides filholi*; Griffin & Tranter (1986a: 253) (key to all 12 known *Thacanophrys* spp.); McLay (1988: 172)

fig. 40a (whole male), fig. 40b–d; Takeda (1990: 370) fig. 298 (colour photo, whole male).

Other significant reference: Ng *et al.* (2008: 118).

Distribution: endemic, northern and southern NZ, Chatham Islands, Subantarctic Islands (not known from Kermadecs); shelf and slope.

Colour: body and appendages reddish orange, cheliped fingers mainly pale.

***Prismatopus goldsboroughi* (Rathbun, 1906)**

NZ references: Griffin & Tranter (1986a: 257) fig. 92c, as *Thacanophrys goldsboroughi*; Takeda & Webber (2006: 197) fig. 3B (photo, male), as *Thacanophrys goldsboroughi*.

Other significant references: Griffin (1970b: 67) figs 1a, 2a–g, 4b,c,f, as *Chlorinooides goldsboroughi*; Davie (2002b: 309); Poore (2004: 379) fig. 113i (carapace); Ng *et al.* (2008: 118).

Distribution: Kermadec Islands (several specimens from *Galathea* expedition); southeastern Australia, Hawai'i; shelf.

***Schizophroidea hilensis* (Rathbun, 1906)**

NZ references: Chilton (1911: 562), as *Schizophrys hilensis*; Griffin & Tranter (1986a: 238) fig. 68c–d, pl. 19 (photos, whole male dorsal and ventral); Takeda & Webber (2006: 196) fig. 3A (photo, female).

Other significant references: Sakai (1976: 245) pl. 89, fig. 2 (colour illustration, whole animal), as *S. manazuruana*; Davie (2002b: 311); Poore (2004: 380) fig. 114c (carapace); Ng *et al.* (2008: 118).

Distribution: Kermadec Islands, intertidal zone and shallow water; eastern Australia, New Caledonia, Lord Howe Island, Japan, Hawai'i.

Colour: body and appendages pink patterned with red (Japanese specimen).

***Teratomaia richardsoni* (Dell, 1960)**

NZ references: Dell (1960: 2) pl. 2, fig. 3 (photos, whole immature female, dorsal and ventral), as *Leptomithrax richardsoni*; Griffin (1966: 79) figs 16.1–7, 23.3–4, pls 3–4 (photos, whole mature male and female, dorsal and ventral), as *Leptomithrax richardsoni*; Griffin & Tranter (1986b: 368) fig. 14 (photo, whole immature female from Tasmania (note: *Galathea* station 651, Kermadec Trench, is 32°10'S, 177°14'W, not E as stated on page 368) at c. 7000 m, see Bruun 1957: 45); McLay (1988: 170) fig. 39a (whole immature female), fig. 39b–f; Takeda (1990: 368) fig. 296 (colour photo, whole animal with

covering of mud on carapace and most of legs); O'Shea *et al.* (1999: 50) fig. 20 (colour photo, whole male).

Other significant reference: Ng *et al.* (2008: 118).

Distribution: Kermadec Trench, Challenger Plateau, Chatham Rise, Campbell and Bounty plateaus, slope down to c. 7000 m (deepest majid known); Tasmanian slope.

Colour: carapace yellowish white; chelipeds and walking legs yellowish white, mottled with red.

Superfamily PALICOIDEA Bouvier, 1898

Family PALICIDAE Bouvier, 1898

***Pseudopalicus declivis* Castro, 2000**

NZ material: one specimen in NIWA from Wanganella Bank.

NZ reference: Webber *et al.* (2010: 227).

Other significant references: Castro (2000: 458) fig. 5c (photo, whole female), fig. 6 (including carapace outline), fig. 55 (distribution map); Ng *et al.* (2008: 128).

Distribution: Wanganella Bank; New Caledonia, Banda Sea, South China Sea; upper slope.

***Pseudopalicus oahuensis* (Rathbun, 1906)**

NZ reference: Takeda & Webber (2006: 223) fig. 16B (photo, female with legs detached).

Other significant references: Davie (2002b: 371); Ng *et al.* (2008: 128) fig. 97 (colour photo, whole animal).

Distribution: Kermadec Islands; Hawai'i, Taiwan to Banda Sea, Coral Sea, Chesterfield Bank, French Polynesia.

***Pseudopalicus undulatus* Castro, 2000**

NZ reference: McLay (2009: 33) fig. 14a–b (colour photos, female, dorsal and frontal).

Other significant references: Castro (2000: 483) fig. 12f (photo, male paratype), fig. 14a–e (carapace and other diagnostic characters), fig. 53 (distribution map); Ng *et al.* (2008: 128).

Distribution: east of North Cape; western Pacific from Fiji to Japan.

Superfamily PARTHENOPOIDEA

MacLeay, 1838

Family PARTHENOPIDAE MacLeay, 1838

Subfamily PARTHENOPINAE MacLeay, 1838

***Garthambrus allisoni* (Garth, 1992)**

NZ references: Takeda & Webber (2007: 147) fig. 1 (photo, female carapace), as *Platylambrus*; McLay & Tan (2009: 11) fig. 5C–D (gonopods), fig. 9B (photo, whole female).

Other significant references: Garth (1992: 790) fig. 5 (male holotype, whole animal, abdomen and appendages); Ng *et al.* (2008: 130).

Distribution: Kermadec Islands (southwest Pacific) to Easter Island (southeastern Pacific).

***Garthambrus tani* Ah Yong, 2008**

NZ references: Clark & O'Shea (2001: 15), as 'the bizarre parthenopid *Tutankhamen*, also newly reported from New Zealand waters'; Ah Yong (2008) figs 25A–B, 26A–F (photos, male holotype, whole animal, various views, and chelae), fig. 27A–H (abdomens and appendages); McLay & Tan (2009: 22) fig. 8A–B (gonopods), fig. 14A–C (photos, male, whole animal, anterior and lateral carapace).

Distribution: northeast of New Zealand on Tumokemoke Seamount and Kermadec Islands; New Caledonia.

***Platylambrus constrictus* (Takeda & Webber, 2007)**

NZ reference: Takeda & Webber (2007: 148) fig. 2A (whole male, dorsal), fig. 2B (whole male, ventral), fig. 3A–F, as *Pseudolambrus*.

Distribution: endemic, Kermadec Islands.

Superfamily PILUMNOIDEA Samouelle, 1819

Family PILUMNIDAE Samouelle, 1819

Subfamily PILUMNINAE Samouelle, 1819

***Actumnus griffini* Takeda & Webber, 2006**

NZ reference: Takeda & Webber (2006: 218) fig. 14 (photos, male holotype, dorsal, ventral and frontal).

Other significant reference: Ng *et al.* (2008: 139).

Distribution: endemic, Kermadec Islands.

***Heteropilumnus fimbriatus* (H. Milne Edwards, 1834)**

NZ references: Chilton (1911: 557), as *Pilumnus*; Takeda & Webber (2006: 233), as *Pilumnus*.

Other significant references: Davie (2002b: 425); Poore (2004: 458) fig. 147a (carapace and right-side pereopods), pl. 25e (colour photo, whole animal).

Distribution: Kermadec Islands; eastern Australia from Queensland to Tasmania; intertidal zone to shallow shelf.

***Pilumnopus serratifrons* (Kinahan, 1856)**

NZ references: Dell (1968: 19) figs 1–4, pl. 3 (photo, whole male); McLay (1988: 240) fig. 53a–b (whole male, dorsal and frontal); Davie (1989: 138) figs 5A–I, 6 (photo, whole male, frontal and dorsal); Davie (2002b: 414); Poore (2004: 452) fig. 145i (whole animal), pl. 24g (colour photo, anterior).

Other significant references: Hale (1927: 161) fig. 162 (photo, whole animal), as *Heteropanope serratifrons*; Ng *et al.* (2008: 140).

Distribution: from northernmost NZ, south to Auckland (not known from Kermadecs), under stones etc. on muddy intertidal areas; southern and eastern Australia.

Colour: carapace brown, cheliped fingers dark brown, walking legs reddish brown; colour often obscured by muddy sediment.

***Pilumnus lumpinus* Bennett, 1964**

NZ references: Bennett (1964: 72) figs 69, 76–78, 134 (photo, whole male); McLay (1988: 244) fig. 54a (whole male), fig. 54b–e; Walsby (1990: 122), fig. (colour photo, whole animal).

Other significant reference: Ng *et al.* (2008: 142).

Distribution: endemic, North Island and northern South Island south to Banks Peninsula, Chatham Islands (not known from Kermadecs); intertidal zone and shallow water.

Colour: body and appendages covered with a short mat of yellowish setae, usually coated in muddy sediment; cheliped fingers dark brown or black.

***Pilumnus novaezealandiae* Filhol, 1885**

NZ references: Borradaile (1916: 99) fig. 10a (whole male), fig. 10b, as *Pilumnus maori*; Bennett (1964: 70) figs 70, 73 (carapace outline of whole animal), figs 74–75, fig. 133 (photo, whole animal); McLay (1988: 248) fig. 55a (whole male), fig. 55b–d; Walsby (1990: 122) (colour photo, whole animal); Takeda & Webber (2006: 218) fig. 15a–b (photos, juvenile, dorsal and ventral).

Other significant reference: Ng *et al.* (2008: 142).

Distribution: endemic, North, South and Chatham islands (not known from Kermadecs); intertidal zone and inner shelf.

Colour: body and appendages covered with a mixture of long and short setae, giving an irregular bristly appearance; cheliped fingers black.

Superfamily PORTUNOIDEA

Rafinesque, 1815

Family CARCINIDAE MacLeay, 1838

Subfamily POLYBIINAE Ortmann, 1893

***Liocarcinus corrugatus* (Pennant, 1777)**

NZ references: Borradaile (1916: 97) fig. 9a (whole female), fig. 9b, as *Portunus corrugatus*; Stephenson (1972: 23), as *Macropipus*; McLay (1988: 216) fig. 48a (whole male),

fig. 48b–d; Takeda & Webber (2006: 200) fig. 5B (photo, juvenile); McLay (2009: 43) fig. 21a–b (colour photos, male, female).

Other significant references: Stephenson & Campbell (1960: 92) figs 1E, 2G, pl. 2, fig. 4 (whole animal), pl. 5, fig. G, as *Macropipus corrugatus*; Ingle (1980: 94) fig. 36 (carapace outline of female), pl. 9, fig. a (photo, whole male); Davie (2002b: 459); Poore (2004: 413) fig. 130a (whole animal), pl. 22, figs f–g (colour photos, individual and mating group); Ng *et al.* (2008: 149).

Distribution: northern NZ including the Kermadecs, tidal flats and shelf; North Atlantic, Mediterranean, Indo-West Pacific from Red Sea to Australia and Japan.

Colour: variable colour patterns, ranging from white to mottled grey and white, to grey, sometimes with a white stripe down middle of carapace; chelipeds and walking leg dactyls with a red band.

***Ovalipes catharus* (White, 1843)**

NZ references: Chilton (1911: 554), as *O. bipustulatus*; Stephenson & Rees (1968: 224) figs 1c, 2c, 3c, 4c, pl. 36A (photo, whole animal), pls 38E–F, 42C; Stephenson (1972: 23); Miller & Batt (1973: 116) fig. 112 (colour photo, whole animal); Dell (1974: 1242) fig. (photo, whole animal); Powell (1987: 35) fig. 187 (whole animal); McLay (1988: 200) fig. 45a (whole male), fig. 45b–d; Walsby (1990: 121) fig. (photo, whole female ventral view with orange egg mass); Davie (2002b: 460); Poore (2004: 416) fig. 131b (carapace front outline); McLay (2009) fig. 20b (colour photo, female).

Other significant reference: Ng *et al.* (2008: 150).

Distribution: northern and southern NZ including Chatham Islands (not known from Kermadec or Subantarctic islands), surf zone and shelf; southern Australia (Victoria and South Australia).

Colour: carapace pale orange background densely covered with dark red-brown dots concentrated in four spots (a smaller antero-branchial pair and a larger postero-lateral pair) in a central butterfly-shaped gastroducardiac mark, and along the lateral edges of the antero-lateral teeth; chelipeds with dark red-brown marking on dorsal longitudinal ridges, walking legs pale orange; ventral surfaces white; female egg mass bright orange.

Other names used: *Ovalipes bipustulatus* (A. Milne-Edwards, 1861); *Ovalipes punctatus* (De Haan, 1833).

***Ovalipes elongatus* Stephenson & Rees, 1968**

NZ references: Chilton (1911: 554), as *O. bipustulatus*; Stephenson & Rees (1968: 232) fig. 1E, pl. 36, fig. B

(photo, whole animal), pls 39C–D, 42E; Stephenson (1972: 23); McLay (2004: 21); Takeda & Webber (2006: 200) fig. 5D (photo, young male); McLay (2009: 41) fig. 20a (colour photo, male).

Other significant references: Bennett (1966: 140) pl. 101a (photo, holotype from Lord Howe Island), as *Ovalipes* sp. *vide* Stephenson & Rees 1968; Davie (2002b: 460); Ng *et al.* (2008: 150).

Distribution: Kermadec Islands, northern half of the North Island; Lord Howe Island.

Colour: similar to *Ovalipes catharus* but a lot paler, and with dark areas not as strongly marked (C.L. McLay, pers. comm. 2004).

***Ovalipes mollerii* (Ward, 1933)**

NZ references: Stephenson (1972: 24); Dawson & Yaldwyn (1974: 1); McLay (1988: 210) fig. 46a (whole male) fig. 46b–d; O’Shea *et al.* (1999: 49) fig. 18 (colour photo, whole animal); Stevens *et al.* (2000: 57) (colour photo, whole animal); Davie (2002b: 460); Poore (2004: 416) fig. 131e (carapace front outline), pl. 23c (colour photo, whole animal); Ahyong (2008: 60) fig. 5B (photo, male).

Other significant references: Stephenson & Rees (1968: 237) figs 1H, 2G, 3G, 4G, pl. 37, fig. A (photo, whole animal), figs 40B, 41B, 42H; Jones & Morgan (1994: 161) fig. (colour photo, whole animal); Ng *et al.* (2008: 150).

Distribution: northern NZ, south to Chatham Rise (not known from Kermadecs), Louisville Ridge (outside NZ EEZ), shelf and slope; eastern and southeastern Australia.

Colour: carapace and 3rd and 4th walking legs pale with orange markings; cheliped hand and fingers red; dactyls and propodi of 1st and 2nd walking legs red; carapace and upper surface of chelipeds and legs strongly iridescent. Large specimens with a pair of conspicuously thin, semi-transparent areas of cuticle on posterior half of carapace.

Family GERYONIDAE Colosi, 1923

***Chaceon bicolor* Manning & Holthuis, 1989**

NZ references: Manning *et al.* (1990: 605); Dawson & Webber (1991: 2); Webber *et al.* (1990a: 10) fig. (photo, whole animal).

Other significant references: Griffin & Brown (1976: 256) figs 7–8 (photos, whole male, dorsal and ventral from Australia), fig. 9, as *Geryon affinis*; Sakai (1978: 9) figs 18, 19, pl. 2, fig. D (colour photo, whole animal from Emperor Seamount Chain), as *Geryon affinis*; Davie (2002b: 188) fig. page 187 (whole animal); Poore (2004: 406) fig. 126 (carapace); Ng *et al.* (2008: 147).

Distribution: northeast and east of North Island (not known from Kermadecs), slope (in shallower depths than *Chaceon yaldwyni*); western Pacific from eastern Australia and New Caledonia to Emperor Seamount Chain in central Pacific.
Colour: carapace varying from uniform tan to shades of purple, chelipeds and legs yellowish brown.

***Chaceon yaldwyni* Manning, Dawson & Webber, 1990**

NZ references: Manning *et al.* (1990: 602) fig. 1a (photo, whole male), figs 1b–c, 2; Takeda (1990: 376) fig. 304 (photo, whole female), as *Chaceon* sp.; Dawson & Webber (1991: 2); Ah Yong (2008: 31) fig. 17E (photo, male), fig. 28E (colour photo, male).

Other significant reference: Ng *et al.* (2008: 147).

Distribution: endemic, off eastern North Island and northeast of Chatham Islands, Louisville Ridge; 1040–1276 m.

Colour: carapace uniform yellowish red.

Family **MACROPIPIDAE** Stephenson & Campbell, 1960

***Nectocarcinus antarcticus* (Hombron & Jacquinot, 1846)**

NZ references: Dell *et al.* (1970: 54) fig. 1b (carapace outline of male), figs 2b,e, 3c–d, pl. 2 (photos, whole male, dorsal and ventral); Stephenson (1972: 21); McLay (1988: 220) fig. 49a (whole male), fig. 49b–d; Takeda (1990: 372) fig. 300 (colour photo, whole animal); McLay (2009: 46) fig. 23a–b (colour photos, immature male, female), fig. 24a–b (colour photos, mature male, female).

Other significant reference: Ng *et al.* (2008: 148).

Distribution: endemic, northern and southern NZ including Chatham and Subantarctic islands (not known from Kermadecs); sub-littoral zone to 550 m.

Colour: carapace and dorsal surface of chelipeds and walking legs mottled with dark red over a background of pinkish red; no trace of iridescence but with some white marks on ridges and spines; fingers of chelae dark red on longitudinal ridges; dark coloured tomentum on carapace and sternum gives *N. antarcticus* a ‘hairy’ rather than smooth appearance.

***Nectocarcinus bennetti* Takeda & Miyake, 1969**

NZ references: Takeda & Miyake (1969: 166) figs 3, 4a–b, pl. 2, fig. B (photo, whole male); Dell *et al.* (1970: 52) fig. 1a (carapace outline of male), figs 2a,c–d, 3a–b, pl. 1 (photos, whole male, dorsal and ventral); McLay (1988: 224) fig. 50a (whole male), fig. 50b–d; Takeda (1990: 373) fig. 301 (colour photo, whole animal).

Other significant reference: Ng *et al.* (2008: 148).

Distribution: endemic, southern NZ from Chatham Rise south to Campbell Island; sublittoral zone to 480 m.

Colour: carapace and dorsal surface of chelipeds mainly purplish red with areas of pink iridescence; walking legs and ventral surfaces of body and legs pale off-white to dirty cream; main areas of iridescence are across front of carapace, in a broad band along each antero-lateral margin, and over entire dorsal surface of cheliped wrist, palm and free finger; very little dark tomentum present on carapace or sternum gives *Nectocarcinus bennetti* a smooth rather than ‘hairy’ appearance, in contrast to *N. antarcticus*.

Family **PORTUNIDAE** Rafinesque, 1815
 Subfamily **CAPHYRINAE** Paulson, 1875

***Capbyra acheronae* Takeda & Webber 2006**

NZ reference: Takeda & Webber (2006: 198) fig. 4A–D (photos, male holotype, dorsal and antero-ventral, female paratype, dorsal and antero-dorsal).

Distribution: endemic, Kermadec Islands.

Subfamily **NECRONECTINAE**
 Glaessner, 1928

***Scylla serrata* (Forskål, 1775)**

NZ references: Dell (1964b) figs 59–60 (photo, carapace); Manikiam (1967) fig. 1 (photo, whole animal); Poore (2004: 42) fig. 133b–d (carapace outline, cheliped).

Other significant references: Stephenson & Campbell (1960: 111) fig. 2N, pl. 4, fig. 4 (photo, whole animal), figs 5N, 6C; Jones & Morgan (1994: 156) fig. (colour photos, whole animal); Davie (2002b: 470) fig. page 462 (whole animal); Ng *et al.* (2008: 153).

Distribution: northern NZ mainland, possibly recently introduced naturally or accidentally, and possibly more than once (breeding in NZ waters not yet proven); Indo-West Pacific from east Africa to Australia, Japan and French Polynesia; estuarine, burrowing in intertidal zone and shallow water.

Colour: variable, dark green or purplish brown with paler patches on chelipeds and walking legs (Australian specimens).

Subfamily **PORTUNINAE** Rafinesque, 1815

***Portunus pelagicus* (Linnaeus, 1758)**

NZ references: Dell (1964a: 303) fig. (photo, whole animal); McLay (1988: 212) fig. 47a (whole male), fig. 47b–c; Poore

(2004: 419) fig. 132e (carapace), pl. 23d–e (colour photos, live animals in defensive and burrowing postures).

Other significant references: Stephenson & Campbell (1959: 96) figs 2A, 3A, 4A, 5A, pl. 1, fig. 1; Jones & Morgan (1994: 159) fig. (colour photo, whole animal); Davie (2002b: 467); Ng *et al.* (2008: 152).

Distribution: northern NZ mainland, possibly recently introduced naturally or accidentally, and possibly more than once (may not breed in NZ waters); Indo-West Pacific from east Africa to Japan, Australia and French Polynesia; intertidal zone and shallow water.

Colour: carapace purplish brown with variable symmetrical blue mottling; chelipeds and walking legs purple to blue with pale mottling (Australian specimens).

Subfamily THALAMITINAE Paulson, 1875

Charybdis japonica (A. Milne-Edwards, 1861)

NZ references: Webber (2001: 80) figs 1–2 (colour photos, whole male dorsal and ventral), as *Charybdis* sp.; Gust (2002: 3) (large numbers of *Charybdis japonica* taken in Waitemata Harbour during NIWA biosecurity survey in April 2002); Smith *et al.* (2003: 753) fig. 2A–D (colour photos, whole animals), fig. 3A–D, F–G; Poore (2004: 425) fig. 135d (carapace outline), fig. 137a,g (antenna and cheliped).

Other significant references: Leene (1938: 30) fig. 5 (whole female), figs 6–7; Sakai (1965: 121) pl. 59, fig. 1 (colour illustration, whole animal); Sakai (1976: 355) pl. 123, fig. 1 (colour illustration, whole male); Wee & Ng (1995: 34) fig. 15A (whole female), fig. 15B–E; Ng *et al.* (2008: 153).

Distribution: Waitemata Harbour, Firth of Thames; Red Sea to Southeast Asia, China and Japan; shallow coastal waters.

Colour of NZ specimens: pattern of colour and markings constant but colour and intensities variable; dorsal surfaces of carapace and appendages from pale green and off-white through olive green to deep chestnut with purple markings. Light yellowish-orange markings present towards tips of legs and inner cheliped, ranging to more extensive areas of orange-chestnut dorsally on appendages and carapace. Ventral surfaces of body and appendages white to off-white. Hands with free fingers dark pinkish olive, teeth along cutting edge of fixed fingers and often entire distal third of each fixed finger similarly dark pinkish olive.

Thalamita danae Stimpson, 1858

NZ reference: McLay (2009: 46) fig. 22a (photo, male, from Stephenson & Hudson 1957: pl. 3, fig. 1).

Other significant references: Stephenson (1972: 46); Davie (2002b: 478) fig. page 471 (whole animal); Poore (2004: 429) fig. 136a (carapace outline), fig. 137n (chela); Ng *et al.* (2008: 154).

Distribution: Kermadec Islands; Indo-West Pacific from Red Sea to Japan and French Polynesia.

Thalamita macropus Montgomery, 1931

NZ reference: Takeda & Webber (2006: 201) fig. 5C (photo, male).

Other significant references: Stephenson (1972: 46); Davie (2002b: 479); Poore (2004: 429) fig. 136c (carapace outline); Ng *et al.* (2008: 154).

Distribution: Kermadec Islands; Abrolhos Islands (Western Australia) around Northern Territory to New South Wales.

Superfamily TRAPEZIOIDEA Miers, 1886

Family TRAPEZIIDAE Miers, 1886

Subfamily CALOCARCININAE Števcic, 2005

Calocarcinus africanus Calman, 1909

NZ reference: Ahyong (2009a: 66) fig. 1D (juvenile female).

Other significant reference: Ng *et al.* (2008: 185).

Distribution: Kermadec Islands; western Indian Ocean to western Pacific Ocean.

Subfamily TRAPEZIINAE Miers, 1886

Trapezia cymodoce (Herbst, 1801)

NZ reference: Takeda & Webber (2006: 221) fig. 15C (photo, small male, dorsal).

Other significant references: Davie (2002b: 498) fig. page 493 (whole animal); Poore (2004: 480) fig. 152b (carapace and chelipeds outline); Ng *et al.* (2008: 186).

Distribution: Kermadec Islands; Western Australia, Indo-West Pacific.

Trapezia guttata Rüppell, 1830

NZ reference: Takeda & Webber (2006: 221).

Other significant references: Davie (2002b: 500); Ng *et al.* (2008: 186).

Distribution: Kermadec Islands; Indo-West Pacific.

Trapezia septata Dana, 1852

NZ references: Chilton (1911: 556), as *Trapezia ferruginia* var. *areolata* Dana, 1852; Takeda & Webber (2006: 221).

Other significant references: Davie (2002b: 501); Poore (2004: 481) fig. 152d (carapace and chelipeds outline); Ng *et al.* (2008: 186).

Distribution: Kermadec Islands; Indo-West Pacific.

Superfamily XANTHOIDEA MacLeay,
1838

Family XANTHIDAE MacLeay, 1838

Subfamily ACTAEINAE Alcock, 1898

Gaillardiellus bathus Davie, 1997

NZ reference: Takeda & Webber (2006: 204) fig. 7A (photo, female).

Other significant references: Davie (1997: 339) fig. 1a–g (male holotype diagnostic characters), fig. 15c (photo, male holotype); Ng *et al.* (2008: 195).

Distribution: Kermadec Islands; New Caledonia.

Gaillardiellus rueppelli (Krauss, 1843)

NZ reference: Takeda & Webber (2006: 204) fig. 7B (photo, male).

Other significant references: Davie (2002b: 514); Ng *et al.* (2008: 195).

Distribution: Kermadec Islands; Indo-West Pacific from South Africa to Japan and Australia.

Subfamily ANTROCARCININAE
Ng & Chia, 1994

Antrocarcinus petrosus Ng & Chia, 1994

NZ reference: Takeda & Webber (2006: 201) fig. 6A (photo, male).

Other significant references: Ng & Chia (1994: 707) figs 1A–C, 2A–C, 3A–C (photos, male holotype and female paratype, dorsal, frontal, ventral, and chelae), fig. 4 (diagnostic characters); Ng *et al.* (2008: 196).

Distribution: Kermadec Islands; New Caledonia.

Subfamily CHLORODIELLINAE
Ng & Holthuis, 2007

Pilodius nigrobrinitus Stimpson, 1859

NZ references: Chilton (1911: 557), as *Chlorodopsis melanochira* A. Milne-Edwards, 1873; Sakai (1976: 461) fig. 284a–b (male and male pleopod), pl. 164 fig. 2 (colour painting, male); Takeda & Webber (2006: 233).

Distribution: Kermadec Islands; western Pacific from Japan to Australia and east to Fiji; shallow rocky waters.

Subfamily EUXANTHINAE Alcock,
1898

Medaeops serenei Ng & McLay, 2007

NZ reference: Ng & McLay (2007: 44) fig. 4A–C (photos, holotype male, dorsal, frontal and ventral), fig. 5A–B (photos, paratype female chelae), fig. 6A–E (carapace and chelae), fig. 7A–E (appendages).

Distribution: endemic, Kermadec Ridge.

Miersiella haswelli (Miers, 1886)

NZ references: Takeda & Webber (2006: 208) fig. 9B (photo, male); Ah Yong (2008: 61), fig. 5F (photo, male), fig. 29E–F (colour photos, male, ovigerous female).

Other significant references: Davie (2002b: 536); Poore (2004: 472) fig. 150f (carapace); Ng *et al.* (2008: 199).

Distribution: Kermadec Islands; Japan, Christmas Island (Indian Ocean), New South Wales.

Subfamily LIOMERINAE T. Sakai, 1976

Liomera yaldwyni Takeda & Webber, 2006

NZ reference: Takeda & Webber (2006) fig. 8A–B (photo, male holotype, dorsal).

Other significant reference: Ng *et al.* (2008: 201).

Distribution: endemic, Kermadec Islands.

Subfamily POLYDECTINAE Dana, 1851

Lybia leptochelis (Zehntner, 1894)

NZ reference: Takeda & Webber (2006: 208) fig. 9A (photo, male dorsal, with appendages detached).

Other significant reference: Ng *et al.* (2008: 201).

Distribution: Kermadec Islands; Fiji to Indonesia.

Subfamily XANTHINAE MacLeay, 1838

Euryxanthops chiltoni Ng & McLay, 2007

NZ reference: Ng & McLay (2007: 38) fig. 1A–C (photos, holotype female, dorsal and frontal, buccal cavity), fig. 2A–C (photos, holotype female, ventral, and chelae), fig. 3A–F (holotype female carapace, appendages).

Distribution: endemic, Kermadec Islands.

Leptodius nudipes (Dana, 1852)

NZ references: Chilton (1911: 555), as *Xantho*; Takeda & Webber (2006: 233).

Other significant references: Davie (2002b: 551); Ng *et al.* (2008: 203).

Distribution: Kermadec Islands; West Pacific.

***Nanocassiope* sp.**

NZ reference: Takeda & Webber (2006: 210) (identification tentative; more material required).

Distribution: Kermadec Islands.

***Pseudoliomera helleri* (A. Milne-Edwards, 1865)**

NZ reference: Takeda & Webber (2006: 212) fig. 9C–D (photos, male, dorsal, and female, antero-ventral).

Other significant references: Davie (2002b: 516); Poore (2004: 464) fig. 148e (chela); Ng *et al.* (2008: 196).

Distribution: Kermadec Islands; Indo-West Pacific.

***Serenius actaeoides* (A. Milne-Edwards, 1873)**

NZ references: Chilton (1911: 557), as *Lophactaea*; Takeda & Webber (2006: 233).

Distribution: Kermadec Islands; Indo-West Pacific.

***Xanthias dawsoni* Takeda & Webber, 2006**

NZ reference: Takeda & Webber (2006: 212) fig. 11A–B (photos, male holotype, dorsal and ventral), fig. 12A–C (photos, male paratypes, dorsal and ventral).

Other significant reference: Ng *et al.* (2008: 204).

Distribution: endemic, Kermadec Islands.

***Xanthias lamarckii* (H. Milne Edwards, 1834)**

NZ references: Chilton (1911: 556), as *Xanthodes*; Takeda & Webber (2006: 233).

Other significant references: Davie (2002b: 555) fig. page 505 (whole animal); Poore (2004: 474); Ng *et al.* (2008: 204).

Distribution: Kermadec Islands; Indo-West Pacific.

Subfamily ZALASIINAE Serène, 1968

***Banareia armata* A. Milne-Edwards, 1869**

NZ references: Chilton (1911: 557); Takeda & Webber (2006: 233).

Other significant references: Davie (2002b: 557); Ng *et al.* (2008: 205).

Distribution: Kermadec Islands; Indo-West Pacific.

***Banareia banareias* (Rathbun, 1911)**

NZ reference: Takeda & Webber (2006: 204) fig. 6B–C (photos, female, dorsal and frontal).

Other significant references: Davie (2002b: 558); Ng *et al.* (2008: 205).

Distribution: Kermadec Islands; Indo-West Pacific.

Subfamily ZOSIMINAE Alcock, 1898

***Platypodia delli* Takeda & Webber, 2006**

NZ reference: Takeda & Webber (2006: 210) fig. 10A–D (photos, male holotype, dorsal, chelae and P5).

Other significant reference: Ng *et al.* (2008: 206).

Distribution: endemic, Kermadec Islands.

Subsection THORACOTREMATA Guinot, 1977

Superfamily CRYPTOCHIROIDEA Paul'son, 1875

Family CRYPTOCHIRIDAE Paul'son, 1875

***Cryptochirus coralliodytes* Heller, 1861**

NZ references: Chilton (1911: 561); Takeda & Webber (2006: 234).

Other significant references: Fize & Serène (1957: 31) figs 4A–D, 5A–E (carapace outlines), pl. 1, figs 3–6 (including photos of female and male carapace), pl. 2, figs 1–2 (photos, whole female, dorsal and ventral), pl. 3 (photo, whole male), pl. 10, fig. A (photo, typical hole bored in brain coral), pl. 14, figs A–H (including colour illustrations of whole males and females); Davie (2002b: 142); Poore (2004: 483) fig. 153 (whole animal); Ng *et al.* (2008: 212).

Distribution: Kermadec Islands; Indo-West Pacific from east Africa to northeastern Australia and Hawai'i; lives exclusively in brain corals of the family Faviidae.

Colour: variable, several colour forms recorded; carapace usually pale greenish grey, cornea black, cheliped hands dark with longitudinal red streaks (Vietnamese specimens).

Superfamily GRAPSOIDEA MacLeay, 1838

Family GRAPSIDAE MacLeay, 1838

***Geograpsus grayi* (H. Milne Edwards, 1853)**

NZ references: Chilton (1911: 560); Takeda & Webber (2006: 225) fig. 18B (photo, male).

Other significant references: Banerjee (1960: 159) figs 1f, 3n–p; Crosnier (1965: 18) fig. 13 (carapace outline), figs 14, 17–18; Davie (2002b: 213); Ng *et al.* (2008: 216).

Distribution: only land crab in NZ EEZ, burrowing in forest and rocky slopes on Sunday, Meyer and Herald islands in northern Kermadecs (Chilton 1911a), and on Macauley and Curtis islands in southern Kermadecs (JCY collections, November 1970); Indo-West Pacific, from east Africa to Australia, Japan and Polynesia.

***Leptograpsus variegatus* (Fabricius, 1793)**

NZ references: Chilton (1911: 560); Morton & Miller (1968: 89) pl. 22, fig. 5 (colour illustration, whole animal); Griffin (1973: 416) figs 1–3 (carapace outlines, showing changes in carapace shape with growth), figs 4–5, 6 left (photo, whole male), fig. 6 right (Australian specimens); Miller &

Batt (1973: 65) fig. 13 (colour photo, whole male); McLay (1988: 266) fig. 59a (whole male), fig. 59 b–c; Walsby (1990: 114–115) figs (colour photos, live specimens feeding); Takeda & Webber (2006: 225) fig. 18C (photo, young female).

Other significant references: Jones & Morgan (1994: 182–183) (colour photos, live animals); Davie (2002b: 215); Poore (2004: 507) fig. 161c,g (carapace, orbit), fig. 162f (male abdomen); Ng *et al.* (2008: 217).

Distribution: North Island and northern part of South Island (south to Kaikoura and Westport), Kermadec Islands, intertidal zone on rocky shores, occasionally ranging a little above high-tide level; Australia (Western, southern and eastern), Middleton Reef (north of Lord Howe Island), Norfolk Island, Easter Island, Juan Fernandez Islands, and west coast of South America from Paita, Peru, south to Valparaiso, Chile.

Colour: variable; carapace red and yellow, mixed or dotted with violet-red, or sometimes whitish. Some specimens bluish grey, transversely lined and blotched with black or red; cheliped palm, fixed finger and outer surface of hand white.

***Pachygrapsus minutus* A. Milne-Edwards, 1873**

NZ reference: Takeda & Webber (2006: 227) fig. 20A (photo, male).

Other significant references: Davie (2002b: 218) fig. page 212 (whole animal); Ng *et al.* (2008: 217).

Distribution: Kermadec Islands; widespread in Indo-West Pacific.

***Planes major* (MacLeay, 1838)**

NZ references: Dell (1968: 21); McLay (1988: 318) fig. 67a (whole male), fig. 67b–d; Walsby (1990: 123) fig. (colour photo, live animal among goose barnacles on flotsam), as *P. cyaneus*; Takeda & Webber (2006: 229) fig. 20C (photo, female).

Other significant references: Chace (1951: 88) fig. 1b (whole male), figs 2b,e,h,m–o, 3i–n (carapace outlines, showing changes with growth); Sivertsen & Holthuis (1956: 50) pl. 1 fig. 4, pl. 2, figs 1–4 (all figs colour illustrations of whole crab), as *P. minutus*; Davie (2002b: 219); Poore (2004: 508) fig. 161e (carapace), fig. 162c (walking leg); Ng *et al.* (2008: 217).

Distribution: North Island south to a little north of Cook Strait, Kermadec Islands; Indo-West Pacific, east Pacific, and North and South Atlantic, from Madagascar to Western and eastern Australia, Japan, Hawai'i, west coast of North and South America, Caribbean, Azores, Madeira

and Canary Islands in the mid-Atlantic, and from St Helena in the South Atlantic; oceanic, often washed ashore clinging to floating objects.

Colour: variable and usually protective, matching floating flotsam to which they are clinging. Overall colours recorded include blue, greenish, bluish grey mottled with brown, yellowish clouded with brown, and reddish brown.

***Planes marinus* Rathbun, 1914**

NZ references: Dell (1963c: 180) fig. 1 (whole male), figs 2–3, as *Pachygrapsus marinus*; Chace (1966: 646); Dell (1968: 21); McLay (1988: 322) fig. 68a (whole male), fig. 68b–d; Takeda & Webber (2006: 229) fig. 20B (photo, male).

Other significant references: Chace (1951: 92) fig. 1c (whole male), figs 2c,f,i,p,q,r, 3o–t (carapace outlines, showing changes with growth), as *Pachygrapsus marinus*; Ng *et al.* (2008: 217).

Distribution: North Island south to Cook Strait, Kermadec and Chatham islands; Indo-West Pacific, east Pacific and South Atlantic including St Helena, from Madagascar to Australia, Japan and west coast of North America; oceanic, often washed ashore clinging to floating objects.

Colour: dark reddish brown.

Family **PLAGUSIIDAE** Dana, 1851
Subfamily **PERCNINAE** Števcíć, 2005

***Percnon planissimum* (Herbst, 1804)**

NZ references: Chilton (1911: 559), as *P. pilimanus*; Takeda & Webber (2006: 227) fig. 19A (photo, male); McLay (2009: 49) fig. 25a–b (colour photos, male and female), fig. 26a–b (colour photos, live specimens in habitat at Poor Knights Islands).

Other significant references: Edmondson (1959: 194) figs 24, 25a (photo, whole animal), as *P. pilimanus*; Crosnier (1965: 86) fig. 132 (carapace outline), figs 133, 137, 142, 147, 148, pl. 7 fig. 1 (photo, whole animal as *P. affine*); Davie (2002b: 439) fig. page 436 (whole animal), as *P. affine*; Ng *et al.* (2008: 219).

Distribution: Kermadec Islands and northern North Island; widespread throughout Indo-West Pacific.

Subfamily **PLAGUSIINAE** Dana, 1851

***Miersiograpsus australiensis* Türkay, 1978**

NZ reference: Ahyong (2008: 60) fig. 5D (photo, male).

Other significant references: Davie (2002b: 438); Poore (2004: 513) fig. 164e (carapace and chelae outline); Ng *et al.* (2008: 218).

Distribution: east of North Island; southeastern Australia, New Caledonia.

***Plagusia chabrus* (Linnaeus, 1758)**

NZ references: Heath & Dell (1971: 38) fig. 111 (colour illustration, whole animal); Griffin (1973: 426) figs 7a–g, i–n, p–u, 8a, c–g, 9a–f, 10a–c, 14A (photo, whole male), fig. 15A; Dell (1974: 1241) (colour photo, live animal in crevice); Dawson (1987: 40); McLay (1988: 272) fig. 60a (whole male), fig. 60b–e; Walsby (1990: 113) (colour photos, live animals); Poore (2004: 513) fig. 164a–b (whole animal, chela), pl. 29g (colour photo, live animal, frontal); Takeda & Webber (2006: 227) fig. 19B (photo, male).

Other significant references: Davie (2002b: 440); Ng *et al.* (2008: 218).

Distribution: North, South, Kermadec and Chatham islands, low-tide level on rocky shores down to about 25 m; Indo-West Pacific and east Pacific, both west and east coasts of South Africa to Western, southern and eastern Australia, Lord Howe and Norfolk islands, Tonga, Juan Fernandez Islands and Chile.

Colour: carapace, chelipeds and legs various shades of red, naked ridges on dorsal surfaces darker, ridges and tubercles on front and chelipeds white; setae yellowish; ventral surfaces pale or cream.

***Plagusia dentipes* De Haan, 1835**

NZ references: Chilton (1911: 558); Dawson (1987: 41).

Other significant references: Sakai (1965: 205) pl. 99 (colour illustration, whole male); Griffin (1973: 434) figs 7h, o, v, 8b, h, 9g, 10d–f, 14B (photo, whole male), fig. 15B; Davie (2002b: 440); Ng *et al.* (2008: 218).

Distribution: Kermadec Islands, intertidal on rocky shores (not known from NZ mainland, Chatham Islands or Subantarctic Islands); western Pacific from Japan, Korea and Taiwan to Norfolk and Lord Howe islands, and to Easter Island.

Colour: carapace, chelipeds and walking legs with irregular patchwork of red and purple; ridges and tubercles on front and hands white.

***Plagusia squamosa* (Herbst, 1790)**

NZ references: Chilton (1911: 558), as *P. tuberculata*; Foster & Willan (1979: 147) fig. 3h (photo, whole animal); Dawson (1987: 42) fig. 1a (photo, whole animal with legs detached, dorsal), fig. 1b (photo, whole animal, ventral view), fig. 1c–f, as *P. depressa tuberculata*; McLay (1988: 276) fig. 61a–b (whole male), as *P. depressa tuberculata*;

Takeda & Webber (2006: 229) fig. 19C (photo, male), as *Plagusia tuberculata* Lamarck, 1818.

Other significant references: Crosnier (1965: 80) pl. 7, fig. 3 (photo, whole carapace); Sakai (1965: 206) pl. 100, fig. 1 (colour illustration, whole male); Tinker (1965: 126) fig. 51 (photos, whole male, dorsal and ventral); Schubart & Ng (2000: 334) fig. 3A (photo, whole male lectotype), fig. 3B (photo, whole female paralectotype); Davie (2002b: 441); Ng *et al.* (2008: 218).

Distribution: Kermadec Islands on subtidal rocks, northern NZ off Whangarei on long-line floats and off Taranaki on oil-platform piles (Maui Field); Indo-West Pacific and east Pacific, from east Africa, Red Sea and Indian Ocean to Australia, Norfolk Island, Indonesia, Japan, Hawai'i and Baja California, often found on driftwood.

Colour: carapace, chelipeds and walking legs reddish purple; cheliped fingers and palm pale; setae on carapace yellow.

Family **VARUNIDAE** A. Milne-Edwards, 1853

Subfamily **CYCLOGRAP SINAE**

H. Milne Edwards, 1853

***Austrohelice crassa* (Dana, 1851)**

NZ references: Beer (1959: 197) fig. 1A (illustration, threat attitude), fig. 1C (illustration, ritualised fighting); Fielder & Jones (1978: 41) fig. 1 (illustration, feeding pose), fig. 2, as *Helice crassa*; McLay (1988: 294) fig. 64a (whole male), fig. 64b, as *Helice crassa*; Walsby (1990: 118–119) (several colour photos, live animals), as *Helice crassa*.

Other significant reference: Ng *et al.* (2008: 226).

Distribution: endemic, North and South islands (not known from Kermadecs); intertidal zone, burrowing in estuarine mud and sand flats (e.g. Nye 1977: fig. 2).

Colour: carapace grey to olive green, blue-green and brown, margins yellow; chelipeds and walking legs dark green, edged with yellow.

***Cyclograpsus insularum* Campbell & Griffin, 1966**

NZ references: Campbell & Griffin (1966: 156) figs 2C, 7, pl. 21, fig. 4 (photo, whole animal), pl. 23, fig. 8; Dell & Marshall (1967: 1) fig. 2 (carapace outline); Bacon (1971: 415) fig. 1 lower (photo, whole animal), table 1; McLay (1988: 306) fig. 65a (whole animal), fig. 65b–e; Davie (2002b: 209); Takeda & Webber (2006: 225) fig. 18A (photo, male).

Other significant reference: Ng *et al.* (2008: 226).

Distribution: North Island from North Cape to East Cape, Kermadec Islands, under stones at high water neap-tide

level to mid-tide level (e.g. Bacon 1971: fig. 5); Lord Howe and Norfolk islands, eastern Australia.

Colour: anterior half of carapace brown or purple, grading to pale brown posteriorly; large specimens may be fawn.

***Cyclograpsus lavauxi* H. Milne Edwards, 1853**

NZ references: Campbell & Griffin (1966: 143) figs 3B, 5B, pl. 20, fig. 4 (photo, whole animal), pl. 23, fig. 4; Dell & Marshall (1967: 2) fig. 1 (carapace outline); Bacon (1971: 415) fig. 1 upper (photo, whole animal), table 1; McLay (1988: 310) fig. 66a (whole male), fig. 66b–c; Walsby (1990: 112) (colour photo, live animal).

Other significant reference: Ng *et al.* (2008: 226).

Distribution: endemic, Kermadecs, North and South islands; high-tide level, overlapping with *Cyclograpsus insularum* but usually higher on shore.

Colour: carapace varying from slate blue through bluish grey and fawn to yellowish brown, speckled with dark reddish brown, pale ventrally.

Subfamily VARUNINAE

H. Milne Edwards, 1853

***Hemigrapsus crenulatus* (H. Milne Edwards, 1837)**

NZ references: Bennett (1964: 81) figs 95, 136 (photos, whole animal); McLay (1988: 286) fig. 63a (whole male), fig. 63b–d.

Other significant references: Rathbun (1918: 266) pl. 68 (whole male, dorsal and ventral, from Patagonia); Garth *et al.* (1967: 184); Retamal (1981) fig. 196 (whole animal from Chile); Ng *et al.* (2008: 228).

Distribution: northern and southern NZ (not known from Kermadecs), mid-tide level and very shallow water, estuaries and sheltered harbours; southern Chile and west coast of Patagonia.

Colour: carapace greenish yellow with white patches, covered with very small dark purple or reddish-brown spots; upper surface of chelipeds marked with dark purple-brown, fingers white with dark brown tips; inner surface of cheliped palm and fingers with obvious mat of dense hairs (hence its common name of hairy-handed crab).

***Hemigrapsus sexdentatus* (H. Milne Edwards, 1837)**

NZ references: Richardson (1949: 130); Bennett (1964: 82) figs 94, 137, 138 (photos, whole ovigerous female, dorsal and ventral); Morton & Miller (1968: 89) pl. 23, fig. 1 (colour illustration, whole animal), as *H. edwardsii*; Miller & Batt (1973: 73) fig. 89 (colour photo, whole animal), as *H. edwardsii*; Gunson (1993: 53) (colour illustration,

whole animal); McLay (1988: 280) fig. 62a–d (whole male), as *H. edwardsii*; Walsby (1990: 123) upper fig., as *H. edwardsii*; McLay & Schubart (2004: 699) (synonymy, record as *H. sexdentatus*) fig. 1 (photo, male).

Other significant reference: Ng *et al.* (2008: 228).

Distribution: endemic, northern and southern NZ (not known from Kermadecs); commonest NZ shore crab, high-tide to mid-tide level on sheltered rocky, stony or muddy shores.

Colour: two different colour types are known. Lightly coloured crabs have extensive light or dark chestnut-red markings on carapace and chelipeds over a grey or cream background; dark-coloured crabs have extensive dark purple or purplish black markings on carapace and chelipeds, as well as banded walking legs; cheliped fingers and lower parts of palm in both colour types white.

Family XENOGRAPSIDAE Ng, Davie,
Schubart & Ng, 2007

***Xenograpsus ngatama* McLay, 2007**

NZ references: McLay (2003: 13) fig. (colour photo, whole animal); McLay (2007: 15) fig. 6A–F, 7A–E (carapace and appendages), figs 8A–B, 9A–B (photos, male holotype, dorsal and frontal); Ah Yong (2008: 61) fig. 5E (photo, male).

Other significant reference: Ng *et al.* (2008: 232).

Significant reference to genus Xenograpsus: Takeda & Kurata (1977: 100) (*Xenograpsus* n. gen. from volcanically active, newly formed island in the Ogasawara or Bonin Islands south of Tokyo).

Distribution: endemic, southern Kermadec Ridge.

Colour: complex pattern of symmetrical red markings on pinkish-yellow background across dorsal surface of carapace and legs (from photo of preserved specimen in McLay 2003).

Superfamily OCYPODOIDEA

Rafinesque, 1815

Family MACROPHTHALMIDAE

Dana, 1851

Subfamily MACROPHTHALMINAE

Dana, 1851

***Macrophthalmus (Hemiplax) hirtipes* (Jacquinot, 1853)**

NZ references: Beer (1959: 197) fig. 1B (threat behaviour), fig. 1D (ritualised fighting), as *Hemiplax hirtipes*; Barnes (1967: 236) fig. 12a–d, pl. 3, fig. D (whole male); Nye

(1974: 244) fig. 2 (photos, burrow excavation); McLay (1988: 336) fig. 71a (whole male), fig. 71b–c.

Other significant reference: Ng *et al.* (2008: 237).

Distribution: endemic, North and South islands (not known from Kermadecs), burrowing from mid- to low-tide level in mudflats of harbours and estuaries, also at shallow-water depths (30–40 m) at hydrothermal vents in Bay of Plenty.

Colour: carapace dark green with scattered dark brown spots, margin dark brown, eye stalks white with dark brown patches, legs yellow-green, and chelipeds red dorsally and white ventrally.

Family OCYPODIDAE Rafinesque, 1815

Subfamily OCYPODINAE Rafinesque, 1815

Ocypode pallidula Jacquinot, 1846

NZ references: Takeda & Webber (2006: 223) fig. 17A–C (photos, male, dorsal and ventral, and chela); McLay (2009: 53) fig. 27a–b (colour photos, female, dorsal and ventral), fig. 28a–b (colour photos, male and female, frontal), fig. 29a–b (colour photo, male, frontal; chelae with stridulating ridges).

Other significant references: Davie (2002b: 358); Ng *et al.* (2008: 240).

Distribution: Kermadec Islands; widespread intertidal species of the Indo-West Pacific.

Superfamily PINNOTHEROIDEA

De Haan, 1833

Family PINNOTHERIDAE De Haan, 1833

Subfamily PINNOTHERINAE De Haan, 1833

Nepinnotheres atrinicola Page, 1983

NZ references: Page (1983: 158) fig. 2I–J (stage one zoea), fig. 3A (whole hard-stage male), fig. 3B–H (whole mature female), fig. 3I–J; McLay (1988: 326) fig. 69a (whole hard-stage male, after Page 1983), fig. 69b–d (whole mature female, after Page 1983), fig. 69e–g (specific name incorrectly spelt ‘*atrinicola*’) (all references as *Pinnotheres*); Ahyong & Ng (2008: 67) (justification for transferring it to *Nepinnotheres*).

Distribution: endemic, North and South islands (not known from Kermadecs); typically commensal, however, McLay (1988: 328) prefers to call pinnotherids ‘parasitic’. Recorded in the horse mussel *Atrina zelandica*, but has been found in several ‘surf clam’ species; intertidal zone and on shelf.

Colour: males have a pale orange carapace with grey or cream splotches separated by orange bands, and with an orange stripe along centre; chelipeds orange with grey patches; walking legs with orange margins or banded orange and grey. Mature females unpigmented.

Nepinnotheres novaezelandiae Filhol, 1885

NZ references: Scott (1961: 307) fig. 1 (outline of pigmented carapace), figs 4, 6; Jones (1977: 145) fig. 1a (whole pre-hard stage), figs 1b–h, 2a–i, 3a (whole hard-stage male), figs 3b–j, 4a–i, 5a–b (whole female), figs 5c–g, 6a–d, 7a–e (whole adult female, combined dorsal and ventral views); Page (1983: 152) fig. 1A (whole hard-stage male), figs 1B–H (whole mature female), figs 1I–J, 2A–H (stage one zoea); McLay (1988: 330) fig. 70a (whole hard-stage male, after Page 1983), fig. 70b–d (whole mature female, after Page 1983), fig. 70e–g; Walsby (1990) fig. page 116 (colour photo, whole dead male and ovigerous female in the mussel *Perna canaliculus*), fig. page 117 (colour photo, whole live animal in *Perna*); Palmer (1995: 1071); Davie (2002b: 433) (all references as *Pinnotheres*); Ahyong & Ng (2008: 67) (first report of an androgynous male of this species, and justification for transferring it to *Nepinnotheres*).

Distribution: endemic, North, South and Chatham islands (not known from Kermadecs), typically commensal (or ‘parasitic’) in mussels *Perna canaliculus* and *Mytilus galloprovincialis*, but has been found in other bivalves (e.g. *Crassostrea*, *Paphies*, *Austrovenus*); intertidal zone and shallow shelf.

Colour: anterior half of carapace in hard-stage males and females orange-brown with white spots and cream areas, posterior half with white spots on a mauve and yellow background, chelipeds yellowish brown; mature females creamy white.

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